

## THE UPPER LIMIT: AN ESSAY ON MENTAL INTEGRITY AND MENTAL ENHANCEMENT

HENRIQUE MANUEL GIL MARTINS<sup>1,2,3</sup>

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<sup>1</sup> ISCTE-Instituto Universitário de Lisboa, Lisboa, Portugal  
henrique@henriquemartins.eu

<sup>2</sup> Universidade da Beira Interior, Covilhã, Portugal,  
henrique@henriquemartins.eu

<sup>3</sup> ISCTE-IUL, Avenida das Forças Armadas, Lisboa, Portugal  
henrique@henriquemartins.eu

CORRESPONDING AUTHOR

henrique@henriquemartins.eu

**Abstract** Brain Computer Interface (BCI) technology is currently used for therapeutic ends but can also be used for enhancing human mental capacities. This essay focuses on non-therapeutic enhancements to human mental capacities using BCI. Being a digital tool, BCI increasingly embeds artificial intelligence. The primary focus is on Digital Direct Mental Enhancements (DDME) situations where the brain is physically connected to a computer and in particular the cognitive functions are targeted. If there is to be an impact on mental capacities, a BCI is always a breach of physical, and potentially also of mental integrity. If we entertain the idea that to have mental integrity is to attain the highest possible level of cognitive capacity, when compared with other humans, then mental enhancement per se could be a way to ensure such integrity rather than only as something that poses a threat to it. The upper limit (of our mental capacities) is at the core of any serious enhancement discussion. A better theory of “mental integrity” is needed to deeply tackle the challenges and potential opportunities posed by novel BCI and their capacity to offer humans not only restorative solutions but also true enhancements of mental capacities.

**Keywords**  
computer,  
brain,  
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law,  
state

## 1 Introduction

The human brain can carry out incredibly diverse and complex functions. Consciousness relates to high-level cognitive, perceptual, and emotional brain functions. This, in turn, relates to mental integrity that could be subject to mental enhancement.

Brain-computer interfaces (BCIs) are communication systems in which messages or commands that an individual sends to the external world do not pass through the brain's normal output pathways of peripheral nerves and muscles, enabling users to send messages or commands directly through brain activity, without any movement. Most BCI systems aim to help persons with severe movement disability by replacing or restoring lost movements (Coscia et al., 2019). BCIs activate or deactivate assistive or rehabilitative devices directly through the brain activity of the user (usually neuroelectric or neurometabolic) without a motor output. BCIs aimed at restoration of movement, however, were built in the tradition of tuning functions of sensor-motor neurons representing different movement directions (Birbaumer et al., 2009). One might say BCI provides its user with an alternative method for acting on the world.

Regarding the machine component, of particular interest are BCIs when computer machines can augment, replace, or otherwise enhance cognitive functions (Dresler et al., 2018), especially those making use of artificial intelligence (AI) tools (often referred to as neurotechnologies) (Goering et al., 2021). AI methodologies have been associated with providing computers with multiple novel functions, such as increased distinction, discrimination, optimization, forecast or prediction, amongst others; but also pose a set of ethical issues that need to be tackled (van Wynsberghe, 2020). So, the focus of this article is on BCI using AI-embedded technologies for the enhancement of human higher mental functions.

BCI technologies are already commonly used in the treatment of deafness, Parkinson's disease, and depression (Berger et al., 2008). Among the most well-established BCIs are the cochlear prostheses that are used to restore hearing in patients suffering from deafness. BCIs are also considered promising future tools for the management of patients with neurological conditions, particularly those who are severely disabled (Awan et al., 2009).

Transcranial magnetic stimulation (TMS) can be seen as a partial BCI since, for the most part, the communication is unidirectional. It is a non-invasive procedure that produces a magnetic field to modulate the excitability of the brain cortex. TMS is used for the treatment of psychiatric diseases such as obsessive-compulsive disorder (OCD), chronic depression and recently, minimally conscious state. TMS can selectively enhance the working verbal memory, and repetitive TMS has been associated with enhanced cognitive performance (Klimesch et al., 2003).

Deep brain stimulation (DBS) involves the direct implantation of electrodes into localized brain regions, with the aim of altering both local and connected brain activity via ongoing, generally high-frequency stimulation. It can also be used to obtain measurements of brain activity in the proximity of implanted electrodes.

Advances in nanoscience and nanomaterials fields mean that more technology is being made available for better brain (neuros) to computers (electrodes) connections to be established, which have higher degrees of special resolution and closer micrometric and eventually nanometric proximity. Artificial intelligence is advancing rapidly, and this can help decoding (Anumanchipalli et al., 2019) and better understanding brain signals. Finally, neuroimaging has moved from low resolution and no functional capture, to high resolution (2-4 nanometres) in experimental advanced Nuclear Magnetic Resonance (NMR) and different types of functional imagery. These three technologies combined means that the new generation of micro/nano BCI offer the potential for much more precise interactions between the different structures of the brain and its “somehow hidden functions” and computers. Such precise interactions generate more precise data and potential for computer induced brain/mind responses. Exponential growth in computing power has meant that in 2005, Matt Nagie became the first person to control an artificial hand using a BCI; in 2013, a BrainGate® patient controlled a robot prosthetic limb via an array of micro-electrodes implanted into the brain; and in 2018, researchers at Berkeley created the world’s smallest, most efficient implanted ‘neural dust’ wireless nerve stimulator. Despite the rapid recent progress and the variety of approaches currently being explored, there are still many significant constraints on development of more ambitious applications of BCI (Committee on Legal Affairs and Human Rights, 2020).

Enhancement is more profoundly disturbing to fundamental freedoms because a person, willingly and of “free will”, decides to be subjected to a procedure that in many cases may restrict/impact on fundamental human rights for the prospect of a state he/she considers an enhancement and thus a benefit to him/herself. In therapeutic usage, on the other hand, the consequences may have similar implications for human rights, namely autonomy, privacy or physical and mental integrity. It can be said that a “trade-off” benefit exists which is the potential improvement of a person’s medical condition or amelioration of suffering. There is a counterargument based on the “right to health” or “right to dignity”. In the case of mental enhancement such is not the case as there is no “right to health” to be invoked as the individual is “otherwise healthy”.<sup>1</sup>

I follow the definition of “human enhancement” proposed by (Coenen et al., 2009), as:

*“a modification aimed at improving individual human performance and brought about by science-based or technology-based interventions in the human body. This definition includes “strong”, second-stage forms of human enhancement with long-term effective or permanent results as well as “temporary” enhancements. Because it is not related to a specific definition of health, this is a non-medical concept of human enhancement. Moreover, we distinguish between purely restorative non-enhancing therapies, therapeutic enhancements and non-therapeutic enhancements.”*

The term “enhancement” has been most often used in medicine-related bioethics in the last decade, “to characterize interventions designed to improve human form or functioning beyond what is necessary to sustain or restore good health”(Juengst, 1998). The notion of “restoration” is still useful for the conceptualisation of human enhancement: The restoration of a previous condition after a disease or after an injury (*restitutio ad integrum*) is a concise definition of a therapy which is clearly not an enhancement (Wiesing, 2008). However, all attempts to use the therapy-

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<sup>1</sup> The use of quotation marks here is to denote that, according to some authors, many humans are propelled to many enhancements, the best example being plastic surgery, due to discomfort and psychological suffering, that results from social and cultural pressures, rather than physical disease. Yet, according to the WHO definition of health as a “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” they could indeed be said to not enjoy “socially well-being” if societal pressures deem performance under those parameters as highly important, or that is the person’s perception of it.

enhancement distinction for delineating medical treatments from human enhancement and for restricting the latter notion to non-medical practices are problematic.

Once we establish the concept of enhancement, we can use this to refer to any technology that has the capacity to promote such modification. This technology can be a drug (e. g., cognitive enhancing medicines, like Ritalin®) or an electronic system interfaced with the brain (e. g., DBS). These technologies can thus be generically called Human Enhancement Technologies (HET). The same authors (Coenen et al., 2009) further provide detailed definitions of both therapeutic and non-therapeutic enhancements. It could be said that most pharmaceutical enhancements, being too often transitory and temporary, should not be considered true human enhancements but rather states of enhanced capabilities, since these cannot be sustained over long periods of time. This, however, begs the question of how long an enhanced mental capacity state needs to last to be considered an enhancement rather than just a higher cognitive capacity with a certain duration.

The focus of this article is on non-therapeutic enhancements to human mental capacities. The use of BCI's implies the use of digital tools, and to an increasing extent, the use of embedded AI methodologies. It is important to distinguish, however, this area from the rapidly growing field of Digital Therapeutics (DTx), that uses mostly digital tools, cognitive therapy principles and self-care to introduce/modify human behaviour and by doing so, alters physical signs but mostly symptoms associated with a plethora of diseases, such as addiction disorders or sleep deprivation (Dresler et al., 2018). While these could be classified as Digital Mental interventions, they are not direct, and in almost all cases they operate under the conscious control and effort of the subject. They, nonetheless, show the power of how changing some neuronal patterns and cognitive functions can alter the body of the person, not to mention a vast array of mental disorders. Therefore, we could call them Digital non-Direct Mental Enhancements or Therapeutics.

While it is important to bear in mind these distinctions, our focus is on Digital Direct Mental Enhancements (DDME), where the brain is physically connected to a computer. Because of this “linkage”, authors often use the term neuroprosthesis or neural prosthesis to also include these technological solutions (Lavazza, 2018). The fact that a focus on the brain and in particular the mind is at stake, I prefer the term

DDME as the subject matter of this essay. In one of the most recent texts on enhancement published in 2011, Buchanan recognises this form of enhancement according to his suggested five types and five modes (p25) (Buchanan, 2011). He mentions mode 5 “brain-computer interface technologies, using nanotechnology to connect neural tissue with electronic circuits”, which according to his typology could introduce two types of enhancements: “Type 2 – Improvements in cognitive capacities, such as various aspects of memory, information-processing and reasoning; and Type 3 – improvements in affect, emotion, motivation or temperament”. Shortly after (Buchanan, 2011) he admits his decision to focus on more established technologies, namely on enhancement drugs for pragmatic reasons calling “more exotic interventions” to “nanotechnology-enabled microcomputer brain implants”. Ten years later, these “exotic interventions” have accumulated and reached high degrees of scientific inquiry, publication, and review.

## 2 Why is Analysing Mental Integrity Important?

A BCI is always a breach of physical, and potentially also mental integrity, if it is to have an impact on mental capacities. When these capacities have been somehow reduced (due to disease/congenital defect), some may argue that using a BCI technology on the brain is not imposing a breach of integrity, as this had already been compromised. On the other hand, others could argue that it is still a breach on mental integrity justified by the therapeutic nature of the intervention as it seeks to restore the human to a “previous”, or “natural” state of mental capacity. This means that our understanding and conceptualization of mental integrity is not a merely academic exercise of relatively low or no importance. It is essential for a study of neural prosthesis as Lavazza proposes (Lavazza, 2018). It can determine and inform the grounds of the study of the rights and duties of citizens and the State regarding not only the use of BCI for “therapeutic” purposes but also, for human mental enhancement – or what I call Digital Direct Mental Enhancement (DDME). For now, I will follow Lavazza’s definition of mental integrity (Lavazza, 2018, p. 4), as he outlined it in a normative sense:

*“Mental integrity is the individual’s mastery of his mental states and his brain data so that, without his consent, no one can read, spread, or alter such states and data in order to condition the individual in any way.”*

### **3 Mental Integrity Layers and Threats Posed by BCI's**

Lavazza's view on mental integrity is a functional and somehow defensive definition. It is in fact a more complex concept in the sense that the mental processes – the mind – are not inseparable from the brain as a physical entity and they are more than data and consent. The study of many mental disorders – e.g., severe depression, schizophrenia, or obsessive-compulsive disorder - have shown us that mental processes and their integrity can be significantly compromised even in the complete absence of any evidence of physical change. As such, it is easy to consider that significant lesions to brain tissues can lead to mental integrity compromises, but again only to a certain extent as brain plasticity, particularly in children, is incredible. A second layer is psychological, associated to perceptions, ideas, feelings, and emotional life. This can result in changes of personality, cognition and affects altering the persona to a point that it sees itself as someone else or does not recognise certain behaviours or thoughts as of him/herself. In these cases, one could consider this a form of lost mental integrity. The information contents stored in our mind can be accessible via conscious and unconscious manner - the first by control of the human will, the second without such control. Many times, we find information in our mind (our mental circuits) that we thought we had forgotten; we recall facts clearly or not and the study of these capacities can be grossly called the study of memory and recall. Dementia and the study of memory loss has shown us multiple pathologies that impact on our usage of stored facts and ways of reasoning. I refer to this as the information layer of mental integrity.

The concept of integrity can be associated with a metaphysical perspective of wholeness. This is a challenge in the mental realm, for the mind cannot be seen as the body can, making the notion of physical integrity quite intuitive. There is physical integrity when no discontinuity to the human body can be found, and any cut or alteration of its physicality is a breach of physical integrity. Therefore, a theory of the mind is necessary to reach a definition of mental integrity and that means more than one such theory is likely to be producible and, hence, result in different understandings of what mental integrity is. One incomplete alternative way of solving this is to think of mental integrity as the capacity to support mental manipulation without the realization of the threats to mental wholeness and personality that could be anticipated. Some of the threats to mental integrity that can be anticipated from BCI are:

- a) Threats to neuro functions, through direct damage (breach in physical integrity) to the brain tissues – The intervention itself could lead to physical destruction of relevant neuronal tissues that would condition sequelae limiting neuronal normal function with all types of signs and symptoms similar to those in a post-stroke patient.
- b) Threats to cognition or emotional life – While not damaging the neuronal circuits themselves, it is possible to anticipate that an intervention that uses neuromodulation to alter the way of thinking/reasoning, perceiving or expressing ideas, could equally alter the same mental functions accidentally for outcomes that were not anticipated or even leading to a cognitive or emotional adverse response.
- c) Threats to autonomous control – In this case, what is at stake is that others can “control” our neuronal functions: Regarding the motor function this is already a reality via deep-brain stimulation, where external control serves exactly to override pathological control pathways in movement disorders. The issue at hand is that mental autonomous control could equally be corruptible.
- d) Psychological trauma – The exposure to mental stimuli that can be psychologically capable of generating ideas and emotional reactions that by themselves destabilize psychological wellbeing even if no neuronal or cognitive damage has occurred. This could happen because of unintended neuronal stimulation, or the way by which information is reaching certain areas of the brain via new, more direct, channels.
- e) “Covert operations” – These are situations where there is the use of parts of the brain, without the person being aware of that. This can result from the intended actions by a researcher/practitioner or from tapered systems, raising the issue of cybersecurity (see more from (Panetsos et al., 2017)).

#### 4 Mental Enhancement and Mental Integrity Revisited

If, for one moment, we entertain the idea that to have mental integrity is to attain the highest possible level of cognitive capacity when compared with other humans, then mental enhancement *per se* could be a way to ensure such integrity rather than only posing a threat to it. Why could it make sense to think this way? For two reasons: i) the highest level of cognitive human capacity is a relative concept; ii) there is no consensus of what is “too much” in relation to a given cognitive capacity.



The highest level of “possible cognitive capacity” for a given person, is not just dependent on his or her genetics and/or basis life patterns, but also is clearly related to their exposure to experiences, particularly social interactions, and with literacy and numeracy. Hence, some authors consider literacy one of the first human enhancements (Buchanan, 2011), later to be brought to scale, as a duty of the advanced states, under a “social development” argument, and even to be made “compulsory” under most advanced nations in the world, through “compulsory basic schooling”. This is implemented with the argument of social well-being, the need to ensure individuals social acceptability and the welfare of others, as it could be worsened by the “subdevelopment” of non-educated individuals prone to be “more likely” aggressive, dangerous, unemployed, unintegrated, social misfits. This means today we do not consider for one second that sending children to school is sending them to a state supported/state obligatory large-scale mental enhancement program. Rather, we would more likely think that parents, exerting their parental rights and preventing their children from being exposed to an often intense and quite exhausting program of 30h-40h education a week, would be significantly damaging or at least threatening to damage their children’s capacity to think and enhance their cognitive capacities, condemning them to be lesser cognitively developed. This means, they would be to some extent attempting harm to their children’s mental integrity.

It follows from the previous argument that if a general “standard” of cognitive capacity, unattainable without a BCI intervention, is decided as the “new normal” for children, then what separates this from a more “demanding” or “sophisticated” basic high school education program? Probably the fact that some “physical” manipulation of the human body is necessary for the implementation of that “enhancement” additional intervention. Paradoxically, it is the breach of physical integration, and not that of mental integration, that from the onset highlights the difference. In other words, if we could “magically” connect the brain to a computer, and hence increase childrens’ capacity to deal with trigonometry problems two years earlier, as we have done with the evolution of mathematics education techniques, then “it would be ok”. Perhaps even so, it would not be. Many authors argue that the distinguishing line (Lavazza, 2018) is then the capacity to offer such enhancement interventions without threat to other individual rights (in this case the rights to health and physical integrity), or the rights of others if such interventions are not “generally applicable” and offered as a matter of common access to all

humans, thereby not aggravating existing human inequalities and protecting both equity and the principle of equality. In its extreme, this line of argumentation could lead us to conclude: if all children need a BCI intervention in order to attain new levels of numeracy and literacy through advanced cognitive capacities, and the State is capable of offering such enhancement programs to all in an egalitarian manner, then only the balance between the rights to individual health and physical integrity and those of social integration stand in the way of a State-promoted or State-guaranteed program of general mental enhancement for all future citizens. Not going to school, lower levels of literacy (that depends on formal structured schooling), and not being capable of higher levels of social interaction have been clearly associated with poorer health in the teenager and adult life. This means that our present “working definition” of health includes elements that can only be fully realized if a person has been schooled. No doubt everyone would agree that “schooling” is not a natural endeavour, not without its “risks” to mental and physical integrity, as some children have accidents, suffer significant levels of school related stress or from bullying, just to give a few examples.

## **5 The Rights of the Citizens to Mental Enhancement and the Role of the State**

If we follow Buchanan’s network effects argument (Buchanan, 2011) about the generalizability<sup>2</sup> of a human enhancement across society through an analogy argument exercise, we could reach the following hypotheses. If we could launch a general BCI intervention program to increase a cognitive (general or specific) capacity in all children and/or adults, thereby increasing the general “normal” standard of human performance for a given mental task, that would not threaten health and social rights more than would traditional education and/or other social (non-BCI related collective) intervention programs, and there would be no evident legal obstacle for its execution. Note that I am not suggesting that there may not be ethical or moral obstacles. Only that from a human rights point of view, this “functionalist” thesis on general mental enhancement through the use of BCIs – what I call DDME – posits that, everything being equal, a population-based DDME that boosts all humans to a higher level of cognitive capacity is as justifiable as

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<sup>2</sup> A measure of how useful the results of a study are for a broader group of people or situations. If the results of a study are broadly applicable to many different types of people or situations, the study is said to have good generalizability

compulsory education programs, which have transformed first from a “State sponsored” societal advantage, then to a State organized intervention, and ultimately to the UN Charter for the rights of children. Today, few would argue that a child’s right to education is questionable, and many would condemn a State that does not offer and “guarantee” such right to their people. Could it then be that what we call a DDME could be seen no longer as an enhancement, when societies have accepted and later actually “promote” and even “require” an advanced mental capacity impossible to attain without such intervention? Once implemented in all members of society it would provide immense social progress and welfare. Such a “generalist” thesis makes acceptability of mental human enhancement only dependent on the State’s capacity to ensure it is universally available, even if some temporary discomfort, minimal health risk and clear breath of physical integrity are endured by the general population.

It follows then, that any appreciation of a DDME for an individual cannot be dissociated from the State’s role. There is space to explore the individual’s right to mental enhancement, or the lack of it, without a discussion and previous conceptualization of the role of the State (its duties and indeed even its rights regarding mental enhancement), not just as a lawmaker and judiciary guardian but ultimately in its administrative/governing function.

## 6 The Upper Limit

I suggested that if we entertain the idea that to have mental integrity is to attain the highest possible level of cognitive capacity when compared with other humans, then mental enhancement *per se* could be a way to ensure such integrity rather than only as something that poses a threat to it. This would make sense as there is no consensus of what is “too much” in relation to a given cognitive capacity.

Indeed, while it is relatively easy to determine that a person has lower than “normal” capacities, for example, memory loss or lack of capacity for solving numerical problems adjusted for a certain level of literacy and numeracy, the reverse is practically never entertained by medical science. Medicine has developed a sophisticated set of tools, diagnostic psychometric tests to “measure” cognitive, emotional and even socialization metrics. Furthermore, medicine creates criteria, arbitrarily determined and culturally and historically fluid, to classify people as

“normal”, near normal, below normal, and diseased. It further elaborates mental deficits and lower than “average” cognitive capacities as sets of characteristics associated with behaviours and health risks, to conclude that people presenting such “limitations” are at risk or evidently incapable of performing routine daily activities, are unable to live according to “established” social norms, or lack the capability to function in increasingly complex societies without support and hence, unaccountable even for their acts in court. The upper limit is, for the most part, uncharted medically, and I argue, legal (and necessarily ethical and philosophical) territory. That I am aware of, no person has even been “diagnosed” as being “too intelligent”, having “too much memory” or being capable of “too fast numerical reasoning”. Only in the latter two examples have these symptoms been described in association with other more severe mental dysfunctionalities. Presented as the case of certain patients, suffering from disease X, who can “actually be capable of higher-than-normal memory for numbers”, for example. As a somehow “ironical” or “paradoxical” finding. In other words, even when “the upper limit” has been made evident to medicine, it quickly turns it around as a “consequence” of a lesser state. In summary, I would say medicine has not been very welcoming of the upper limit challenges. There are two main reasons for why this may be true.

One is that medicine was developed as a reactive social technology to restore normalcy in individuals. To make people well again, or, at best, to make people better, or even for making people feel better with their limitations, imposed upon them by disease of all origins. In the worst- case scenario, to help them in the last days of life or in too painful moments (palliative care), and, in selected jurisdictions to help people end their life in case of extreme suffering (euthanasia).

The second reason is its individualistic origin, albeit the timid attempts at promoting “hygiene” and “general wellbeing” – what today we could call a public health perspective – as far as the Greek and other Asian medicine traditions were concerned. Focusing on the general betterment or enhancement of the collective of individuals was not seen as medicine by most. Hygiene and other “wellness” behaviours were promoted and propagated often via religious rituals mostly for an individual cleansing function, and not because of the idea that an improvement in the environment (hygiene, sanitation etc.) or on the human capacity to react to its environment (e. g., vaccination and later “health literacy” to include food choices) could be desirable collective behaviours that could help or be fundamental for

individual health. This only came about in the Nineteenth Century with the discovery of the germ theory and much later with the modern public health concepts associated with non-communicable diseases and its public health ethos.

Focusing on the individual and on its lower limit – in comparison to a “normal” and “statistically averaged” life – medicine has left us with an extraordinary empty picture of the impact interventions oriented to the collective good and focussing on the upper limit could achieve for general human health and life, and consequently for the way enhanced humans could live better and longer.

The upper limit is at the core of any serious enhancement discussion. I would go as far as saying that, in the absence of any evidence that people with green or blue eyes or of higher-than-average height, for example, discussing genetic manipulation of such characteristics cannot indeed be considered a true discussion on human enhancement. Only interventions that “make a difference” are worthy of being called enhancements. For this, we need to map the upper limit of human capacities more accurately, studying upper performing humans with the same, or even more urgent, dedication that we devoted in the last centuries to people with lower capacities or phenotypes associated with suffering and life-limitations. We need to study the “over performing” humans in order to determine “the upper limit” of human capacities, especially mental capacities, if we are to develop a true argument for or against mental enhancement. The society can be in a position to judge the true merits and demerits of human mental enhancement regardless of its technical feasibility only when knowing the upper limit and determining what could be higher than that and its consequences. This “experimentalist” thesis postulates that mental enhancement could be justified almost only, or even only, for the obvious reason of the benefits that will derive when we study and better understand what the consequences and implications are of having mentally enhanced humans not only for the individuals themselves but indeed for the collective.

Nature and medicines’ traditional low interest for studying the “over performing”, was a natural consequence of providing for the needs of humans mentally operating at the lower limit or below the lower limit. As an example, we are well aware of the consequences of memory loss in dementia populations, not just for the individuals in terms of incapacities introduced, but also for the social burden, costs and implications to the greater society and the increasing numbers of people suffering

from dementia. How much do we know of the consequences for themselves and others of people possessed with extraordinary memory capacity, except perhaps for the occasional praise they receive, or on the flip side of the coin, the inherent jealousy people having less memory skills feel when in the presence of more gifted people. Studying the weak and weakened persons reinforces our own self-confidence and does not threaten our scientific and human status. Contrarily, studying the stronger, higher performing humans and dedicating careers to perfecting others than ourselves takes a degree of humility and an appreciation for perfection that may not be in high supply in the medical and scientific society.

The experimentalist perspective would then imply that to study mental enhancement consequences, exemplars of individuals are needed, and for truly understanding their collective implications, we would need to study a large sample of enhanced humans. This right to research and explore the outer limits of science exposes the heated debate about human cloning, the right for its research agenda, and ultimately the true effectiveness of “banning human cloning” via a fundamental human rights approach, even when ethical and legal argumentation could possibly have led us to no other solution for the meanwhile. Such should be the fate of mental human enhancement or is it more constructive to see DDME as technical and evolutionary fatality for which we should use law to better balance rising tensions and conflicts of interest rather than simply banning it formally. This is the “deterministic” thesis, sustained by Buchanan (Buchanan, 2011), for example, regarding many technologies, including DDME. Alternatively, the “prohibition” thesis, as supported by Sandel (Sandel, 2007) in his “Case against perfection” or even more clearly in Kass, regarding human cloning (p. 172-173) (Kass, 2002), based on moral grounds and considerations on human dignity, while apparently looking much more straightforward, clearly and often considered more “ethical”, is not without its problems. The biggest one, and maybe the only one needed to weaken this thesis, can be enunciated in simple terms: “if we are to prohibit the use of DDME because they have the potential of creating humans with supra cognitive/mental capacities, higher than “other humans” what is ‘The upper limit’ above which humans could not go and which justifies the prohibition for undergoing enhancement?” For example, what is the maximum memory they can aspire to when improving their cognitive capacities in other ways? What is the upper limit that is used to define that more than that would be unfair (fairness argument) unethical, or immoral (anti-god argument) to a point that it needs to be prohibited? Since this limit is not possible

to calculate, or at least has not been significantly attempted, where is the line to be drawn?

Alternatively, other grounds for prohibition can be anticipated like: 1. that there is a “direct” link between the brain and a machine; 2. the fact that the machine may operate forms of AI which can be “threatening to the human intelligence”, or 3. that it is never possible to guarantee full consent and awareness of a BCI. These three sub-arguments for banning DDME can also be contradicted.

If the core obstacle is the fact that there is a need for a direct link between the brain and a computer, then this would imply that mental enhancement when a direct link is not needed would be acceptable. This is consonant with the recent advances in Digital Therapeutics (DTx)<sup>3</sup>, where behavioural change is at the core of its definition as they act mostly by conditioning of the human mind, altering the brain’s capacity to perceive and understand incoming information differently, leading it to think in a more “advanced” and “health-promoting” way. So, non-direct digital interventions in the brain/mind have been subjected to regulatory scrutiny since 2017 in the US for “therapeutic purposes”, but they rely on an enhanced capacity of the human mind, for example, to control impulses/cravings as in the example of cognitive therapy via software-based intervention in smoke cessation programs. Is this truly therapeutical in the sense of “restoring” some defect, injury, or lesion? No. It is the increase in mental capacity to deal with additions to drugs or tobacco for example. This is in all terms human mental enhancement, for that human is now capable of a mental task they were not previously capable of, and, as a result from that and their decision to apply such new capacity to stop smoking, they achieve something they had not been capable of attaining before. It seems, therefore, that tampering with mental capacities does empower the mind to be capable of something new, something that requires enhanced capabilities at least for that person, is acceptable by a growing number of jurisdictions. Pacemakers provide a good example. For many years, pacemakers have provided millions of people with direct links between their natural cardiac cells and an electric, and now increasingly digital, and even

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<sup>3</sup> Digital therapeutics (Dtx) – a quite consensual definition of DTx is presented by the European Data Protection Supervisor as *evidence-based therapeutic interventions driven by software to prevent, manage, or treat a medical disorder or disease. In other words, DTx are patient-facing software applications that help patients treat, prevent, or manage a disease, and have a proven clinical benefit. For example, Digital Therapeutics can support patients with the self-management of their symptoms, and thereby improve their quality of life and other clinical endpoints. DTx uses digital implements, like mobile devices, apps, sensors, the Internet of Things, and other tools to spur behavioural changes in patients.* Source: Digital Therapeutics (DTx) | European Data Protection Supervisor (europa.eu).

wirelessly connected device. Indeed, some people could argue that cardiac cells do not “think, feel, or have emotions” and that is why this would be a different matter from neuronal cells. Using direct brain stimulation for epilepsy control, for Parkinson’s Disease, and other movement disorders is now commonplace in many hospitals around the world. Direct electric linking into body cells – myocytes or neurons – has never been problematic for medical science, but rather it is established practice – *leges artis*. It follows that it seems that it is acceptable to enhance neuronal circuits into new mental capabilities of control; it is acceptable to electrically stimulate the heart, and indeed the brain, to change patterns of transmission of certain groups of electrically excitable cells by directly linking these tissues to electronic and digitally controlled devices; then why would it not be acceptable to do both together? And under what grounds? Definitely not those of physical integrity, for that is breached regularly under these procedures, nor that of increasing mental capacity, for that, as I have shown with DTx, is an emerging and regulated field of non-pharmacological interventions, *ergo* it has been accepted, as long as it follows regulatory constraints.

The element of AI-embeddedness in the DDME is as debatable as it is in any other form of human computer interaction (HCI) and a subject of vast analysis in current medical, technological, ethical and legal scholarship. For the sake of this essay, it is enough to say that if a Digital Therapeutic intervention using AI is acceptable and indeed associated with increased mental capacities, then it is not evident why, if the interaction happens in a direct manner, there should be any additional, particular concerns.

Finally, it is impossible to refute the argument that full consent and awareness of a BCI is never possibly guaranteed. Some scholars (Lebedev et al., 2019) sustain the risks associated with situations where consent is given for submission to an intervention using BCI and the possibility that corrupt intentions explore this “pathway” into the mind to undertake non-consented interventions. While admittedly this is a serious risk, it is nevertheless true it is by no means new to medical interventions. Too often court cases arise where the individual presses charges against a doctor or an institution for an intervention to which he/she had not “consented”, while the reverse (that there was consent) is argued by the medical provider side. Consent concepts, its formalization and its dynamic nature are recent evolutions that attest to its complexity. I would argue, however, that there is no



“significant” difference between the challenges involved with ensuring that a BCI intervention complies with legal consent requirements and that they are adhered to in intervention cases when the patient is unconscious under anaesthesia. In both, disputes over agreed intentions and interventions can occur. The risk of such disputes occurring is perhaps higher in the case of BCI interventions and the impacts on mental enhancement. Furthermore, the nature of such disputes is perhaps more difficult to grasp. Nonetheless, it was not the inability for always obtaining full consent and ensuring individual awareness of the procedures that has prevented many other procedures on the brain to evolve into standard practice. Often, the bioethical solution to this dilemma has been found in balancing the risks inherent in situations where there arguably has not been full “consent” with the principle of “beneficence”, in the articulation that such risks can be condoned because the benefits the intervention stands to offer the individual in question outweigh (often substantially, i.e., the difference between life and death) the lack or possible lack of fully informed consent. This formula has been used to solve, not without controversy, medical interventions in patients incapable of providing consent for many reasons. In the case of mental enhancement, the benefit is always there *a priori*, so the direct application of this principle could even imply that people would naturally give, or could be assumed to give, their consent to something that is beneficial to them. A fictitious example would be that a person only grants a neurosurgeon permission to implant a deep-brain stimulation device for controlling a Parkinson’s Disease (PD) associated movement disorder. However, during the course of the same procedure, the neurosurgeon could employ a simple technique of implanting a digital device that can help sustain or indeed increase memory. Doing so would likely benefit the patient as medical science knows that memory loss is something often associated with PD. But in this hypothetical situation, even the neurosurgeon’s benevolent intention is not enough to justify not obtaining consent for the secondary procedure. There always is a risk that someone may use a programmable pacemaker, or any form of neuronal control via brain implants, to carry out a non-authorized or non-consented to action. Accordingly, consent should be sought, and to the point that it can be communicated and explained so it can be understood and consented *a priori* by the individual seeking a Mental Enhancement intervention by means of DDME. Indeed, that is the ultimate expression of self-determination, to decide to stop being a self-determining human being, according to KASS this is no different from euthanasia where “humans choose to stop being a choosing human being” (Kass, 2002).

So, albeit not fully contra-argued, these three sub-arguments seem equally valid for activities that societies have accepted, progressively in different ways and shapes, across liberal democratic jurisdictions. This returns us to “the upper limit” argument. Who then can decide, or how can societies devise a mechanism to decide, what is the upper limit that humans can attain in their mental capacities, when indeed we never defined or imposed, for example, the maximum capacity a person can have to lift weights, or to train their memory? While for sports the argument of fairness in competition has been well discussed (see for example Sandel argument against perfection and the use of enhancements in sports (Sandel, 2007), we can anticipate cases where a person may want to enhance their mental capacities solely for the purpose of doing so, without entering competition at sports, and not for the purpose of improving performance at school or work. In this case, why and who can determine that the upper limit is the highest recorded capacity without a DDME (historical limit hypothesis) or an arbitrarily defined limit (arbitrary limit hypothesis)? Both are highly problematic, the first because there is a recording and measurement challenge, the second, even more because to those same challenges two additional aspects can be added: i) the arbitrary nature of the definition, and the second ii) paradoxically, it would be that some humans would determine the degree to which other humans could enhance themselves in a particular mental capacity that the first have less of.

## **7 Mental Enhancement Potential Through BCI Solutions**

Mental and physical integrity are useful concepts because they allow for the balancing between risks and benefits for the particular individual. All things being equal, if no significant harm to integrity can be ensured and assuming enhancement is attainable, we are left only with self-determination and freedom as principles to guide us on the argument for or against mental enhancement (with or without direct digital linkage – using BCI) and with “the upper limit” argument.

The balance between a breach to mental integrity and the therapeutic advantages of a BCI that can restore human mental capacities to something closer to a “normal range” seems now relatively easy to accept. However, in some cases the boundary between therapeutic purpose and enhancement would depend on where the mental integrity boundary is to be delineated.

In the cases of mental isolation – where a deficit of communication with the outside world exists – such as observed in persons with autism or, much more commonly, any sensing (hearing/vision/smell/spatial perception) reduction or absence, if a BCI is used to restore or avoid the absence of capabilities such as hearing via already existing cochlear implants in a baby, the question arises whether we are contributing to his mental integrity as he will form a mental world richer than without the intervention, or, alternatively, are we augmenting his mental capacities and, hence, enhancing him? Likewise, if a brain-to-brain or brain-to-computer communication device is possible (and research of this nature is underway in animals), that could allow autistic children to communicate effectively and bi-directionally their ideas, are we to conclude that their previous “natural” state commensurate to their mental integrity and their new state is one of enhancement or are we to conclude that their “natural state” is more appropriately referred to as “neuronal/neurological integrity”? The point when his or her brain is now capable of communicating with the world is when “mental integrity” is restored. If we accept this proposition, then we must conclude that autistic children do not possess full mental integrity, but only “potential mental integrity”. If, on the other hand, we reject this proposition, then we are accepting the idea that for an autistic child to be able to communicate fully with others if a BCI is required, then such is a form of DDME. The same could be said for any sensory deficit situation: for example, hearing loss, blindness, smell or special perception. For a congenitally blind person, seeing would be an enhancement and not a restoration of health. Otherwise, we would have to accept that a blind person depleted from understanding and integrating the colours and movements of distant objects is experiencing full mentally integrity.

Physical integrity, because of its “natural” offspring characteristics, is thus different from mental integrity, seen as the potential capacity of the human mind. This is an important distinction for determining whether utilizing a BCI is being used for restoration or enhancement, although it immediately becomes evident that if a technology exists that can make blind persons see, would this be either unjust or unethical, or at least awkward that it could be provided to those that “had seen” and hence now, their blindness is anew and justifies restoration, but not to those who had never seen and would those benefit form an “enhancement”, with definite impacts onto their mental processes experience and ultimately, I would argue, integrity. This conundrum compels me to propose the concept of “potential mental integrity” as that which can be achieved via interventions that are capable of significantly altering

mental processes either by channelling inputs and outputs of the brain better or by allowing new types of inputs and outputs.

We have discussed the challenge of “the upper limit”. What is the “normal” higher level and can an upper limit be identified, determined, and upheld. These questions exist with respect to many human mental capacities including cognitive (such as reasoning, memory, etc), emotional (control, empathy, etc) and sensing (accuracy of vision, hearing capacities, taste, smell and even tactile). Nevertheless, there are many technological solutions currently in research benches (Goering et al., 2021) regarding communication and sensing that, if transported to a DDME paradigm, mean quantum changes in mental capacities. Their discussion bypassed “the upper limit” and certainly the restoration/enhancement discussion for there are new capacities that combined with existing mental capacities can only be classified as mental enhancements. To cite to examples we can consider: 1. technologies for new communication and coordination capacities between two or more “normal” brains for solving problems (Pais-Vieira et al., 2015); or 2. new sensory capacities like eco-guidance, allowing the brain to receive stimulation when proximity is detected by an eco-sensor, much like most modern cars blip when approaching a wall. No one would argue that these are futuristic scenarios. Now is the time to determine their acceptability and desirability, even at a research level, and of course following that, at the level of whether people should be free to be the recipients of such enhancements and/or whether other people can be allowed to perform the necessary interventions to that end even if the subjects have expressed their wish unambiguously in that direction.

If, due to science, people can better coordinate the use of computers, emails and videoconferencing technologies, Buchanan argues, these are social improvements that increase their well-being through better cooperation and communication, to the extent that, he argues, states have a duty to expose their citizens to “social enhancements” in the name of general development and their own welfare (Buchanan, 2011). In short, people should be given access to digital literacy, as they are somehow “incomplete” without such tools to operate in a digital society. If the same argument is used for brain-to-brain communication, then there is no longer a state role to potentially forbid these experiments in humans, but rather the argument can be further extended even to the point of the state sponsoring a national health service providing enhancements to all its population under the theory that doing so

will improve quality of life. This approach might be justified on the basis that currently some humans are benefiting substantially from these new methods of communication and coordination of social life, while others in society are somehow lacking something. In that sense, their mental integrity is lower than if their brains were connected via a BCI, as they cannot fully express their ideas, uphold their beliefs, protect their intellect, or project their personality and freewill. All these could be considered dimensions of mental integrity. In other words, if it is possible to coordinate with others better via a BCI solution, in order to overcome deficits that exist in my inner self, with the result being that I can increase my mental integrity, then I would have the right to demand that solution in order to define and defend that same mental integrity. As is the case with many human rights, this would create a state duty to guarantee such right is upheld in interpersonal relationships and in the relation between the individual and the state.

Finally, I turn to the potential for mental enhancement through neuromodulation. This is the use of BCI solutions that allow the manipulation of data memory (deletion, expansion, faster recall), data processing (thinking through associations/analogy, logic, and computing), focusing attention, or emotional resilience or enhanced empathy. These topics benefit from older discussions (Buchanan, 2011; Kass, 2002; Sandel, 2007), following the uptake of the use of Methylphenidate and other attention-increasing drugs first prescribed for Attention-Deficit-Disorder children but that is increasing prescribed (or illegally obtained) also for both adults and “normal” children for their cognitive-enhancement effects clearly associated with better school performance and despite the absence of scientific/medical knowledge regarding its long-term effects. The method of administration (swallowing a pill or placing a BCI link into the brain) cannot be a measure of valuation of the merits or demerits of these enhancements. The “drug version” is on the market, either legally or illegally, despite warnings and being used for clearly off-label indications. We should therefore expect that a DDME may be an “inevitable” result or subproduct of BCIs for therapeutic use. Should the assumption of that risk be enough to forbid such experimentation when it did not do so, in the case of medicinal drugs? With the eventual consequence of that stopping science to find BCIs potential mental therapeutic effect such as for post-traumatic stress, phobias management as hinted by some research? (Goering et al., 2021).

## 8 Final Reflections

First, a better theory of mental integrity is needed to comprehensibly tackle both the challenges and the potential opportunities posed by novel BCI and their capacity to offer humans not only restorative solutions but also true enhancements of mental capacities. This I called DDME to clearly identify the two main elements of debate: i) direct linking of neurons with digital technology, and ii) the enhancement, and not restoration of mental capacities. This term also clearly sets DDME apart from emerging digital therapeutic, a growing regulated market not without its own ethical and legal debates. From a theoretical point of view, I tried to address the underlying question of whether mental enhancement can be examined through the prism of (mental) integrity. Although this appears to be the case, it also seems that a richer understanding of mental integrity is necessary for this exercise to lend itself support to some of the legal debates outlined, namely those pertaining to the duties of the state and the arbitrary and unexplored nature of “the upper limit”.

Necessarily left unsolved, but hopefully with some sunlight over the tip of the iceberg, were the topics of the right to enhancement as an expression of a general right to freedom and self-determination. Interestingly, referring to “personal dignity” here may not help us much, as Kass suggests that it is of “limited value in the realm of bioethics” (Kass, 2002, p. 17) and any discussion on DDME cannot avoid bioethics. Also left for resolution is the topic of the role of the State in the provision of mental enhancement regulations, its prohibition or even its generalization. What is then the duty of the State regarding the “enhancement enterprise” as proposed by Buchanan (Buchanan 2002, pp. 60-63), especially when BCI technologies are used, and especially as they may progressively use embedded AI?

The role of the State, its institutes, and laws it could use, will differ depending on whether it assumes a more conservative or progressive stance about the individual rights to self-betterment or the potential of DDME to be a new form of “literacy and numeracy” revolution like that which has crossed though human societies to establish a new normal – the literate human being.

One thing is certain. Now is the time for the State to “act”, either by defining very clearly what barriers researchers and developers cannot cross, or by defining the lines that frame the actual commoditization of DDME which can sum up the concepts of exploring and using BCIs to directly alter mental functions by enhancing them, and not merely restoring them to some “natural” previous physiological level.

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