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CYBORGS AND SMART MICE
HOW HUMAN CAN THEY GET?

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Abstract

There are at least two scientific debates concerning the possibility to offer enhanced lifetime to the human race. One of them derives from the medical sciences and the other from the computer sciences. The former has to do with improving the quality and length of human life by improving their biological systems, for example by way of smart pills. The latter concerns possible improvements of the quality and length of human life by correlating high technology with human beings. Medical scientists illustrate their research progressions using smart mice. Computer scientists present advanced robot models and other high-technological systems. To conquer nature seems to be humankind's everlasting driving force. However, the scientific dream of enhanced lifetime is problematic at least from a philosophical point of view. The aim of this paper hence is to give a critical philosophical analysis of the problems. After giving a brief historical view of the conquests of technology, the capacities of computer scientists to simulate human behaviour in computer systems is critically analysed. How are these capacities interpreted? Which consequences do these understandings have for human life? In addition, how is the medical success to produce mood and mutation drugs understood and which consequences is it thought to have for human life? What or who, in the end will save humanity? The first part of the article, which concerns computer sciences focuses on philosophical problems while the second part, which concerns medical sciences regards ethical problems.

Keywords: humanity, Cybernetics, artificial intelligence, Neuropharmacology, Cognitive neuroscience, Theology and Philosophy

1. Introduction

The philosopher Hypathia, who lived 370 to 415 AD, was said to possess *Plato's Brain and Aphrodite's Body*. For that time, having these features was considered as something extraordinary. Today we would not be impressed unless *Plato's Brain* implies: enhanced cognition, improved or reengineered memory, improved motor systems, attention, learning, mood and affect and furthermore, *Aphrodite's Body* would be reengineered with metal arms and legs, would be

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tremendously strong and insensitive to heat and cold, has no need for oxygen nor food and can be preserved for thousands of years.

2. Brief historical overview

Already in the 14th century, Leonardo DaVinci made drawings of a mechanical calculator. A working model of his calculator was constructed in 1967. In 1642, Blaise Pascal developed a calculating device called the *arithmetic machine* to help his father with his accountancy. Thirty years later, Pascal's calculating device was improved by Gottfried von Leibniz. Leibniz' machine could be used for addition, subtraction and multiplication. It worked with variable toothed multiplicand gears and variable sized multiplier discs. Interesting for the present discussion is also that Leibniz wanted to create a mathematics, which he baptized *Characteristica Universalis*, in order to replace all thinking by calculation. The idea is that instead of disputing (on whatever matter), the opponents simply make a calculation and the right answer automatically appears. Hence, dispute could only arise from mistaken calculation. In Characteristica Universalis, which is based on Euclidean geometry, one uses a small set of clear and self-evident postulates as a basis for generating the right answers to complex problems [1]. One could perhaps say that Leibniz was the first founder of Artificial Intelligence (AI).

Again two centuries later, Charles Babbage and Ada Byron Lovelace designed an *analytical engine*, which was a calculator that not only could perform arithmetical calculations but even all kinds of analyses, if their laws were known [2]. Based on some general principles that the machinery could translate into operations, the machine became what we today call, a general-purpose computer. It was novel in that it could be programmed and reprogrammed by way of punch cards. One might hence say that it is at this point that we have entered the computer age.

However, it would take approximately yet another century before this human creation would start to compete with its creator. Alan Matheson Turing was first to illustrate a challenge for humanity. He did this by way of an experiment, which is known as *Turing's test* or the *imitation game*. Roughly, a woman (Ada) and a man (Alan) take place before a computer. Both are sitting in their own cubic and have only contact with the world outside by way of a terminal on which they write the answers to the questions of the experiment. The task of the experiment leader is to find out which answers are Ada's and, which are Alan's. Ada has to answer the questions in a way that confuses the experiment leader while the Alan is supposed to answer her in a helpful manner. After a while, computer Z112 programmed to simulate human behaviour replaces Alan. If the answers coming from Z112 are in such a way that the experiment leader takes them to be Alan's, the computer is considered to be able to think, i.e. to behave with human intelligence, according to Turing [3].

In the 1950ties then Artificial Intelligence (AI) was born. The main goal was to exhaustively copy human cognition and language on a digital computer. According to Winograd, this goal has two distinct aims: firstly, to explain human mental processes as thoroughly and unambiguously as possible, and secondly to create intelligent tools, not necessarily duplicated from human intelligence, applying intelligence to serve specific purposes [1, p. 201]. The problem-solving power of an AI program derives from the knowledge it possesses [1, p. 208]. However, we need to observe that knowledge is seen as a kind of commodity to be produced, refined and packaged, there is no concern with the epistemological problems of what constitutes knowledge and understanding. Nevertheless, defenders of AI argue that the methods and theoretical foundations that are being applied to micro-behaviour (a microstructure) may be extended to cover the full range of cognitive phenomena (a whole human being), which included human knowledge, i.e. what constitutes knowledge and understanding [1, p. 209]. I will return to this later. The idea is that many distinct problem solutions will finally interpolate the wasteland in between (is it maintained that it is here intelligence emerges). Rule A is especially written for circumstances of A-type, and rule B is especially written for circumstances of B-type when combined, may lead to a solution for circumstances of C-type.

This was the time for philosopher to wake up. How could a machine be compared to a human being? Could a machine possibly think? There were many philosophical actors but one who is important for the present discussion and whom I hence want to mention is John Searle. To illustrate his objection to the suggestion that a machine could possess cognitive capacity similar to a person he forwarded the *Chinese room* thought experiment. Roughly, the idea goes as follows. Assume Searle in his office. The door is locked from the outside. Searle does not know any other language than English. Through ticket windows, he and Chinese persons exchanges notes consisting of Chinese characters. When he receives a note, Searle has to compare the written character with the signs in an instruction manual he has at his disposal. This manual is written in English and explains how he has to compose a Chinese answer to the signs on the note. However, the manual does not give any guidance concerning the meaning of the sign. For example, if he receives a note with the Chinese character 猴, he has to answer it with 羊. To Searle the characters 猴 and 羊 are completely meaningless symbols, but to not for the Chinese persons. Searle in the Chinese room is suggested to be analogous to a computer program, i.e. both perform a pure syntax manipulation of symbols. Searle does not have any clue what the Chinese signs mean, he simply does not understand Chinese. Nevertheless, the Chinese room experiment would pass the Turing test. To manipulate symbols is not sufficient to understand them in a cognitive sense. Computer programs are not able to think, i.e. to behave with human intelligence [4].

One of the objections to Searle's Chinese room argument and which is of interest for our discussion is the *Robot objection*. In the robot argument, it was suggested to replace the computer by a robot with arms, legs and a camera. It was then argued that the robot as a whole might behave with human intelligence, because, to interaction with the environment, to have impressions, to move and to handle things are essential parts of the process of thinking and understanding. Cognitive capacity, it was maintained, also includes perception and motoric abilities. Hence, cognition is not only a matter of symbol manipulation because it also comprises a range of causal relation with the environment. Searle counter argued, however, that a robot merely manipulates patterns without knowing what these patterns actually mean. This is an important remark as will become clear later.

The differences between a computer and a human being, or, more precisely, between computer processes and the human brain could be summarised as follows:

- Computer processes are independent of any hardware implication, which is not the case for the human brain.
- Every system that is capable to act, as a brain needs to possess the brain's essential and specific capacities. Hence, every artificial brain has *to copy* these capacities and not only *simulate* them. (Copy-paste)
- With computer programs only, one cannot handle mental phenomena in the way that the human brain can.

Winograd compared AI with bureaucracy and writes: "The techniques of AI are to the mind what bureaucracy is to human social interaction" [1, p. 211]. AI has similar advantages as bureaucracy, among others, its rational character, a lot of rules, means-end calculations, elimination of personal commitment or responsibility [1, p. 214].

Artificial Intelligent computer are not thinking machines. Something more was needed to make computers worthy competitors of human beings.

3. Philosophical discussion

Computational neural networks replaced hence classical artificial intelligence (AI). The program is such that it simulates the brain's structure. Briefly, the data is distributed and stored as a pattern in the connections (weights) between the different nodes (neurons) of a neural network. Each node operates on simple general principles. The fundamental intuition guiding this work is that cognitive structure in organisms emerges through learning and experience, not through explicit representations and programming. There are no rules for how problems are to be solved. Instead, the rules describe how the nodes are connected to each other, how the weights are to be modified and how the information between the nodes is transferred. A learning process is activated by presenting different patterns as well as correct answers to the program. Today, neuronetworks are successfully applied in computer programs for picture analyzing, recognition of fingerprints, speech recognition, and interpretation of written text, weather forecasting, or stuck-marked prognoses. There is thought, unbalance between symbolic and physiological description, i.e. the connectionism is inspired on biological systems but the detailed models typically assume a simplistic representational base similar to AI [1, p. 216].

However, that it is possible to simulate the human neural system does not mean that a computer neural network is equal to the human neural system. Nevertheless, there are scientists who believe that machines are conscious systems humans can download their minds into, and still end up as aware of their identity as before [5]. Some computer scientists even see this possibility as a necessity for the survival of the human species.

Evolutionary biologist Gregory Paul and computer scientist Earl Cox assert that a machine is "[b]asically, anything that uses energy to do work or that processes information according to an internally logical set of rules […]" [5, p. 37]. A computer is such a machine. However, computers need not to "be bi-digital machines that do calculations with a series of yes's and no's" [5, p. 38]. In the 30ies, Alan Turing presented his thought experiment about an information system that can be processed digitally, i.e. by way of series of *yes's* and *no's*, i.e. *does exist* and *does not exist*. What is important here is that the Turing machine is not overloaded by processing the same information over and over again but that there is room for *surprising* information to be processed. The machine is thought to have a *randomizer* [3, p. 34]. One could say that John von Neumann's computer put Turing's machine into practice.

A group of people they say may constitute a computer. For example, the late Quantum Chemist Per Olof Löwdin at the Uppsala university called his Ph-D students a *parallel computer* when they collectively but manually performed advanced calculation tasks he ordered them to do. A computer then is "any system that uses signals to process information via calculations that solve algorithms according to a set of rules". He continues: "furthermore, a computer can either be natural in origin or manufactured by intelligent systems" [5, p. 38].

Hence, a computer may be a biological system such as a human being or a mechanical/technical system such as a solar cell, a car, a robot or a mixture of a biological and a mechanical/technical system.

Since Gregory Paul is an evolutionary biologist, it is not surprising that the question is raised what is evolution? Paul and Cox answer, "Evolution is a living expression of a Turing machine […]" [5, p. 38]. They maintain that Darwin's theory of evolution should not only be adapted to life, but also to technological and economic systems and human societies. Furthermore, according to them Darwin could not know that biological evolution is based on RNA and DNA, which can be represented as digital computers. Consequently, evolution is an 'information processing system' [5, p. 48]. Moreover, they continue, what Darwin could not foresee either was that the rate of change would increase over time. This, they suggest implies that not religious faith (or culture, economy or medicine for that matter) will "save humanity or human souls, but technology makes it possible to save human minds" [5, p. 76].

Let me now try to reconstruct Paul and Cox’s thinking.

1. A machine is everything that uses energy to process information according to an internally logical set of rules.
2. A computer (machine) uses signals to process information according to a set of specific rules and can be natural in origin or manufactured by intelligent systems.
3. RNA and DNA are considered as digital computer (machines), i.e. Turing-von Neumann machines permitting change and randomness.
4. Evolution is based on RNA and DNA.

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5. Consequently, evolution is an information processing system, using signals according to a set of specific rules and permitting randomness and can be either natural in origin or manufactured by intelligent systems.

Thus, it seems that evolution is not only a biological theory. In addition, technology may benefit from it. Paul and Cox mean that evolution should not only be seen as a feature of life, but also of technology. Furthermore, as mentioned above, technology makes it possible to save human minds.

Since evolution also counts for manufactured machines and since the rate of change increases over time and furthermore, since the human race became more intelligent because of evolution manufactured machines will become more and more intelligent. Soon enough they will surpass the intelligent of their intelligent manufacturers.

6. Evolution also counts for manufactured machines (from premise 2).
7. The human race became more intelligent due to the evolution process

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8. Hence, manufactured machines will become more and more intelligent
9. The rate of change increases over time

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10. Consequently, soon manufactured intelligence will surpass human intelligence.

However, can this really be correct? The error lies, according to me in premise 3. Even if it is now known that DNA/RNA are not mechanical in nature but information-moving units doing no physical work [5, p. 49], DNA and RNA are and remain biological life systems while computers are and remain calculating machines made by biological life systems, i.e. human beings. Therefore, conclusion 5 is wrong. There cannot be an evolution of the manufactured machines because there is nothing like a ‘computer race’ such as the ‘human race’ to evolve. There can be no mutations or reproductions of manufactured machines. Two computers do not produce small computers carrying on their *computer genes*. There are no computer genes. In other words, premise 6 is erroneous too. According to me, Paul and Cox *confuse evolution with development*. It is true that it took approximately 500 years to *develop* the von-Neumann machine from a DaVinci’s mechanical calculator. However, this is not the same as saying that the von-Neumann machine *evolved* from it.

However, are also the premises 8 and 9 erroneous? Can manufactured machines become more and more intelligent? As mentioned above, the Turing test was meant to argue for the thought that a computer could operate in a way that it *seems to think*, i.e. behave with human intelligence. Philosophically, this is problematic, in other words, what is meant by *thinking, intelligence, common sense* and *understanding* need be clarified, because these concepts are often confused. Take for instance the following example of a thinking-intelligent-understanding machine called Cyc. Cyc is kind of computerized artificial intelligent encyclopaedia.

Cyc is […] a sort of *thinking* encyclopaedia, ergo Cyc [and] uses programs to integrate and *understand* what it is told. When it is perplexed, it asks germane questions. […] Cyc can successfully define new concepts in terms of other concepts. […] Cyc will get to the point that it will do better reading about facts on its own, rather than being spoon-fed data. At this happy stage, humans will become tutors for a truly self-learning machine. [The] ultimate hope is that Cyc will be the basis for the first generation of truly *intelligent*, *common sense* systems very early in the next century [21st] [5, p. 102]. Cyc is today available and some versions are free of charge. Cyc is an artificial intelligence project which attempts to assemble a comprehensive ontology and database of everyday common-sense knowledge with the goal of enabling AI applications to perform human-like reasoning [6].

Is the following sentence true: I am intelligent, thus I think? Consider the following example. Maria has a very peculiar gift. One day a matchbox fell on the floor releasing a certain amount of matches. Maria looks at it and says 148. Upon the question how she knew how many matches were on the floor she answered that it was easy because the amount was equal to four times the prime number 37. Her gift consisted in recognizing prime numbers. Can we accept this as an intelligent performance? I believe we can because what Maria did was recognizing a pattern and that is an intelligent act. However, did Maria think? She probably thinks a lot but in this case, she did not need to. Intelligence does not necessarily imply thinking. Thinking implies reflection. It implies to contrast several possible solutions or outcomes and to draw a good solution. Hence, the sentence I am intelligent thus, I think is possible but not true. Computation is also about symbol manipulation and pattern recognition. In this sense it may be plausible to say that the computer displays human intelligence-like behaviour, but that does not imply that it is plausible to maintain that the computer also thinks.

Can the capacity to understand be a computer feature? If we mean by to understand, to be able to perform a logical analysis, I think it is plausible to describe it as a possible component of a computer program. For example, if the radio switch is turned on, there is music, i.e. if A occurs then B. However, if by to understand, we mean to be able to know exactly what is happening, I suggest the answer to be different. To the question why is there music, the logical analytical answer would be because the radio switch was turned on. To understand that music needs sound waves, i.e. air that vibrates in different sequences and with different amplitudes is not a feature of logics and algorithms. This type of understanding is perhaps a characteristic of the human species only.

Paul and Cox maintain that Cyc is a truly intelligent common sense system. If they are right, what could they mean with common sense? To think we need to reflect as was mentioned above. Common sense does not necessarily involve reflection. It rather based on having the necessary information to make a good assessment of the situation. Common sense can be understood as a feature that involves logics. For example, a common sense opinion could be as follows: if A and B but not C then it may be the case and probably will be the case that D, hence D. If we put water (A) in the freezer (B) and do not add any heat (C), than we will have ice (D). Understood as such a computer program, for example a neural network program, might include a common sense-like element.

To the question whether it is plausible to state that computers will become more and more intelligent, the answer is *yes* if by intelligence is meant to manipulate symbols and recognize patterns (how complex these might be) but *no* if its intelligence is understood to include thinking. Consequently, premise 8 should be replaced by 8´.

Premise 8´ then says that manufactured machines will become more and more intelligent, i.e. they will be constructed to manipulate more and more advanced symbols and to recognize more and more complex patters.

Premise 9 concerned the rate of change. However, what is this premise actually based upon? The idea is that because everything was simple at the beginning of the universe, there was not much information to be processed and thus, the rate of change was slow. However, the more complex things started to become (not least since *Homo Habilis* made the first tools), the more information that had to be processed and the faster things changed. And thus, the more information that is processed, the more complex systems become with the result that even more information has to be processed etc. [5, p. 64] Evolution is seen as information processing progressive process system.

In addition, this premise, I believe, is problematic. Firstly, that it took approximately 10 billion years before single-cell life forms evolved on the planet Earth, and only 600 million years between the evolvement of multicellular animals and reptiles, and only 26 million years between big-brained primates and hominids, it does not imply that there is a similar evolutionary relation between the evolution of homo sapiens and development of agriculture and finally of high-technology. Secondly, the speed by which human beings are able to develop things cannot be compared with the speed of biological evolution. We are talking about two different categories and two different logical levels. Human beings are part of the biological evolution something which human constructions (at whatever speed) are not. I believe we can conclude that premise 9 is erroneous. Hence, the conclusion, that manufactured intelligence will soon surpass human intelligent is based on erroneous and incomplete premises.

Nevertheless, Charles T. Rubin maintains that computers will “at the very least, be capable of responding to stimuli in ways that are indistinguishable form human responses.” Furthermore, neuroscience provides us with more detailed and exact information concerning how the brain works. Computer scientists study these neurological observations in order to duplicate the functions of the brain in machine circuits [7].

There are today humanoid robots that seem to have some kind of consciousness and other human characteristics such as motivation, emotions and cognition. In order to construct these humanoid robots the relationship between parent and child is studied. Computer scientists study the attachment theory, a theory used by psychologists. According to Arkin, the relation between a mother and her child is a “primary example of an inter-reaction where the child prefers to be close to the mother in unfamiliar situations, especially when young” [8]. Entertainment robots are constructed in such a way that they give the human the illusion of being alive and that an emotional bonding can be established between the human and the robot. Hence, they are programmed to learn emotional grounded symbols (neural networks). When they hear the symbol’s name spoken, they know which behaviour is associated with that symbol. Arkin writes that the robots in a sense know what the symbol stands for, “in a way in which it affects both [their] internal state and what behaviours are the correct ones to use in the associated object’s presence” [8, p. 24]. In other words, they recognize speech and seem to behave emotionally.

Cybernetic Kevin Warwick introduced a real interaction between humans and robotics. He implanted a computer chip into his left elbow (1998). The chip included an electromagnetic coil radio receiver. He described the chip in his arm as the ‘ultimate man-machine interface’ [9]. Warwick had sensors placed in his department and home that could detect him by communicating with the chip. For example, when he came in his office, a computer voice would say “Welcome, Professor Warwick”. This voice would also tell him how many mails he had received. When he came home, the light automatically switched on, music started to play and the bathwater began to run. Hence, his computerized body interacted with the environment.

However, does this implant really qualify Warwick as a cyborg? How then should we classify persons who have a pacemaker or other advanced technological implanted? For instance, persons with chronic diseases who have computerised sensors implanted detecting changes in their metabolism. These sensors transmit the data via a mobile phone to the patient’s doctor [10]. It is maintained that a person with a spinal-cord injury has better chances of recovery when they have a special developed chip implanted [11]. Do these persons then become cyborgs? Another implant that would turn humans into cyborgs would be the BrainGate system. The system has a silicone chip and electrodes that can be implanted in the brain allowing paralyzed persons to operate a computer with their thoughts [12]. Furthermore, would persons with Parkinson’s disease who have a brain implanted allowing them to perform normally also be considered as cyborgs? [13] A last example of an implant that would transform a person into a cyborg is the VeriChip implant, which contains a Global Positioning System. An individual with a Veriscanner has the capacity to find another person's position.

The question is how much technology has to be implanted into a person to transform the person into a cyborg. How many organs have to be replaced with technological systems? When does a person end to be a person and become a cyborg?

Charles T. Rubin asserts that in the future, human beings, realizing being inferior intelligent machines, will voluntarily transform themselves into machines, i.e. become cyborgs.

Let us reconstruct what has been said:

1. Computer scientists duplicate the functions of the human neural system in machine circuits.
2. Robots speak and recognize speech and seem to behave emotionally. They respond to stimuli in ways that are indistinguishable from human responses.
3. But human beings are inferior these intelligent machines
4. Many people today have computer implants that improve their health or other conditions.
5. Consequently, people will voluntarily transform themselves into machines, i.e. become cyborgs.

Premises 1, 2 and 4 seem to be correct as such. Premise three depends on what is meant. If it is meant that contemporary computers are build with processors that can perform advanced calculations much faster than human being would be able to do, then also premise 3 is correct. However, when the entire human intelligence, including her rationality, social intelligence, etc. is compared to a computer, than the premise is false and it becomes quite difficult to find a rational reason for why people would want to transform themselves into machines.

However, even if we assume that premise 3 is correct, we are still left with some problems. Firstly, to duplicate the functions of the human brain is not the same as to copy (and paste) the human brain. Therefore, robotic speech is not equal to human speech. A robot's voice does not sound sad or happy. That the robot seems to behave emotionally is very different from the robot having emotions. For instance, imagine a robot down on its knees and pray. To whom would the robot pray? A robot may seem to be in love, behave like a human being in love but does the robot feel butterflies in its stomach or think about the other person all the time? Even though there are today implants that can cure people or improve their situations, this does not imply that it is possible or wishful to change all organs and limbs with cybernetic alternatives. Hence, even if we could accept the premises to be correct one by one and as such, they are false *in relation* to the conclusion that is drawn.

4. Ethical discussion

Advanced imaging technology allows neuroscientist to see which parts of the brain have altered activity because of different drugs. Since brain activity directly influences our health and behaviour to "*read* the brain will be exploited [...] for purposes as screening job applicants, diagnosing and treating disease, determining who qualifies for disability benefits and, ultimately, enhancing the brain" [13]. Today, at least in the United States, lawyers consider to submit brain scans to prove their clients innocence. Military pilots, astronauts and secret agents may be asked to undergo a scan test in order to see how they respond to stress. Victims of war, for example, can erase their horrifying memories by way of pills. Special pills, such as Ritalin, are very helpful for claming the nerves and increasing concentration when important exams are at head. Smart mice are now the stalking horses for new pharmaceutics. These little animals are given a memory drug. Normally, a mouse needs approximately 15 minutes to explore its environment to be able to remember it in such a way that the mouse will notice any change of the environment later on. However, with the memory pills or smart pills as they are called, the mouse only needs three and a half minutes to do the same.

Today there are specific drugs that provide human beings enhanced cognitive abilities, as well as improve their memories. Furthermore, Medicine intended to treat Alzheimer's disease, severe depressions, multiple sclerosis and other clinical conditions, are now tested and sometimes even regularly used, by healthy people in order to increase their memory, to enhance their cognitive abilities and to sleep less, stay up longer and work harder [14].

Assume that these smart pills do not leave any unwished side effects; is there something fundamentally wrong with trying to improve our brain capacity? As Anjan Chatterjee asked, would you, knowing that there are no or only very mild side effects, take a pill before Danish lessons so that you would learn the language much quicker, or give a similar pill to your child for a similar purpose? Would you be willing to pay more for a flight ticket if you knew that the pilot had taken pills making him or her more alert in emergency cases? [15] Would it be wrong to use medicine to treat Alzheimer's disease to improve normal memory? Is it wrong to take a pill and learn Chinese in minutes or to city complete books or part of books?

At least three objections could be put forward.

Firstly, one could say that it is *unethical* to use such pills because; some would be able to improve their brain while others will not. Caplan, however, rejects this argument because; there are already mind-improving facilities, which are unfairly distributed. To give some power to his argument he presents the example of his son going to a private school. He writes, "people in a poor neighbourhood do not say `I would be ashamed of myself for giving him an advantage´ but rather `I wish I could do that for my child´" [13]. The solution is, he says, to se to it that *all people* have access to brain improving facilities (be its pills or computer chips). However, is Caplan's argument really a good one?

Surely, our world is unfair but does this mean that it has to continue to be that way. According to me, Caplan's argument misses the point. Brain imaging technology is very expansive. This implies that not all patients who would benefit of an Imaging Technological diagnose will be able to do so, due to the cost. How then does Caplan think, a solution would look like that gives everybody access to the possibility to scan his or her head (without being ill) in order to see what can be improved and to improved it? Who would pay the cost?

As mentioned above, surgeons do quite some implants such as pace makers but until now, *only* to *heal* patients. (Except from plastic surgery) These implants are not meant to make a perfect working heart even better! How do we want to divide our financial resources in the world? Do we want some chosen people who, thanks to the advantages and the landmarks of SciTech, can live healthy for many years or do we want a world in which all, or at least as many as possible, can live a good but normal human live, where people have access to advanced medicine when they need to. Do we want an artificial world or a natural world? Better, do we want the artificial part of the world to dominate the natural part of the world or do we want a fair balance between the two?

A second objection is that brain enhancement is wrong because it involves *coercion*. People might feel that they are forced to enhance their brain in the hunt for jobs and social success. The argument Caplan puts forward now is that we have to make sure that enhancement always is done by choice and is never dictated by others. The question is how much choice would we have? Usually, employees test the applicants by way of IQ-test or other job-related tests. Who then would have the biggest chances to get the job? Would it be the applicants who enhanced their brain or those who have not? Would it be rational to think that one would do better with some brain enhancement? Even if the choice is made by the person him or herself, the choice cannot be said to be entirely voluntarily.

A third objection is that brain engineering is *unnatural*. The question is if we enhance our brains more and more, would we still be human or how human would we still be? Also to this argument, Caplan has an objection. He argues that we already wear eyeglasses, use insulin, have artificial hips or heart valves, benefit from transplants, ride on planes, dye our hair, talk on phones; write on computers, etc…nothing which is *natural*. Once again, I believe that Caplan's argument is beside the point. The question concerns when a human being stops to be a human being, i.e., it is natural for a human being to need time to learn a language, to forget or to need a certain amount of sleep. Another human aspect that could be discussed is a person's uniqueness. How unique would we be if all of us have exactly equal enhanced brain capacities?

4. Conclusion

It is time to draw some conclusion. It is clear that the medical and computer sciences have the possibilities to improve the human live in different ways. Their possibilities will probably even increase. If not the most important, than at least one of the most important questions to solve is, in my opinion, what exactly is the hallmark or core of being a human being? In other words, what is the very aspect of a human being that cyborgs cannot possess and smart pills cannot improve? The very aspect of human being is that what made Plato, Plato and Aphrodite, Aphrodite and Hypathia to be this intelligent philosopher with a well formed feminine body and everything else making Hypathia, Hypathia and nobody else.

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