
THE NATURALNESS OF THE NATURALISTIC FALLACY AND THE ETHICS OF NANOTECHNOLOGY¹

To appear in Hansson S.O. (ed), *Technology in science. Philosophical perspectives*, Springer

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Abstract In the first part of this paper, I try to clear the ground from frequent misconceptions about the relationship between fact and value by examining some uses of the adjective “natural” in ethical controversies. Such uses bear evidence to our “natural” tendency to regard nature (considered in a descriptive sense, as the complex of physical and biological regularities) as the source of ethical norms. I then try to account for the origin of this tendency by offering three related explanations, the most important of which regards it as the outcome of an adaptation: if any behaviour that favours our equilibrium with the environment is potentially adaptive, nothing can be more effective for this goal than developing an attitude toward the natural world that regards it as a dispenser of sacred norms that must be invariably respected. By referring to the Aristotelian notion of human flourishing illustrated in the first part of the paper, in the second I discuss some ethical problems raised by mini-chips implantable under in our bodies. I conclude by defending the potential beneficial effects of such new technological instruments.

Keywords: fact, value, natural selection, natural, adaptation, microchip, natural laws, symbionts

1 INTRODUCTION

Despite an increasing attentiveness to technology – focussing in particular on the epistemology of artificial models of natural systems and on the use of simulations and numerical calculations allowed by more and more powerful computers – philosophers of science still seem to be more devoted to the so-called “pure” science rather than to clarify the conceptual connections between applied science and

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traditional philosophical issues. The consequence is that, at least in the last century, a philosophical reflection on the nature of technology has been left only to continental philosophers and theologians, who are typically animated by a negative attitude toward it (see for instance Marteens, Lokhorst, and van de Pool 2010). The general public is therefore often misleadingly frightened by the cultural influence of these intellectual circles.

Traditionally, two philosophical issues have been considered to be central in the philosophy of technology. The first (Q_1), more discussed by philosophers of science, involves the question whether it is technology or pure science that is the driving force of our increased understanding of the natural world. The second (Q_2), much more discussed by continental philosophers and only recently by analytic philosophers, concerns the relationship between technology and values in general.²

Q_1) As to the former question, few remarks here will suffice. The first is that we are aware from historical studies on science that the role of technology has been essential both for the first scientific revolution (Rossi 1970) and for the so-called “second scientific revolution”, a process that, according to Bellone (1980), took place during the second half of the 19th century and culminated in the birth of relativity and quantum theory in the early part of the 20th century. Thermodynamics for example is a classical case in which an inquiry into the efficiency of the steam engine – a problem of engineering – has predated and made possible the formulation of phenomenological principles in thermal physics and, subsequently, of theoretical laws in statistical mechanics. The second remark is that the politically, economically and socially central problem³ whether new discoveries in pure science precede or are preceded by applied, technologically-oriented science, presupposes that the distinction between pure and applied science is clear-cut. But historical evidence shows that such a distinction is at best one of degree, and even in the discipline where it might seem to be more at home, *mathematics*, pure and applied mathematics are in constant and fruitful interaction. As is well-known, the branches of mathematics that are regarded as *pure* do not remain “unapplied” for long, and are often those that unexpectedly display more “applicative” or “technological” power. Abstract computability theory, a

² Today many more questions are being discussed, but here I refer just to these two traditional issues.

³ The political, economical and social importance of the problem of the relation between pure and applied research depends obviously on the fact that many governments, in periods of economic crisis, tend to cut budgets for research programs that have no immediate applications and are regarded as “pure”.

branch of pure logic, has become the basis for the production of computers, and has therefore been the springboard of a good part of the world economy today. The application of number theory to cryptography is a second well-known example that, together with the application of group theory to current, might be sufficient to illustrate the power of pure speculation in generating new technology.⁴ On the other hand, it is from branches of applied mathematics (computer-generated proofs) that have often come the solutions to problems of pure mathematics, and the role of physics (applied mathematics) as a stimulating factor in the growth of pure mathematics hardly needs any illustration (think of Newton's invention of the calculus, of the use of statistical methods in physics and the growth of probability theory or Dirac's delta function and the theory of distribution).

Q₂) Under the heading "ethics of technology", I think that not only should we count the relationship between epistemic values (explanation, consistency, evidential strength, etc.), served by scientific theories, and non-epistemic values (economical, social, political, etc.) called into play by technology (Dorato 2004), but also the relationship between technology and the controversial notion of "human flourishing". Considering that contemporary neurocognitive sciences tell us that we discover our most important values through emotions and through emotions we choose,⁵ it is becoming more and more important to tackle the literature from a new angle, offered by what, for lack of a better term, I will refer to as "*our emotional attitudes toward the dyad nature/technology*". As far as I know, the perspective offered by this angle has been neglected in the analytic philosophy of technology. And yet, the above-mentioned radically negative attitudes toward technology in general – that are typical in much of what Mitcham (1994) referred to as 'humanities philosophy of technology' – are widely shared by the public and often dictate political agendas. Such negative attitudes need to be understood more thoroughly, since they might reflect a deeply rooted and possibly *innate* emotional attitudes toward nature and our place in it. Until they are better understood, I maintain, also the ethics and politics of technology will suffer from superficiality.

More in details, the two main theses that I will articulate in this paper are as follows:

⁴ Consider that quantum mechanics is, on its turn, at the basis of most of today's technology.

⁵ See among others Damasio (1994, 1998) and Le Doux (1998).

T₁) If we want to understand the impact of new technology on the wide public (nanotechnology in particular), we must first pay attention to our pre-theoretical, emotional attitudes toward nature. Such attitudes include the fact that we tend to refer to nature as a source of ethical norms, for reasons having to do with our evolutionary past (both biological and cultural).

T₂) fears of technology (in particular, of nanotechnological devices implanted in our bodies, which will be the object of a brief case-study in the second part of the paper) are mainly motivated by these attitudes.

The plan of the paper is as follows. In section 2 I will show the ubiquity of attempts to deduce norms from empirical generalizations taken from the biological world. A simple analysis of the words “nature”/“natural” will reveal this fact. The well-known, ensuing confusion of the fact-norm distinction has been denounced several times from Hume onward, but it is important to understand that the tendency to fall prey of the naturalistic fallacy is quite “natural” on our part and needs to be discussed in the wider context of the Aristotelian notion of “human flourishing”. Section 3 will provide some hypotheses to explain the possible origins of this tendency, by stressing not only its possible adaptive value but also the role of anthropomorphic projections of our mental and social setups onto the natural world. In section 4, I will finally discuss the case study given by implantable chips by arguing that current and foreseeable developments of this form of nanotechnology are *not* so threatening after all, provided that we have a clearer understanding of the origin of our fears and that we exercise prudence and wisdom.

2 SOME PARADIGMATIC EXAMPLES OF APPEALS TO NATURE AS A SOURCE OF ETHICAL NORMS⁶

Many of us have not come to terms yet with the rapidly changing image of our place in nature that the development of science and technology has fostered in the last five hundred years, in particular for what concerns the relationship between facts and values in the application of technology. The following list of examples, which I present as slogans in order to stress their rhetorical appeal, has the purpose to show the importance of the adjective “*natural*” in arguments trying to justify ethical and

⁶ This list was discussed also in my Dorato (2012).

social norms. The comments that follow the list have will set the theoretical framework against which I will discuss the particular case of implantable microchips.

- 1) Unequal distribution of resources is often justified by social darwinists' slogans of the kind: "it *natural* that the stronger prevails over the weaker";
- 2) "this action, this law, this rule, this technological device trespass the limits of *nature*" is a frequently used appeal, based on an allegedly normative notion of "human nature";
- 3) "this is natural, *biological* food", is frequently used by environmentalists and movements that want to defend non-adulterated food;
- 4) "mammals are *naturally* carnivorous, or *naturally* polygamous", used against vegetarians or believers in monogamy;
- 5) "the (Italian) Republic acknowledges the rights of the family as a *natural* society founded on marriage"⁷;
- 6) «Our individual natures are part of universal nature. Hence the chief good is life *according to nature*, that is, according to one's own and to universal nature». [Zeno of Cittium, Diogenes Laertium].

Let me briefly comment on each of these. All of the uses of "natural" in the above list, and similar others that can be found in common discourse and social/political agendas, can be classified under the opposite labels of laws, actions, behaviours, etc. that are "*according to nature*" or that are "*against nature*".

1) This first slogan was first proposed by the ancient sophists, who introduced a fundamental distinction between what is "by nature" (*physis*) and what holds by "human convention" (*nomos*). We should notice that what holds "by nature" for the sophists concerns more or less stable regularities of the natural, biological world – like "the law of the strongest." In the Platonic dialogue *Gorgias*, for instance, Callicles contrasts such regularities with the conventions of human laws, which in his opinion were created by the weak ones to protect themselves against the strong ones. In Callicles'

⁷ This is my translation of the 29th article of the Italian Constitution.

view, there is a radical tension between nature and human laws, and the latter are opposed because they are “against nature”.⁸

Unlike Callicles, however, we do not consider *the fact* or even the *generalization* that big fishes eat smaller ones, and similar “natural” facts, as a *justification* for the validity of an ethical or a legal principle that were to grant stronger or more intelligent human being more rights than to weaker or less able ones. Whether the Christian precept of helping the vulnerable and the needy is going against *our* nature is doubtlessly a matter of debate (see below and note 9), but it certainly amounts to a reversal of *some* widespread regularities of the biological world. It follows that our laws and ethical values, to the extent that they defend the weak and limit the strong, are “*against nature*” (at least in part, and in a descriptive sense of “nature”), but this is no reason to criticize them from the moral point of view. Unlike Callicles, we prefer our ethical, possibly conventional or culturally induced moral convictions to what happens in nature, and refuse to model our institutions on the relationship between predator and prey.

In a word, ethical arguments drawn from “nature”, that is, from widespread biological regularities, are unsound, even if we selected examples of “altruistic”, animal behaviours. In the natural *and* in the human world, in fact, there are cooperative or “sympathetic” inclinations,⁹ but they coexist with predatory and aggressive motives. These remarks also show that it is our *prior commitment* to certain values (cooperation *versus* selfishness), and our attempt to justify them, that guide us in selecting those biological regularities that best match them. Such appeals to regularities of the biological world, if used to maintain that certain (nano)technological devices are “against nature”, misfire.

2) Nevertheless, in public discussions scientists and engineers are very often invited not to trespass the “limits of nature”, or not to go “against nature”. Likewise, politicians and legislators are reminded

⁸ «But in my opinion those who framed the laws are the weaker folk, the majority. And accordingly they frame the laws for themselves and their own advantage, and so too with their approval and censure, and to prevent the stronger who are able to overreach them from gaining the advantage over them, they frighten them by saying that to overreach others is shameful and evil, and injustice consists in seeking the advantage over others. For they are satisfied, I suppose, if being inferior they enjoy equality of status. That is the reason why seeking an advantage over the many is by convention said to be wrong and shameful, and they call it injustice. But in my view nature herself makes it plain that it is right for the better to have the advantage over the worse, the more able over the less. And both among all animals and in entire states and races of mankind it is plain that this is the case--that right is recognized to be the sovereignty and advantage of the stronger over the weaker» (Plato, Gorgias 482e).

⁹ Think of all the examples of cooperation in the animal world described by de Waal (1996). For a defence of our altruistic nature, see also Sober and Wilson (1998).

not to pass bills that would go against nature, or “human nature”. However, what does “against nature”, “going beyond nature”, or “overcoming the limits of nature”, *mean*? At a closer look, there are *two* ways of interpreting the expressions “against nature” or “beyond nature”, corresponding once again to a *descriptive* and a *prescriptive* sense of “nature”.

In a *descriptive* sense, events going “against nature”, or that “trespass its limits”, would be events that occur very rarely, or even “miracles”. These, however, would not count as events breaking the laws of nature, if by laws we mean exception-less, universal regularities described by mathematical equations, or corresponding to weaker generalizations of the kind “all butterflies have wings”. An exception capable of breaking a law would simply refute the known laws, but obviously would not be “against nature”. There is a clear sense in which physical processes *cannot* trespass the limits of, or go against, physical laws, since laws, interpreted descriptively, constituted the very concept of *physical possibility*. If a law *L* were falsified by an event “going against” it, we would simply say that *L* is not as universal as we previously thought, and has “exceptions”, or that is outright false. That is, we would say either that *L* is not a law, or that it holds only *ceteris paribus* (see Dorato 2005). In no sense can “going over the limits of nature” or “going against nature” imply violating the laws of science regarded as descriptions of natural laws.

In the other sense of “against nature”, which is more relevant to my purpose, the word “nature” is interpreted *morally*, and calls into play the realization of *our (alleged) moral essence*. “Nature” here does not refer to the individual characters or natures of distinct human beings, but to a standard of moral perfection possibly shared by all human beings *qua* human beings. In other words, “nature” in this second sense raises the question “how human beings ought to live”, not the question of how they practically and de facto live. Technological inventions can go against a *morally interpreted human nature*, provided of course that such a notion makes sense.

Well, does it make sense? From which premises can such shared ethical norms be derived, if not from empirical regularities characterizing our biological nature? Leaving aside the hypothesis that a human life should be lived in a certain way because God created us to fulfil his preordained aims, it seems possible to invoke a traditionally Aristotelian notion of “human flourishing”, which presumably bases humans’ moral behaviour on our natural, moral impulses (sympathy, compassion, love or

impulses that drive us toward a fulfilled life).¹⁰ If it were defensible, this notion of a moral human nature could be invoked to criticise those technological applications that could predictably thwart its full development or its flourishing.

There seem to be at least two objections to this notion, but they can both be met. The *first* is epistemic: since we are also endowed with passions that lead us away from self-realization, how can we identify the good impulses from the bad ones, previously and independently of a moral evaluation? (see Sidgwick 1907). The reply to this objection is that only the good passions make us really *flourish*, and that we have a natural tendency toward *flourishing*, unless a bad education distorts our “nature”. Cultivating genuine friendships and, devoting one’s time to meaningful work, having a healthy parent-child relationship, or possessing literacy and education, are all objective goods for human beings, or part of what we mean by “flourishing”, and are not just instrumental to it.

The *second* problem might consist in the vagueness of the metaphorical notions of “flourishing” or “thriving”, when referred to humans. However, the meaning of these notions *can* be clarified, since one can plausibly claim that it refers either to our being absorbed in a meaningful activity (for instance, playing, or having an instructive conversation) or to our possessing certain capacities (like having literacy, or being curious and capable of feeling wonder toward the natural world). Both engaging in an activity and having a capacity are *facts* that we evaluate positively: the notion of human flourishing, if based on our common biological nature, seem to water down the fact-value distinction.

The reply to this objection is that it doesn’t go against a certain way of construing the latter distinction, and that the distinction itself needs to be articulated (see below). Agreed: from the fact that well-educated persons appreciate and enjoy in a special way certain activities (say, spending time with friends they love) one cannot derive an ethical imperative *per se*. In cases of this kind, one can always raise the question “why ought we to value enjoyments of that kind?” However, it does not seem too far-fetched to reply to this second objection that posing such questions is like asking “why do we enjoy enjoyment?”

¹⁰ Philosophers have referred to a *virtue-centered* morality (McIntyre 1984), or to the neurophysiological basis of human flourishing (Thagard 2011)

Of course, one might ask how do we find out about what contributes to our flourishing and there might be disagreement on the answers one may get. Despite individual variability, I submit (with no possibility of expanding this claim here), that *courageous*, *generous*, *loyal* and *loving* actions are universally appreciated in all cultures, despite the fact that the particular way in which these virtues manifest themselves may change diachronically and synchronically, due to differences in societal roles. A courageous soldier and a courageous politician are both appreciated but in the two cases the behaviour is largely different. It is the kind of emotions that accompany those acts that are the epistemic means to recognize what matters for us. Self-realizing activities or the possessions of certain capacities or capabilities are not instrumental to something else, but are rather *ends in themselves*. In a word, I submit that the notion of human flourishing, which entails treating persons like end in themselves, is quite decisive to create a general framework for case-by-case studies about the foreseeable consequences of any technological application.

3) “this is natural, non-adulterated, biological food,” is a catchphrase often used against both genetically modified organisms (OGM) and harmful pesticides. At times, however, the fanatic fans of biological food tend to forget that agriculture, even if “biological”, is not wholly natural. On the contrary, it is the product of an art (“artificial” in the etymological sense of the word), since it is the result of a complicated, contingent technique which, together with the domestication of animals, has changed the history of human beings. Of course orange-trees produce oranges “naturally”, but their cultivation often requires wearing and “artificial” interventions on our part (watering, pruning, or cross-fertilizing the trees). This example is another instance of our “natural” tendency to try to justify norms by bringing to bear an illusory ideal of an unadulterated, untouched nature. If “natural” food cannot be synonymous with non-artificial, we should consider it to be suggested by what we are most used to, or what we have experimented so far. On the other hand, feeding animals with hormones or antibiotics, or spraying plants with harmful pesticides, is likely to cause health problem. It follows that we should not stress the opposition “natural/artificial” or “according to nature/against nature”, but rather that between what is beneficial and what is harmful for our health, where the latter is not only a good in itself, but a precondition for human flourishing. The same practical attitude should prevail on

the issues surrounding the OGM, which, however, present economical complications that cannot be analyzed here.

4) the fourth case uses animals' behaviour to defend certain human choices. The fact that mammals typically eat meat, and that we are mammals, does not make a choice for vegetarianism *immoral*. And yet sometimes we hear discussions in which vegetarianism is condemned in the name of what is natural, of what factually most mammals do. Another instance of trying to derive norms from natural facts, one that is also used in the name of discouraging or encouraging sexual promiscuity. Choosing pairs of mammals that show a faithful behaviour after copulation, or alternatively, indicating male mammals that are promiscuous as a standard of behaviour for human males presupposes a previous commitment to values that cannot be justified in the name of what happens in the biological world. And yet slogans of this kind continue to be appealing for many people. Why?

5) the expression to the "family as a *natural* society" has been recently the subject of hot controversies in relation to the rights of gays to marry, questions on which here I will not enter. The adjective "natural" here refers to one of our biological functions, namely reproduction, with all the related behaviours, namely caring for the children etc., which are regarded as pre-legal, pre-institutional, pre-social-contract facts of which the Italian constitution takes into account.

The institution of marriage is then regarded as a legalization or the "institutionalisation" of our biological function of reproduction. We should also note that the fact that human beings have the ability to reproduce, does not create by itself a moral duty to reproduce: priests, nuns and other human beings choose and have chosen not to do so. Analogously, establishing whether the only kind of "family" should be formed by people of different sex – an ethical and legal principle – cannot be justified solely on the basis of *facts* having to do with our natural capacity for reproduction, but depends on some other values. And yet such naturalistic fallacies have remarkable impact on the large public in various western countries. Why?

6) "living according to nature" is an important moral recipe in stoic philosophy, which influenced deeply later cultural movements. The stoic precept is based on the idea that everything *is as it should*

be, so that our failure to accept the presence of evil is simply due to our short-sighted incapacity to perceive the whole series of events in the history of the universe. From a cosmic viewpoint, our life is but a fragment of an immutable sequence of events that is permeated by an impersonal logos (reason) ensuring the rationality of the whole. As the quotation above shows, the highest duty of the philosopher is to get to know the cosmic order of things, and be in command of one's passions in such a way that the unavoidable is accepted as if it were an effect of our own free will.

In a word, since the natural order of the physical world is the expression of the impersonal rationality of the universe, such order also offers automatically a moral guidance. The adaptive power of this position can hardly be exaggerated: not only is it related to the above-mentioned idea that there is a human nature in the factual and moral sense and that the two are intertwined, but it also leads us naturally to the next section, which stresses the *evolutionary advantage* of regarding nature as a source of moral rules, and therefore puts forward a possible explanation of our tendency to fall prey to the naturalistic fallacy.

3 THE NATURAL ENTANGLEMENT OF THE NATURAL WITH THE ETHICAL

In these six types of rather common arguments,¹¹ “the entanglement of facts and values” referred to by Putnam (2004) is quite evident but devoid of argumentative power, except, importantly, when it refers to a morally characterized human nature, and therefore to the notion of human flourishing. In the previous section we have seen that while a natural regularity cannot in general justify a juridical norm or an ethical rule because the latter cannot be derived from the former, we have nevertheless a strong tendency to identify in nature a foundation for our ethical values. Why is this the case? Are there explanations for this natural, tendency of human beings to find a norm in the equilibrium/stability of the natural world to which we adapted during many millennia? There are at least three possible answers to this complicated but still neglected question¹², partly biological and partly cultural.

¹¹ I agree that they are commoner in person-in-the-street's arguments, but this is grist to my mill, because it shows their naturalness in the sense of this section.

¹² For a brilliant exception to such a neglect, see Daston (2002, p.374): “I wish to explore how nature could ever have been endowed with moral authority and why that authority still exerts such a powerful, if covert, pull upon our modern

The first is that identifying norms in the natural, biological world, regarding nature as a source of values, might itself be a form of natural or cultural adaptation. We live in a natural environment to which we adapted during very long intervals of time. Consequently, keeping an equilibrium between ourselves and the environmental niche tends to increase the probability of our survival. Not by chance, much of environmental ethics is based upon the importance of maintaining an equilibrium between ourselves and nature.

Put it in a nutshell, my hypothetical explanation is as follows. Since keeping an equilibrium with our natural environment plausibly involves a certain invariance or stability of the niche in which we have lived for millennia, we probably evolved a universal attitude (which could have manifested itself in many cultures) to regard any radical change in our relationship with the environment as a potential *threat* to our survival. Since technology in particular nowadays is certainly perceived as a probable cause of such a change, technology is regarded as dangerous and threatening.

If any behaviour that favours the stability and invariance of the environment is potentially adaptive, nothing can be more effective for this overarching goal than developing an approach toward the natural world that considers it as a source of sacred norms that must be invariably respected. In order to preserve the equilibrium between ourselves and the external world – an equilibrium upon which our survival obviously depend – the development of human morality might have then become inextricably entangled with the regularities of the natural and biological world. I think that the reasons for the fearful suspicions that new technological devices have always generated must be found in our evolutionary past, a factor that should be kept in mind in all public debates concerning science and (nano)technology policies.

The second, more culturally derived reason that might account for the current tendency to use the notion of natural regularity (laws in the *descriptive sense*) for justifying moral laws in the *prescriptive sense* derives from anthropomorphic *projections* on nature belonging to our more or less recent cultural past. By this I mean to refer to a pre-scientific attitude leading us to explain the pervading

sensibilities, despite innumerable critiques and cautions against conflating “is” and “ought,” against “naturalizing” judgments that are really social and political, and against anthropomorphizing “Nature,” designated with a capital N and often with a feminine pronoun.”. See also Daston (2004) in Daston and Vidal (2004).

existence of regularities in the physical world with an animistic attribution of “a willing soul” also to inorganic matter. This projection might be an instance of an ADD, *Agents Detection Device*, our tendency to over-attribute intentions to the unanimated world, which has been advocated by cognitive scientists to explain the origin of religious beliefs (see Csibra et. al 1999). This over-attribution has an adaptive value because the assignment of intentionality also to unanimated entities is an application of the prudential rule “better safe than sorry”: a noise in the wood might be due to an animal or to a gust of wind, but the readiness to act appropriately in all circumstances entails assuming that also the wind might carry some hostile intentions toward us.

In a word, this second explanation stresses the fact that the cultures from which we inherited the first forms of natural religion were struck by the notable order and regularity shown by natural phenomena. So they tried to explain this order in an anthropomorphic way, i.e., by postulating the existence of spiritual entities who made it possible and explainable (angels moving the planets along precisely predictable orbits, for instance, explain why such orbits are so regular and predictable). These “entities” had to be capable of *will* and *thought*, so that they could compel nature to follow a certain course, just as human legislators impose norms of social coexistence which may not be violated.

This tendency was already evident in Babylonian thought: the characteristics of the movement of the planets, which Babylonian astronomers studied with attention and skill, were interpreted «[. . .] by the authors of tablets who created the library of Assurbanipal [. . .] as dictated by the “laws” or decisions governing “heaven and earth,” as pronounced by the creating god from the beginning.» (Eisler 1946, pp. 232 and 288). The same author later adds that our modern notion of universal, scientific law derives “from this mythological concept [. . .] of decrees from heaven and from earth,” and in one of his other studies, (Eisler, 1929, p. 618), he highlights the importance of the social/political condition on the way nature is represented, given that the idea of the world as an ordered entity (what the Greeks called *Kosmos*) originated, in his opinion, in Babylonian social theory. These quotations hints to a *third*, possible explanation for our persisting tendency to confuse nature and norms, one that comes from an inclination to project the social political world, with its own rules and structure, onto the natural world.

Armed with this theoretical background, we are now ready to discuss the case study given by implantable micro-chips.

4 EXTERNAL VS. INTERNAL MACHINES: IS IT STILL AN IMPORTANT DISTINCTION?

We have been relying for a long time now on *macroscopic, external* prop-ups, like glasses, walking sticks, or electronic agendas, that are extensions of our bodies and, controversially, also of our minds (Clark 2010). On the other hand, we already have macroscopic *internal* prostheses, like artificial knees, hips, cochlear implants, pace makers, or ligaments constructed out of tendons of our own bodies. In the near future, however, we might end up relying also on many *microscopical* internal parts, artificially constructed or produced *via* staminal cells, as the case maybe (Clark 2003). Is this process of “hybridation” of our bodies something to be afraid of? How should we proceed?

The following quotation from Giuseppe O. Longo, professor of computer science in Trieste, Italy expresses a widely shared viewpoint: «it is impossible for the biological part of the symbiotic hybrid to keep in step with the speed of the technological evolution, and this creates a deep discomfort. The second problem is the self perception of the person. Our body is the source of our personal identity... the unity of body and mind would be altered by fictional prosthesis that, for instance, could alter the capacity of our memory».¹³

The first fear expressed by Longo is grounded on the radically different speeds distinguishing technological and biological changes. And this reinforces the already stressed evolutionary fact that for our well-being it is of extreme importance to keep our relationship with the environment and with ourselves as part of it as stable and constant as possible. On the other hand, the second fear is not purely science fiction. Stefano Rodotà, an Italian jurist, refers to the hybridation yielded by such fiction prosthesis as a “post-human state”: «On the 12th of October 2004 the Food and Drug Administration, has authorized the use of a very small chip that can be read at a distance, called VeriChip, to be installed under the skin of the patient and containing her whole clinical story.» (Rodotà 2004) The chip, as the www.verichip.com web page advertises, “is able to offer rapid, secure patient

¹³ <http://www.swif.uniba.it/lei/rassegna/021119h.htm>.

identification, helping at-risk patients to get the right treatment when needed most.” The chip would help patients affected by memory losses, impaired speech or simply patients that have lost consciousness. According to the web page, further applications of “Verychip” envisage (i) a protection against “baby switching”, which amount to thousands of cases per year in the United States only; (ii) the prevention of incidents related to old people affected by mental diseases that wander around and get lost, or (iii) the possibility to have a maximum security of access to houses or banks or secret archives via a radio frequency identification. As an example of this latter application, consider that in Mexico the public attorney and some of his dependents had an implant which could not only identify them when they entered a classified archive, but could also track them in case of kidnapping. Another possibility would be tracking persons under house arrest.

Rodotà concludes his article in a very dramatic tone: «in this way the subject changes her personal and social status. A subject can always be on line, and become a networked person, configured in such a way that she can emit and receive impulses that allow others to track and reconstruct physical and mental conditions, habits, movements, contacts, thereby modifying the sense and content of her autonomy» (ibid.).

There is no doubt that cases like these deserve a very careful study and evaluation, which can only be attained via a case-by-case analysis. Given what was maintained in the previous sections, however, the particularizing strategy favoured by this pragmatic attitude can be compensated by the general outlook suggested by the morally-laden notion of human nature illustrated above, suggesting to treat human beings as end in themselves and not just as means to an end. For instance, as noted by Rodotà, the importance of protecting personal data in cases like these should be obvious in this moral setting, especially if, say, the medical data contained in the microchip are accessible (or even alterable) by non-legitimated others. This dangerous possibility, unfortunately, reinforces an attitude that is still widespread in our cultures, for reasons that have been presented above, and which regards the whole of technological evolution as *the* dehumanising force of mankind, characterized by an exploitative and rapacious approach toward nature.

In order to contrast this attitude, the following *three* brief considerations will try not only to clarify the main issues at stake but also to convince the reader that we must learn to live with the

extraordinary potential offered by implantable chips and in general by nanotechnologies, while at the same time steering away from easy and superficial enthusiasms. The first argument is theoretical, and shows how much progress has been achieved in trying to explain the macro-world in terms of the micro-world. The second shows how the progress of technological miniaturization, that will probably continue, enjoys great selective advantage in a market economy. The third discusses a few cases taken from the biomedical sciences, all marked by potentially beneficial effects.

1) As a general remark, let me begin by stressing that the technological development is following (and has at the same time greatly promoted) a scientific tendency of going “inward bound” (see Pais 1988) that has accompanied the last two century of physics, from the postulation of molecules to atoms, to quarks of various kind and then strings or loops (if they exist). The take-home moral of the physics of the last two centuries in particular is that the macroscopic properties of all the physical bodies at least partially depend on, and are explainable by, the microscopic ones. Clearly, the major impact that nanotechnologies will have on our future lives is going to depend on this *asymmetric* dependence of the macroscopic properties of the big things on the microscopic ones.

2) Despite their different speed, biological evolution and technological evolution obey the same abstract laws of development. Namely, a reproducing mechanism generating some variations with respect to the original, and a process of selection, which leads to the extinction of biological or technological devices, as the case maybe. Clearly, the reproduction of a machine or of an artefact is based on different supports, since it depends on human brains, on culture, and therefore on education and other learning processes, while the reproduction of an organism relies on chemical resources (the DNA and the RNA). It is the difference of the relevant and selective mechanisms that explains the disparity in the speed of change of biological organisms and technological devices. Analogously to happens in the case of biological species, however, variations in the projects of technical artefacts explain their different impact on the market, and this, in turn, creates a selective process depending on many aspects, like price, dimension, pollution, etc. The advantage of a tablet over a desktop having the same speed and memory is so obvious that the selective process goes in the direction of miniaturization and portability. This remark explains a strong selective push toward the miniaturization of all technological devices.

3) Let me now apply the considerations of the previous sections to the question of the possible role of nanotechnologies in our societies. It seems that we have no difficulty in accepting the idea that artificially constructed hearts, or parts thereof, or dental prosthesis, or artificial breasts, or metallic knees and hips can be inserted in a human being, so that a person becomes a mixture of natural and artificial parts, that is, a cyborg made of mixed parts. However, where should we stop? In order to answer this question, I will begin by presenting two examples involving the application of future nanotechnologies in the biomedical sciences, both with potentially advantageous effects, and then discuss two possible applications of chips that might alter our cognitive capacity.

3.1 Neuro-engineers are studying the possibility that microchips implanted in the brain of an epileptic patient might detect the onset of an epileptic seizure and switch it off by cooling down the involved neurons. Times are still premature, but researchers at Washington University in St. Louis, some years ago, developed a microchip that can detect an oncoming seizure. The study, published in the journal *New Scientist*, claims that it is possible to stop seizures in the brain of rats by cooling their brain cells from body temperature (about 37 degrees Celsius) to around 22 degrees Celsius. The process of cooling shuts off the release of neurotransmitters, thereby rendering the cells less susceptible to seizures: apparently after the treatment the cells did not suffer any injury and worked properly. Other possibilities in this research are, that are still under approval by the FDA, are offered by microchips programmed to detect seizures and respond via electrical shocks to interrupt them.

3.2 Secondly, the future of pharmacology can be revolutionized by the so-called individualized medicine: one could synthesize a particular gene, insert it in a certain organism, and then obtain a molecule with a certain shape and function to be used to attack a determinate target (Boncinelli 2006, p. 66). Along the same line, there is the well-known case of regenerative medicine, with the possibility that stem cells or other similar *totipotent* cells might create new biological tissue. This is certainly a very promising and important field of bio-nanotechnology.

3.3 Thirdly, of course, limiting oneself to examples taken from future, beneficial applications to medicine may render my positive attitude toward “cyborgs” superficial. What about so-far imaginary applications that foresee the possibility of implanting a nanocomputer in our brains that can either modify at will our mnemonic and algorithmic capacities, or augment the natural perceptive abilities?

Wouldn't this cause a collapse of our identity? However, even in these as yet fictional cases there are no compelling reasons to depict a catastrophic landscape.

Patients suffering from serious prosopagnosic disorders (face-blindedness), or even people with memory losses, for example, could be helped by a chip that – let us imagine – could correct the malfunctioning of the relevant parts of their brain. After all, we write down in external artefacts (soft or hard *agendas*) the things that we have to do in order to prevent our forgetting them. Of course, there is a considerable difference between an external and an internal device, but why should the implant of an internal agenda that could be constantly updated by our voice be regarded as something tragic? In what sense would it affect our identity?

This wholly imaginary case, however, must be regarded with due care, since the possibility of being always “on line” could give other people the chance of manipulating our own wishes and desires via a direct intervention in our brains, thereby allowing the possibility of manipulating others in a much more effective way than is permitted by today's technology.

Furthermore, it must be admitted that a chip that would enable us to remember every single experience or episode of our life would not only jeopardize our identity, but would also jeopardize our social adaptation and well-functioning. One only needs to be reminded of the tale of Jorge Borges titles *Funes el memorioso*, the man who was incapable of forgetting.

«We, in a glance, perceive three wine glasses on the table; Funes saw all the shoots, clusters, and grapes of the vine. He remembered the shapes of the clouds in the south at dawn on the 30th of April of 1882, and he could compare them in his recollection with the marbled grain in the design of a leather-bound book which he had seen only once, and with the lines in the spray which an oar raised in the Rio Negro on the eve of the battle of the Quebracho» (Borges 1962, p. 85).

It is well-known that our brains work by relying on an effective system of filtering information: this is important not only to prevent them from being cluttered with useless details but also to achieve the aim at hand. Living without forgetting would be practically impossible because remembering is, as empirically and phenomenologically proven, selecting and reconstructing certain aspects of our experience at the expense of others that are less salient. Borges' literary case has a real counterpart in the studies of the Russian psychologist Luria (1969), who reported his clinical experience with a

patient that could never complete any task, even the simplest one, because he was constantly reminded of thousand of things that were connected with his present experience. And socially he could function very poorly. In a word, without forgetting we would not be able to remember anything and therefore we could not live because we would constantly think about our future death, while during our daily life we often *forget* that we are mortal.

One could imagine that one day it could become possible to transfer the whole ocean of data available in the web in the head of each of us, just by using a powerful microchip. However, who would want *that*? We must not forget that already now we can have as many (externally available) data through the web as we may want. The important question is organizing them and understanding them in more economical schemes, i.e., frame them in order to construe valuable hypotheses or arrive at significant truths. This is what, for instance, discovering a law of nature is: summarizing a lot of possible observations in a single formula. [. . .] «science is a form of *business*. It aims, with a minimum of effort, in a minimum amount of time, and with a minimum exertion of thought, to appropriate the maximum amount of infinity and external truth for itself» (Mach 1896 p. 14). It is exactly considering facts like these that one can easily realize that transferring the whole web in an updatable chip would not serve any purpose. And I trust that people would not even try to have such a chip implanted.

3.4 The previous point has explored the cognitive rather than the *emotional* part of the possible changes introduced by chips implantable in our heads. However, what about a future chip capable of altering our emotional states, in a way not too dissimilar from the experience machine invented by the philosopher Robert Nozick in *Anarchy, State and Utopia* (Nozick 1974, pp. 42-45)? In this book Nozick imagines a machine capable of simulating perfectly all the pleasurable experiences we may dream of, with the corresponding pleasure. Suppose now that a chip could be realized in such a way that we would not be able to tell that those experiences are *not* real. So we could experience to have a dinner with the most beautiful men or women, to win the final game of Wimbledon, to cross the Pacific with a sailboat, or receive a Nobel prize for physics or peace. Given that by hypothesis all of these would not be real experiences, but simply virtual ones, how many of us would decide to have

such chips without the possibility of coming back to the real world? That is, would we choose to have the chip implanted and prefer it to living a real life of toils, joys and pains?

Nozick gives the following three reasons against choosing to attach to the machine, which, if well-argued, could be extended to microchips altering our emotional states:

- i. We don't want an ice cream because we like the experience of eating one, we like the experience because we want to eat an ice cream. "It is only because we first want to do the actions that we want the experiences of doing them." (Nozick, 1981, p. 43). Here the opposition is between the real action and what doing it feels like. But we could imagine that the chip gives us the impression of acting as well. Nozick's point here does not seem convincing.
- ii. We want to be and become a certain kind of person: "Someone floating in a tank is an indeterminate blob." (ibid, p. 43). This point appears to be more effective, as it refers to our need of living a real ethical life constituted by efforts, plans and possible failures from which to learn. However, the reply of the "nano-hedonist" could be that the chip could give us the impression and feelings of living such a life. Same as in (i): Nozick's response is not wholly persuasive.
- iii. "There is no *actual* contact with any deeper reality, though the experience of it can be simulated." (ibid, p. 43). This point raised by Nozick seems to be the crucial one. Knowing in advance (*before* our irrevocable decision), that what we will experience after having a microchip implanted in our brain has not been gained with honest toil and is not real, may deprive the expected pleasurable experience from any meaning and may convince us to refuse the "pleasure implant".

Point iii) might be regarded as insufficient to show that hedonism is not the correct theory of our behaviour, in the sense that it the *only* reason that motivates our action is the search for immediate or postponed pleasure. If hedonism were correct, the choice for a microchip giving us pleasurable but "unreal" experience could still be preferred by the vast majority of human beings. But Sober and Williams (1998) convincingly argue that hedonism is not the only motivator of our behaviour. This conclusion is compatible with the fact that if someone knew to have only few days to live, and were in terrible pain, one might decide to have the chip implanted until the final moment. And it is also

consistent with the fact that the chance of refusing to attach to a virtual machine tends to be greater in subjects that are sufficiently young and in good health condition.

However, even though more empirical study is needed in order to conclude that pleasure is the only motivator of our actions (hedonism), the mere fact that human beings *can* postpone the immediate satisfaction of their needs is evidence against the correctness of hedonism so intended. Furthermore, even merely mixed answers to the questionnaire: would you decide to have implanted a non-removable chip simulating pleasurable experience? show that maybe we should not worry too much about chips that in the foreseeable future could alter our emotional states, no more than we worry about current abuse of drugs or alcohol.

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