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After Human

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Abstract:

Human beings are in the midst of very powerful shifts in our understanding of what it means to be a human. There is a non-trivial chance that sometime in the future humanity will transform itself, leading to an emergence of posthumans with God-like qualities – *Homo Deificatio*. Such a transformation has great potential for both good and bad. Posthumanism seeks to improve human nature, increase the human life- and health-span, extend its cognitive and physical capacities, and broaden its mastery over the environment. As such, the notion of posthumanism implies a radical breaking off from, and reconceptualisation of, the state of being human. As neuroscientists, we aim to bring a neuroscientific perspective to this debate. Current scientific and technologic developments (related to brain and its augmentation) clearly demonstrate that what was formerly considered to be science fiction is slowly but firmly becoming a scientific reality.

Keywords:

Posthumanism, Human Brain, Neuro-Technology, Human Nature

"The important factor is time: what appears science fiction today may turn out to become reality in a not too distant future, giving rise to ethical questions that are not fundamentally new but gain in salience."
Torgersen et al., 2010

"The Posthuman is always a step ahead of itself, unable to stop and be."
Botez, 2017

"You must not make for yourself an idol of any kind or an image of anything in the heavens or on the earth or in the sea. You shall not bow down to them or worship them."
Exodus 20:4-5

1. Introduction

The current issue of the Futura journal is dedicated to a theme best summarized by the question "*What comes after Homo Sapiens?*". This question, or more accurately, the answer to it has a direct relation to *Posthumanism*, a modern movement which has gradually emerged over the last few decades from within Humanism and the Enlightenment (Botez, 2017). While the term "posthuman" is used in many contexts, according to one of the most influential figures within this movement – Nick Bostrom – posthumanism is centered on the belief that human nature *is* improvable (Bostrom, 2003, 2005, 2009). From this perspective, posthumanism (through an intermediate stage of transhumanism; Vásquez Del Aguila and Solana, 2015) seeks to improve human nature, increase the human life- and health-span, extend its intellectual/cognitive and physical capacities, and broaden its mastery over the environment (Jotterand, 2010). James Hughes, a colleague of Dr. Bostrom, extends this proposition by claiming that human beings should use technology to transcend the limitations of the body and mind (Hughes, 2007b). As such, the notion of posthumanism "implies a radical breaking off from, and reconceptualisation of, the (traditional accounts of the) state of being human" (Campbell et al., 2006; p. 345).

So, what comes after human? Will the future applications of currently emerging technologies continue to shift us away from being *Homo Sapiens Sapiens* to the transformative *Homo Sapiens Technologicus* – a species that uses, fuses and integrates technology to enhance its own function (Zehr, 2011, 2015a), and eventually to *Homo Deus* – a species of "super" humans with God-like powers (Harari, 2016).

While some readers may be incredulous of such far-fetched scenarios, current scientific and technologic developments clearly demonstrate that what was formerly considered to be science fiction is slowly but firmly becoming a scientific reality. The seriousness of this fundamental development is exemplified by the recently commissioned report for the Members of the European Parliament, providing them with an overview of current trends in science and technology (van Est and Stemerding, 2012). Authors of the report identified a growing interaction between the physical and biological sciences in terms of two bio-engineering megatrends which constitute a new challenge to humankind: "*biology is becoming technology*" and "*technology is becoming biology*" (Arthur, 2009). According to this report (van Est and Stemerding, 2012), "[t]he "biology becoming technology" trend implies and promises new types of interventions which further enhance the manipulability of living organisms, including the human body and brain. The "technology becoming biology" trend embodies a (future) increase in bio-, cogno-, and socio-inspired lifelike artefacts, which will be applied in our bodies and brains, be intimately integrated into our social lives, or used in technical devices and manufacturing processes" (p. 4). The authors further conclude that both megatrends lead to a future in which the distinction between biology as a science of life and engineering as a science of artefacts will gradually disappear altogether (van Est and Stemerding, 2012). In many respects, this future is uncertain and speculative.

In the last few years, a large number of publications – both in specialized/scientific journals and in the public domain – are dedicated to discussing the future of humanity (e.g. Habermas, 2003; Hughes, 2007a; Bostrom, 2009; Herbrechter, 2013; Buchanan-Oliver and Cruz, 2016; Harari 2016; just to mention a few). As neuroscientists, in this essay, we aim to bring a neuroscientific perspective to this debate. This is especially timely since the brain and its augmentation has become a central theme for trans-/post-humanists on their journey towards transcending biological limitations (Roco and Bainbridge, 2002; Bostrom, 2003; Ramez, 2005; Saniotis et al., 2014).

2. The uniqueness of the human brain

The human brain is unique because it evolved to be a junction point of the material world and the world of ideas, the body and the mind, the objective and subjective (Fingelkurts and Fingelkurts, 2004). The human brain is more than just a physical system or a symbol-processing device, it is an epistemic system that observes and interacts with its environment (Cariani, 2001). It is because of the brain that "[h]umans breathe, cough, sneeze, gulp, and have sex; play football and musical instruments; add and subtract; speak and even reflect—write, sing, and compose poems" (Fingelkurts and Fingelkurts, 2004; p. 844). But above all, the brain supports the mind and our personality, and everything that makes us

US – independent, thinking, and self-aware beings. As we argue elsewhere (Fingelkurts and Fingelkurts, 2004), this is due to the fact that human brain is the organ in which “super-” or “virtual-reality” first arose. Indeed, this super-reality transformed a mammal into a human. From this transition point, the faded pieces of the external physical world were transformed as images into nonmaterial clusters of reality, forming a new mental reality. Possessing virtually limitless degrees of freedom and being instantaneously accessible, these mental images become subjects of the remarkable “theater” of nature – *consciousness* and *unconsciousness*.

The brain is also unique physiologically. First, not only it is the most complex organ of all in our organism, it is by far the most complex object/system known to humankind. Indeed, more than 10^{15} neurons – brain cells that carry electrical and chemical signals (Ashmarin and Sukalov, 1996) – are connected with one another locally to form neuronal assembles with more than 10,000 direct connections per neuron (Singer et al., 1997). To put this in context, there are more of those connections in every cubic centimeter of the human brain than stars in the Milky Way. However, this is not the end of the story: in their turn, these neuronal assemblies communicate with one another through long-distance coordination in order to give rise to behavior, cognition, and eventually consciousness (Fingelkurts et al., 2010, 2013). Furthermore, brain cells have several unique features that distinguish them from all other cells of the human body: they have the highest number of active genes compared with other tissues (and brain cells of other mammals, including the primates; Naumova et al., 2013); they function by close interaction with each other; and are capable of rearranging their functional connections in response to damage or experience (Sophie Su et al., 2016). Moreover, recent research has shown that neurons do not have a fixed lifespan: if they are transplanted from a short-living organism into a long-living one, they survive for as long as the new host does (Magrassi et al., 2013).

Considering these unique properties of the brain and its centrality to trans-/post-humanism, in the next section we will briefly overview major neuro-technologies that may define future applications within the posthumanism movement to allow the transcendence of human limitations.

3. Neuro-technological directions

3.1. Neural tissue engineering and stem cell chimeras

There is currently unprecedented research acceleration within the neural tissue engineering field (Leach et al., 2010; Donaghue et al., 2014; Zehr, 2015b). In 2013, a groundbreaking study was published by Xiaoning Han and colleagues, showing the possibility of augmenting the brain processing ability of a “less advanced” species by surgically implanting brain cells from a “more advanced” species

(Han et al., 2013). The researchers implanted human astroglial cells into a mouse brain. Astroglial cells are different from neurons, e.g. they do not produce electric signals, but they are critical in supporting and protecting neurons and, thus, participate in brain information processing by proxy. Human astroglial cells are larger, more complex, and also operate threefold faster than those of the mouse brain. Han and colleagues (2013) discovered that human glial cells not only survived in the mouse brain, but produced signals at a rate usually found in the human brain. Most interesting of all, the transplanted cells augmented the behavior and enhanced the performance of the mice, including learning, memory formation, dealing with stress, and the ability to identify and find new objects. This experiment demonstrated that implanted human astroglial cells offered noticeable cognitive/behavioral advantage to the mice hosts. While the results are exciting and very promising for potential applications, there were some unexpected findings with unknown consequences. Further observation has shown that there was a dramatic and steady fall in mouse brain glial cells, paralleled by an increase in human glial cell content; this process was so intense that after one year almost all of the glial cells in the mice brain were of human origin (Windrem et al., 2014). This indicates that implantation of the more evolutionary advanced human brain cells "outcompeted" and eventually replaced the host mouse brain cells. To understand the implication of this finding, further studies are needed with a focus on the long-term consequences of such interventions.

3.2. Genetic brain-mind enhancement

Brain and cognitive enhancement via genetic manipulation is another line of research which is currently under rise (Sandberg and Bostrom 2006). For example, genetic memory enhancement has been repeatedly demonstrated in rats and mice. In one line of studies, researchers genetically modified the brain of adult mice, forcing it to over-produce a substance responsible for brain plasticity which is typically expressed only in young brains (Tang et al., 1999). As a result of this genetic manipulation, the modified mice demonstrated improved memory performance, including memory formation and retention. Moreover, similar manipulations allowed researchers to extinguish (unlearn) fear memories in mice (Falls et al., 1992), thus opening up new avenues for dealing with post-traumatic memories in humans. Unfortunately, there also seems to be a nontrivial trade-off between benefits and unwanted side-effects; the modified mice were more sensitive to certain forms of pain as a result of the intervention (Wei at al., 2001). Similar improvements in memory and cognition has been achieved by genetically over-producing the so-called brain growth factors that are responsible for "plastic" changes in the brain, as well as growth, regeneration, survival, and differentiation of neurons (Routtenberg et al., 2000).

Importantly, OFF/ON genes switching can be effectively achieved via pharmacological, dietary, or nutritional supplementation interventions. For example, supplementing pregnant rats with choline (a vitamin-like essential nutrient for animals and humans) changed gene expression in the brains of their pups during development so that their cognitive performance, memory and attention improved significantly (Meck et al., 1988; Meck and Williams, 2003; Mellott et al., 2004). Similar results have been shown in humans. When mothers consume sufficient amounts of choline during pregnancy, their children also gain cognitive enhancement (Boeke et al., 2013; Caudill et al., 2018). Since choline supplements are readily available, one may conclude that such prenatal enhancement may already be taking place in human population (Sandberg and Bostrom, 2006). Another readily available substance, Omega-3, has also been shown to enhance cognition in children, when they were exposed to it in utero (Colombo, 2001; Helland et al., 2003). Again, deliberate changes to the maternal diet may be considered part of a cognitive enhancement strategy (Sandberg and Bostrom, 2006).

3.3. The brain-computer interface

The brain-computer interface (BCI), also sometimes referred to as a brain-machine interface (BMI), is a type of technology that bypasses a human's normal neuromuscular pathways allowing people to interact with or control external devices, computers or robots using their minds (Wolpaw et al., 2002; Nicolas-Alonso and Gomez-Gil, 2012). To achieve this, BCI technology provides the means to record specific brain signals that are responsible for particular human intentions, process them in real-time, and encode them into commands that control or communicate with external devices (Ganin et al., 2013). BCI research and development has undergone an explosive growth over the past two decades (Mak and Wolpaw, 2009). One new development is represented by the Hybrid Assistive Limb system (HAL), which is an exoskeleton with a hybrid system allowing both a voluntary and an autonomous mode of action to support training of gait (Wall et al., 2015). HAL includes a control algorithm with supporting devices, where each knee and hip joint can be controlled independently (Kawamoto, 2002). Another new direction in the BCI research is represented by the cognitive BCI, whereas instead of decoding movement-related signals from motor cortical activity, researchers seek to access the content of cognitive processes such as, for example, attention (Astrand et al., 2014). Yet another development are the attempts of using BCI technology to augment the human ability of predicting future events (Pezzulo et al., 2016).

Recently, it has been demonstrated that the BCI strategy could be extended to brain-to-brain interfaces for shared information processing (Pais-Vieira et al., 2013). In this innovative study, two rats, located in separate laboratories, had electrode arrays implanted into the sensorimotor area of their brains. One rat was the "encoder" – its brain sensed the sensorimotor information during different tasks performance. The electrode array monitored cortical activity generated in the brain of the "encoder" rat and relayed it to the second "decoder" rat. The electrode array implanted in the brain of "decoder" rat electrically stimulated it with the temporal and spatial brain activity patterns received from the "encoder" rat. As a consequence of such brain-to-brain interface, the behavior of the "decoder" rat was guided by brain activity of the "encoder" rat, thus resulting in similar task choices done by both distantly located rats (Pais-Vieira et al., 2013). This impressive experiment shows that rats linked through brain-to-brain interface could learn complex, cooperative, and goal-directed behaviors. An impressive development of this line of research was presented by researchers from Duke University in Durham, who have shown that three brains of monkeys with implanted electrodes can operate collaboratively as a single "brain net" to move, in a coordinated fashion, an avatar arm (Ramakrishnan et al., 2015).

Similar brain-to-brain interaction has been shown in humans. Grau et al (2014) used non-invasive electroencephalography (EEG) measurement of brain activity in a "source" brain of one person and sent a coded EEG-signal through the Internet to a "receiver" brain, which was then stimulated using transcranial magnetic stimulation (TMS), thus establishing an alternative (direct) line of communication between the distant brains of two conscious humans. The authors of this study stressed that it is probably more accurate to use the term *mind-to-mind* transmission here as opposed to brain-to-brain, because both the origin and the destination of the communication involved conscious activity of the subjects (Grau et al., 2014).

Further, there are already proposals concerning possible future bidirectional brain-to-brain interaction applications. In this context, Yoo et al. (2013, p. 7) suggests that "if both BCI and CBI are implemented between two awake human subjects, the information flow could be made bidirectional and communicative between apperceptive identities/individuals."

As these technologies get more sensitive, smaller, smarter, and more portable, new applications in cognitive, social and clinical neuroscience will follow instrumenting human brains with unlimited memory, calculation, and communication abilities. One may expect that the future widespread use of human brain-to-brain mediated communication will create novel possibilities for human interaction with broad social and ethical implications (Trimper et al., 2014; Hildt, 2015).

3.4. Neural engineering and neuro-prostheses

Recent technological advances in BCI/BMI have renewed the interest in implantable systems (neuro-prostheses) for interfacing with the central and peripheral nervous system. As a result, research efforts led to the discovery of neural population coding for directional motor commands (Deca and

Koene 2014) and stable brain cortical maps responsible for motor control (Ganguly and Carmena, 2009). These discoveries have enabled the development of technologies for controlling prosthetic limbs by means of chronic multi-site neural implants in non-human primates (Nicolelis et al., 2003; Gilja et al., 2012), as well as controlling a cursor, wheel chair, TV remote, or a prosthetic hand in humans by a single neuron or by an ensemble of neurons with the help of implantable devices (Hochberg et al., 2006; Simeral et al., 2011).

A related line of research focuses on the possibility of enhancing memory or performance using neuro-prosthetic implants. For example, Berger and colleagues (2011) have shown that a neuro-prosthetic implanted into the rodent brain can enhance performance and improve short-term memory through real-time measuring and stimulation. Further, the possibility of using neuro-prosthetics for the extraction of particular neural information from one rodent brain to successfully induce, recover, or enhance memory related processing in the brain of another rodent has also been demonstrated (Deadwyler et al., 2013). Another potential extension of this line of research focuses on the possibility of replacing damaged brain regions with prosthetic devices replicating their neural functionality. Researchers have designed a neuro-prosthetic model replicating hippocampus functions that has successfully enhanced decision-making performance in monkeys (Dibazar et al., 2013; Hampson et al. 2013). Likewise, a prefrontal brain neuro-prosthetic can reverse the pharmacological disruption of normal decision-making in a monkey (Hampson et al. 2012).

Another important step toward neuro-prosthetic restoration of lost brain function has recently been made by Herreros and colleagues (2014). They successfully demonstrated that a rat can learn and form a new reflex even though its natural brain circuit responsible for this task has been chemically inactivated via anesthesia. This was possible due to neuro-prosthetic interfacing during anesthesia, when the task of forming new knowledge was "outsourced' to a linked neuro-prosthetic system (Herreros et al. 2014). Eventually, similarly improved neuro-prosthetics will have programmable options for pre-existing individual experience-based adaptations, capability of acquiring new behaviors, and the potential to replace damaged brain tissues and systems.

The most recent research efforts in this domain have focused on understanding how the brain incorporates the prosthetic device into its neural representation, thus leading to a subjective feeling of "owning" a device as an extension of the body's schema – embodiment (De Vignemont, 2011). One may think of it like a very primitive version of an avatar. What researchers are aiming at is a sensorization of the prosthetic device – when the neuro-prosthetic device is able to read and send tactile, spatial, and sensory information back to the "host" brains so that they can "feel" this information and respond or adjust to real-life situations in real-time, thus fully closing the BMI loop (Suminski et al., 2010; Vidal et al., 2016). One day, such BMI/neuro-prosthetic systems could even surpass natural biological capabilities, for example, prosthetic eyes which register short-wave electromagnetic radiation.

3.5. Neural Dust

The latest innovative extension of BCI/MCI/neuro-prosthetic research is the so-called “neural dust” interface (Seo et al., 2013). Neural dust (or neural dust mote) is a collection of millimeter-sized, wireless, battery-less, devices which operate as nerve sensors that can get data in and out of the brain/body. The tiny sensor motes are made up of a piezoelectric crystal that can be pinged by external, ultrasonic vibrations (Seo et al., 2016). The crystal converts those ultrasonic vibrations into electricity, powering a transistor that is connected to a neuron, nerve or muscle fiber. An external decoder wirelessly reads and translates changes in the vibrations (“echo”) that come back, interprets them and then feeds it back to the organism. The current challenge is to scale these dust motes down to 50-microns or less, which would then allow researchers to use them in the brain. Eventually, neural dust motes could be placed throughout the brain, allowing a person to control a robotic limb or computer, or to even store, “play back”, and communicate memories and thoughts. Unlike the current implantable sensors, which degrade within a few years, neural dust could last in the brain for a lifetime. At present, there are several laboratories working on this technology at UC Berkeley, MIT, and Harvard.

3.6. Brain stimulation

Transcranial magnetic stimulation (TMS) is a non-invasive procedure in which a changing magnetic field – induced from a coil held near the head – is used to cause change in the activity of neurons in the cerebral cortex (Rossini and Rossi, 2007). It can either increase or decrease the excitability of the cortex, thereby changing its level of plasticity (Hummel and Cohen, 2005). While TMS was originally used for investigative, diagnostic, and therapeutic purposes (Nollet, et al., 2003; Lefaucheur et al., 2014; Bestmann and Krakauer, 2015; Dougall et al., 2015), recent applications have extended to “healthy people” (Clark and Parasuraman, 2014). These include the enhancement of procedural learning (Pascual-Leone et al., 1999), which is the unconscious learning of operations that affect performance; enhancement of the working memory (Luber et al., 2007); motor task performance (Bütefisch et al., 2004); reaction time (Kobayashi et al., 2004); and attention (Hilgetag et al., 2001). Exciting results have been obtained by Dr. Snyder’s group, which has demonstrated that creative and artistic skills (Snyder et al., 2003, 2004), as well as mathematical abilities (Snyder et al., 2006) can be temporarily improved by means of TMS intervention.

Another major non-invasive brain stimulation technology is Transcranial Direct Current Stimulation (tDCS) that modulates brain functioning via the application of a low-amplitude direct current through scalp electrodes (Nitsche et al. 2003). This current can either increase or decrease neuronal excitability, depending upon the polarity and spatial arrangement of the electrodes. Similar to TMS, the application of tDCS can also be used to enhance attention, learning, and memory (Clark et al., 2012; Coffman et al., 2012; Falcone et al., 2012), as well as visuomotor coordination (Antal et al., 2004), vigilance (Nelson et al., 2014), and motor learning (Cantarero et al. 2015).

Optogenetics is yet another neurostimulation technique that involves the use of light to control genetically modified cells (typically neurons) to be sensitive to light (Deisseroth et al., 2006). This technology enables control and monitoring of individual neurons in freely-moving animals and to precisely measure the effects of these manipulations in real-time. It has been shown that with the help of this technology it is possible to improve several cognitive functions, like object feature selectivity and visual perception (Lee et al., 2012), and associative-recognition memory (Benn et al., 2016). The first clinical trials to test this technology in humans are on the way.

Importantly, these technologies could cause long-lasting plasticity in the brain that extends far beyond the intended augmentation effect and this should be studied.

3.7. Silicon or synthetic neocortex

Ray Kurzweil, a prominent figure within the posthumanist movement, who is a computer scientist, inventor and futurist, and recently a director of Engineering at Google, advocates that rather soon (within next 20 years) we will basically expand our biological neocortex by linking it wirelessly to a synthetic neocortex in the cloud (Kurzweil, 2014). He believes this will be done through nanobots or neural dust interfaces (that we have briefly observed above). According to Kurzweil, such a hybrid of biological and non-biological neocortex, will result in an exponential increase in thinking and cognition in humans. The only precedent to such an event is the grand expansion of the neocortex around two million years ago when primates first became humanoids. That cortical expansion resulted in a massive qualitative leap to an additional quantity of thinking, the creation of consciousness and, as a consequence, language, art, science, and technology. Other primates that did not get such an evolutionary bootstrap remained within the confines of “typical” animal behavior.

3.8. Digital cognitive phenotyping

Several researchers have taken the Extended Mind philosophical viewpoint (Clark and Chalmers, 1998) as the framework for studying extended mental states and cognitive phenotyping (for a review see Raballo, 2018). According to this conceptualization, our minds extend beyond the "demarcations of skin and skull" seamlessly incorporating external tools that enhance our cognitive resources. Some researchers, – as e.g. Dr. Insel (ex-director of the National Institute of Mental Health) – have even suggested that digital technology could be used for "a new science of behavior": digital phenotyping (Insel 2017). The main idea is that digital phenotypes are the meaningful descriptive features extrapolated from multimodal, digitally enabled, personal technological devices. According to Raballo (2018) achieving this step would require a broad and dynamic (re)conceptualization of psychological and behavioral phenotypes as they emerge and are continuously measured through the human–digital interaction. It is expected that this high-resolution digitally enabled phenotyping could allow a multimodal profiling of individual neurocognitive performance and cognitive-emotional states, which unfold continuously in real-time while the individual is interacting with personal technological devices. This may have a major novel implication not only for scientific research, but also for the broad spectrum of practical applications. At least in the domain of biomedicine it is already well-established that digitally extracted information brings an unprecedented descriptive resolution with important implications to psychiatry and related cognitive and behavioral sciences (Oellrich et al., 2016). For example, it has been shown that detailed analysis of an individual's motor behavior, revealed as the keyboard typing patterns on personal devices, could lead to early diagnosis of Parkinson's disease (Giancardo et al., 2016), or that mobility patterns obtained from people who carry smartphones during their normal daily activities can be reliably used to diagnose early cognitive impairment signs resulting from Alzheimer's disease (Nieto-Reyes et al., 2017).

3.9. Uploading a human mind to a computer

One of the most breathtaking, fantastic, and unnerving pieces of technology is uploading of the human mind to a computer. Bostrom (2009) has given a concise, but methodically structured description of how this may work. First, a sufficiently detailed scan (anatomical and functional) of a particular human brain is created. Second, using this scanning data, a three-dimensional neuronal network is reconstructed alongside detailed neurocomputational models of the different types of neurons contained in the network (which will implement the cognition of the original brain). Third, the whole computational structure is emulated on a powerful supercomputer or in a computational cloud. If successful, it is hoped that such a multistep procedure would result in a qualitative reproduction of the original mind, with memories and personality intact, onto a computer where it would now exist as software. Further, such a mind could either live in virtual reality or inhabit a robotic body.

While such a scenario may sound far-fetched, it is a fact that major brain research consortiums such as The Human Brain Project in Europe, The BRAIN Initiative in USA, The China Brain Project, and The Brain/MINDS Project in Japan are all working towards understanding how human brain generates the mind, how to go from a physical substrate of hierarchically interconnected neurons to subjective world of images, thoughts, memories, and feelings. Although the complexity of this question is staggering, several theories of consciousness provide a cautious optimism that, in perspective, the digitizing of human mind/consciousness will be possible (Baars, 1997; Hesslow, 2002; Crick and Koch, 2003; Tononi, 2004; Fingelkurts et al., 2010, 2013; Webb and Graziano, 2015). Once more, science fiction is likely to become science reality. Currently, there is intensive conceptual and experimental work going on in the field of artificial consciousness (Marques and Holland, 2009; Fingelkurts et al., 2012; Winfield, 2014).

Let us now imagine that digitizing the human mind/consciousness is possible, that your brain is scanned, and the simulation of your mind is initiated. A copy of you wakes up in the virtual computer, with the same memories, same attachments, and personality quirks that make you YOU. But is it you? What if several copies of your uploaded mind were made and run on different computers, will all of them be you? What if one of them loses its sanity, is it still you, or just the manifestation of change? In other words, are those qualitatively identical but numerically distinct streams of phenomenal experience? Are they aware of their own “self-multiplicity”? It seems that the location of self and identity will be radically challenged and the familiar core assumptions about the nature of the self as well as personal (legal or moral) responsibilities will be shaken by such technologies.

This brief analysis shows that, in perspective, the development of neuro-technologies alongside with genetic, biomedical, and artificial intelligence advancements will transform humans into something else entirely; free humans from problems and limits of biological corporality like pain, disease, fatigue, instinctive drives, aging and death; and enable humans to enhance their cognitive, intellectual, and creative capacities in unprecedented ways. This will be a new type of human with many God-like qualities as some suggest (Harari, 2016). Others argue that such a self-guided transformation (“*playing God*”), coupled with the rejection of God, will bring more harm and suffering (Gan, 2010). Here, “playing God”, as discussed by Fuller and Lipińska (2014), is defined as a situation in which humans “have arrogated for themselves divine powers, while refusing to credit God for the inspiration" (p. 56). Another version of "playing God" is presented in Bostrom and Sandberg (2009; p. 327): "that it is sometimes better to respect 'the Given' than to try to better things using human abilities […]. The claim that society should stick with the status quo can be based on a religious sensibility, the idea that humans literally risk offending God if they overstep their mandate here on Earth. It can also be based on a less theologically articulated feeling that the proper approach to the world is one of humility and that enhancement would upset the moral or practical order of things; or, alternatively, on an explicitly conservative vision according to which the existing state of affairs has, due to its age, acquired some form of optimality".

So, should we wholeheartedly embrace these technologies, or it is a terrible prospect that should not only be avoided but actively resisted? While the last two claims against posthumanists' aspirations of "playing God" can be easily overturned because they basically argue against any scientific and technological development (which is unrealistic and immoral, since there are many diseases and problems that cause unnecessary suffering and inequality), the former argument "that humans literally risk offending God" requires further analysis. However, in order to reach an intelligent conclusion, we first need a firm understanding of human nature itself.

4. Human nature

Before rushing to embrace posthumanism it seems crucial to first know, what it means to have a human nature. It is an eternal, intricate and "hot" topic that generates endless debates. Indeed, human nature is embroiled in many topics (creation, evolution, heredity, essentialism, the animal-human divide, mentality, enhancement, morality, racism, sexism, etc.) and transgresses traditional boundaries between religion, philosophy, science, technology, and politics (Kronfeldner, 2018).

Despite the fact that the precise understanding of human nature has changed throughout human history (from Plato's/Aristotle's beliefs that rationality is a specific human trait that governs other aspects of the soul, to modern ideas where human nature is either "basically good" or "inherently bad"), human nature could be broadly defined as "the sum of the behavior and characteristics that are typical of the human species" (Fukuyama, 2002; p. 130). According to this definition, the following possessions, as *a whole*, differentiate humans (in essence) from animals: moral choice, human language, reason, sociability, feelings, sentience, and consciousness. The unchangeability or malleability of human nature is another point of contention, with trans/post-humanists defending the malleability postulate, which allows the improvement of human nature.

Since we are interested in understanding whether the posthumanist idea of improving human nature could “offend” God and since this argument is usually presented by Christian-minded people, we will focus on what follows on the Christian philosophical thinking on human nature.

Analysis of the respected literature about human nature reveals that “[u]nlike the other creatures, which are confined by the particular nature that has been given to them, being unable to go beyond what that given nature allows them to be, the human is being confined by no bounds. Additionally, it is the human himself who would fix his own limits” (Botez, 2017; p. 93). As the great Renaissance humanist Pico della Mirandola wrote in his “Oration on the Dignity of Man” (1486/1965; p. 4) God said: “We have given to thee, Adam, no fixed seat, no form of thy very own, no gift peculiarly thine, that thou mayest feel as thine own, have as thine own, possess as thine own the seat, the form, the gifts which thou thyself shalt desire”, and later, “thou wilt fix limits of nature for thyself [...]. Thou [...] art the molder and maker of thyself; thou mayest sculpt thyself into whatever shape thou dost prefer” (p. 5). In other words, humans do not possess a *definite nature* and nothing is stable or determinate in respect to the human being. While Pico della Mirandola insisted that he was a devout Christian, he was more of a Renaissance philosopher, and had his foot in the rational domain as opposed to pure theism. Let us then see what other Christian thinkers have to say on this issue.

Gregory of Nyssa, also known as Gregory Nyssen, is one of the most respected Fathers of the Christian church and was also canonized in Roman Catholicism, Eastern Orthodoxy, Oriental Orthodoxy, Lutheranism, and Anglicanism. To Gregory, human nature has to be unendingly perfected on the premise that the purpose of human life is to literally become like the *infinite nature* of God. He wrote: “His [God's] end is one, and one only; it is this: when the complete whole of our race shall have been perfected from the first man to the last […]” (Gregory of Nyssa, 1993). He went on to say that even when Moses, an archetypal Christian, had reached the highest “perfection” and could speak directly to God, “neither the fact that he addressed God as friend to friend, nor his intimate conversation with God put a stop to his desire for higher” (Gregory of Nyssa, 2012; p. 376). While for Gregory Nyssen a perfection of human nature is God’s will, he also makes it clear that this process is essentially endless. In other words, what was a gross unbalanced nature for Plato (1926) and Aristotle (1926), for Gregory of Nyssa, and within the Christian though in general (Botez, 2017), it became the very definition of what it means to be a Christian: no matter how high one climbs up in his/her perfection towards God, the ontological meeting actually never occurs, because “the place where (God) is found it is outside [ἐξώτερος] of every move to apprehend Him, and hence He completely escapes the grasp of those who seek/desire Him” (Gregory of Nyssa, 2012; pp. 376-377). The message is clear: the “no limits” approach to life should be observed by all who follow the Christian thought tradition.

This "never-ending" of the "*continually becoming*" understanding of human nature/identity within Christian epistemology (Botez, 2017) is in fact very close to the Buddhist epistemology on human individuality as not fixed but continually evolving (Chadha, 2015, 2017), as well as to the principle of "becoming" in quantum physics (Kallio-Tamminen, 2004).

Returning to Christianity, one may say that Gregory of Nyssa was a rather unconventional theologist and thinker (Ludlow, 2007); therefore, additional evidence from the Christian thought tradition may be of use. Another prominent Father of the Christian Church, Irenaeus was a theologist and was canonized in Roman Catholicism and Eastern Orthodoxy. He was a student of Polycarp, who was considered to have been tutored by John the Apostle (McDonald and Sanders, 2002). Irenaeus repeatedly insisted that humanity was created immature and that God intended his creatures to take a long time to grow into or assume the *divine likeness*. For Irenaeus (1885) the whole point of God's incarnation is about this intent: "God made Himself man, that man might become God". We find similar statements in the writings of Athanasius and Gregory of Nazianzus, yet other Church Fathers, Christian theologians, who were also canonized in the Catholic and the Eastern Orthodox Church. To speak of the possibility for human creatures to become divine, these early theologians used the Greek term "*theosis*" or its Latin counterpart, "*deification*", which basically mean "*become like God*" (Cole-Turner, 2018). "[D]eification is the fulfillment of creation, not just the rectification of the Fall. One way of putting this is to think in terms of an arch stretching from creation to deification, representing what is and remains God's intention: the creation of the cosmos that, through humankind, is destined to share in the divine life, to be deified" (Louth, 2008; pp. 34-35).

If we now turn to the most authoritative Christian source, the Bible, we read that Jesus asked his disciples to "go and do likewise" (Luke 10:37), further elaborating, "cure the sick, raise the dead" (Matthew 10:8). Jesus wants his followers to be as "children of God" (Matthew 5:9). He says: "You are gods, children of the Most High, all of you…" (Psalm 82:6). This message is most strongly re-iterated in the Sermon on the Mount, where Jesus said (Matthew 5:48): "Be perfect, therefore, as your heavenly Father is perfect." Through this appeal, according to Peter (1:4), we shall become nothing less than "partakers of the divine nature". These citations clearly show that the hope and yearning for transforming beyond human, beyond the current nature of our humanity, and entering into the "continually becoming" perfection, is the central promise of the gospel (Cole-Turner, 2015). So, Christianity is not only compatible with the desire to reach beyond ourselves, it actively encourages it (Botez, 2017).

Summarizing, one may conclude that posthumanism could be considered as a secular contribution to theosis or "salvation as transformation", and that, in this process, humans are valuable not for what they are, but for what they aspire to *become*. What this suggests is that posthumans will not be *Homo*

Deus, but rather *Homo Deificatio*, thus implementing the principle of the "never-ending becoming". This principle also offers protection against fetishizing the posthuman as a fixed "structure" in which the individual is sealed and blocked from further development, thus transforming into an idol.

5. Conclusions

We are in the midst of very powerful shifts in our understanding of what it means to be a human. There is a non-trivial chance that sometime in the future humanity will transform itself, leading to the emergence of posthumans with God-like qualities – *Homo Deificatio*. Such a transformation has great potential for both good and bad. It is therefore incumbent on the people of today to draw on the knowledge of philosophers, scientists, engineers, politicians, and theologians from different religious confessions, and have a productive discussion in order to prevent potentially catastrophic scenarios. Fascism is one such example, where the idea of perfecting human nature was perverted. This time, the social, political and philosophical consequences of similar negative scenarios are likely to be far worse, and the threats they pose are considerable.

For example, the philosopher and political scientist Francis Fukuyama (2002) regarded posthumanism to be extremely dangerous to democratic systems, a threat to human essence, and a destabilizing force that will lead to a radical inequality. Another thinker, Habermas (2003), criticizes posthumanism for sacrificing the moral autonomy of the individual in favor of social, political and economic interests. Similarly, other scholars argue that a gradual transformation of humans into posthumans may lead to slavery and genocide between the camps of transformed and non-transformed (Annas et al., 2002), or worse the extinction of human life altogether (McNamee and Edwards, 2006).

Fortunately, we still have time to do a proper analysis and debate the existential, moral, ethical, social and legal issues related to posthumanism; to understand where we are going and raise public awareness about the future of humanity, about what comes after us – humans.

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