

Influence of Cartesian Reductionism on Nanomedicine

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Abstract—Cartesian automaton model of Human Body inspired organ amputations and invasive therapeutics due the reductionist approach based on Body and Mind dualism. Nevertheless Descartes originally acknowledge an integral approach where Body and Mind are inextricable united. This way Descartes should be closer to an emergent approach where the interaction between parts provides new properties distinct from the properties of the parts. Homeopathy and Transhumanism are discussed in terms of the Descartes automaton model and the need for integral approaches to health are supported. A preventive approach where strong regulation of nanodrugs is advised as long as nanodrug design lacks of a comprehensive approach, taking on account environmental and social impact and rejecting the reductionist bottom up approach that has inspired the development of new nanodrugs.

Keywords—Cartesian Dualism, Descartes Automaton, Transhumanism, Descartes automaton, Nanomedicine, Nanotechnology Regulation.

I. INTRODUCTION

NANOMEDICINE aims to use elements designed to the molecular level to heal sickness to the cellular level, repairing tissues, identifying cancer cells to avoid metastasis, throwing medical substances directly on sick cells so that no secondary effects appear. Intelligent drugs designed to the nanometric level using biosensors to detect malign cells without taking on account the fact that organism has an integral behavior where the whole determines the performance of its parts and where new properties emerge from the complex interactions between its parts. Organisms interact as a whole with environment, developing new effects of drugs which might never be observed experimentally.

Nevertheless, when we observe that many experts are following a reductionist approach in drug development to the nanometric level, ignoring complex interactions between the whole and its parts, thinking that drugs can be designed to the nanometric level, with a bottom up approach, a philosophical revision of this reductionist approach should be done. The issue of the relation between the whole and its parts was thoroughly studied in medieval times via Aristotle's logic assumption that properties of the parts are not always the same as the properties of the whole. Clearly a fallacy can hide the

truth when properties of the whole are studied as properties of the parts, which sometimes is assumed in the bottom up approach of nanotechnology. Reductionism has been associated to Cartesianism due to the tendency of Descartes to study a phenomenon separating this phenomenon in its elementary parts. By the end of Renaissance, Descartes grounded modern philosophy in his *Discourse sur le Method*, which propose a via to the Truth Knowledge. Following the path of the Cartesian Method, new laws will be discovered which link events on causal grounds once the phenomenon is observed and hypothesis are elaborated to be proved by experience. In one of its principles, Descartes proposes the reduction of the understanding of the phenomenon to the study of its parts in order to attain a better comprehension of the phenomenon as a whole. Following this idea, Descartes thinks that human body can be studied considering it as an automaton whose parts interact with each other in the same way as the parts of a clock. This is the reductionist model that has inspired medicine since Descartes all the way up to our time, when Nanomedicine designs new drugs without considering complex behavior due to emergent properties. Human body is studied considering the operation of each one of its organs and this way the operation of the whole is understood as the sum of the operation of the organs. This way the concept of an automatic operation of the human body leads to healing as the replacement of the ill parts of the body in the same way a defective clock is repaired. Invasive treatments have been designed following this automaton model of human body with an extensive damage of the healthy parts of the body. Nowadays, a new Humankind in on the way as the senses and organic faculties are modified by the implantation of nano devices that enhance visual and hearing capabilities of soldiers and workers.

Nanotechnology tries to avoid invasive treatments by healing only sick cells with biosensors. In the past Homeopathy tried to obtain large healing effects with minimal doses of drugs. Euler introduced his least action principle showing that microcosmos and macrocosmos can be explained by this principle and a therapeutic with minimal doses was expected which could recover the normal operation of human body. This perspective was discussed at the French Academy of Sciences, so that a treatment with least doses could attain

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major therapeutic effects. This way the reductionist idea of attaining the control of the whole in terms of its elementary was also applied in Homeopathy.

In our times, integral perspectives have been elaborated that avoid this reductionist approaches, in a century obsessed by health where sickness is not considered a part of daily life and the failure of therapeutics in sicknesses affecting large segments of population is a source of social concern. A huge economic impact of this failure of contemporary medicine is accepted in the case of diabetes, Parkinson disease and 20% of world population will be ill of Parkinson disease. Health problems related to both work force and social security are considered as national security problems for developed and underdeveloped countries. Advanced drugs such as nanodrugs are protected with the patent system and in the past several have been unable to buy pharmaceuticals to alleviate epidemic outbreaks because of the high prices of these advanced technology pharmaceuticals namely those used for VIH treatment. Mad cow disease had a severe economic impact on global economy showing the high level of integration of the global economy. Nanomedicine will develop new drugs which could cause this type of effect if a reductionist approach is followed without taking on account complex interactions in the body that might cause new diseases. Since the protocol for new drugs development holds commercialization of new drugs for a period of about ten years, pharmaceutical companies prefer to register new drugs in countries with light regulations where new drugs could be commercialized in fewer years. The effect of these new drugs on environment is ignored once these nanoparticles are deposited in drainage and subsequently expelled into the sea and rivers. How this drugs will do affect nutritional chains is not well understood and previous experiences with DDT should warn us about it. Therefore a preventive approach is needed that should place a hold on the access of nanoproducts to global markets.

II. CARTESIAN AUTOMATON AND THE CONCEPT OF ILLNESS

Considering the Cartesian reduction of Human Body to an Automaton we must take on account that Descartes uses the same reduction to understand God as an almost perfect machine that could only be conceived by God himself. Descartes himself had hermetic grounds and he was aware of the intuitive aspects of mind therefore Descartes was never in agreement with the conception of Human as only a thinking living being. As a matter of fact, in his letters to princess Elizabeth, Descartes explains the complex relation between body and mind, telling princess Elizabeth that Descartes duality of body and soul is only a reduction of the inextricable union between body and soul. This allows us to understand that the general conception of the duality of body and mind as attributed to Descartes should be the outcome of the misconception of Descartes followers. This misconception has led to the adoption of the Cartesian automaton as the model for the development of new drugs and therapeutics that consider sickness as a defective operation of this automaton that should

be repaired with the extirpation or healing of the ill parts of this automaton.

Descartes thinks that body occupies a place in space, is perceived by senses and cannot be moved by itself. For Descartes, a man is a thinking being even in the absence of the human body. The relation between body and soul had already been considered by Anaximander, member of the Mileto School (610 B.C.), who thought that mind provides body with a living strength and the universal principle is infinite matter to whom every one gets back after death. And for Pythagoras, member of the Italic School, there were two eternal substances, mind and body, who are the source of the whole mathematical universe. Filolao belonged to the Italic School and considered four principal organs: brain, hearth, navel and genitals, whose functions were thinking, sensible soul, the origin of seed and the seminal emission and generation.

Descartes introduced the idea of man as a machine whose movements in part do not depend on will but mind. In his Treatise on Man, Descartes explains the operation of the Human Being as analogous to an automaton whose functions result from the synchronization of its organs which are moved by the heat generated in the hearth and communicated by the blood and its spirits [1]. This conception of the human body is based on a determinism that considers the possibility of controlling a human machine once the forces that move this machine are known. But this would ignore the phenomena that emerge from the complex interaction of the human body parts and that can not be explained by the mere forces that displace the parts of this body. This has been observed in the origin of life on Earth, as the outcome of the complex interaction between lifeless molecules and has been also seen in the evolution of multicellular organism starting from cellular organisms [2]. This complexity inhibits the identification of the properties of the whole in terms of the properties of the parts and is a consequence of the Aristotelian fallacies known as Division and Composition.

Only the process of abstraction can lead to the identification of an ill person with a clock whose parts are defective or to the comparison of a healthy person with a clock that works perfectly. In a similar fashion the inextricable union of body and mind can be ill when the organism is thirsty notwithstanding water can be harmful for that ill condition. This particular relation between body and soul motivates Descartes to consider, in a letter to Regius of February 1642, that even if an angel could possess a human body, this angel could only see the same images but would never feel what a man feels with this body.

In her first letter to Descartes [3], Princess Elizabeth remarks the problem of considering soul as incorporeal as long as Soul interacts with body and therefore needs to be of the same quality as the body in order to set body in motion. But Descartes explains Princess Elizabeth that gravity can move a body even when gravity is immaterial. Descartes thinks that union of body and soul is a human primitive notion just as thought and extension are other primitive notions. And in

human passions, mind influences body so that negative thoughts should be avoided as Descartes advises, which has been considered as a Cartesian therapeutics for mental illness.

III. CARTESIAN DUALISM IN MEDICINE

For some thinkers, nowadays we identify mind with computers or human nature with genome map due to Cartesianism [4]. Nevertheless, as previously mentioned Descartes understood in his maturity the complex and inextricable union of body and mind. In the twentieth century Schrödinger wrote a book on quantum explanation of biological phenomena, introducing the idea of Physicalism in biology which has been used only in nanotechnology to develop nanodrugs capable of controlling life, in terms of the behavior of their nanometrical parts. Life and nature are reduced to molecular processes which can be replicated in a controlled fashion so that life forms can be designed and technologically reproduced [5]. This idea is rooted in von Neumann theory that searched for self replicant systems called cellular automata, which remind the reduction of human body to an automaton. This way Neuman scheme was reductionist and substituted complex life laws for simple laws controlling the systems used to model living bodies. An alternative perspective was devised by Jones, who sets forth bionanotechnology where biological systems are used as models, namely DNA, to develop nanomachines [6].

Erroneous concepts about Cartesianism were developed by Descartes followers, as happened with Henricus Regius who conducted a debate on blood circulation, refuting Harvey and elaborating a mechanics of natural breadth [7]. In his book *Fundamenta physices*, Regius speaks about a theory of neural circulation with a *physilogia integra* inspired on Descartes [8], although this theory was discarded by Descartes who wrote a letter to princess Elizabeth on his disagreements with Regius [9].

Today many scholars consider that body is multiphasic and endowed with absolute freedom leaving behind the automaton model. Cartesian reductionism ignores the world of life of the patient where emotions, doctor-patient relation as well as patient attitude need to be considered in an integral fashion. The phenomenological concept of the living body allows us to incorporate psychological elements intervening on sicknesses where mental and physical aspects are relevant, so that psychotherapy or mechanical interventions are not sufficient to heal the patient and alternative medicine is recommended to readjust the intentions and processes of the living body [10]. Psychoanalysis, yoga as preventive medicine, cultural factors surrounding the concept of illness, archetype medicine that explains illness in terms of the tension between the impulse for living and the impulse for dying. All these approaches are alien to Cartesianism with an automaton whose defective parts should be replaced [11].

IV. COMPLEXITY AND NANOREGULATION

As shown by Whitesides e Ismailov, controlling processes

to a molecular level does not ensure a total control on the structural elements of life [12]. A contemporary tendency is to elaborate models of life that take on account complex relations between the parts of the system studies as well as the emergent properties coming out from the interactions between the parts. This has happened with Tomita who developed a computer program simulating the biochemistry of a cell by the interaction between multiple processes, namely the genetic code of the cells, the proteins and other molecules, their interactions and this way assembles the behavior of the whole system as a complex ensemble [13]. This complex approach has allowed for the design of medicines in a more effective way compared to the reductionist approach that considers the operation of the ensemble as the sum of the functions of its parts.

According to [14], this reductionism has avoided a fluid development of new drugs and vaccines as long as life cannot be understood as the simple addition of physical and chemical processes. There can be no determination from the bottom up, since there are other determinations from the top and also at an intermediate level. Besides, organisms are robust, so that some parts assume the role of the amputated parts so that the whole system keeps on being normal even when some parts do not contribute to global operation of the whole. Medicines that ignore these effects are destined to fail the tests that take on account those global effects and will be discarded.

Nevertheless, propaganda promotes the development of nanomedicines and sometimes makes echo of Transhumanism which tries to excel mental functions implanting nanotechnological devices following the automaton model of Descartes. This standpoint considers that mental functions can be reduced to electrical impulses or chemical reactions, notwithstanding mental processes cannot be reduced to such phenomena. Nevertheless, no one knows the consequences of implanting nanotechnological devices in the brain, in terms of the inextricable relations between body and mind. How human life will be modified in terms of conscience, self-control as well as the development of personality, so that ethical problems related to Transhumanism are expected. Such an implant would be equivalent to the administration of new drugs which demands a new protocol similar to the one used for new drugs development. Another ethical aspect is the social segregation induced by the expensive procedures performed during the implantation since large segments of global population will be unable to pay for these costly treatments. As Freud once declared, any use of an artificial means perceived by mind as an obstacle to its natural operation can be associated to mental problems.

Nanotechnology advances, namely photolithography and bioinformatics allow the design of molecules that can be used in industries as the cosmetics and pharmaceuticals, namely Cosmoceutics, that will produce cosmetics with healing effects [15]. Nevertheless no one knows what effect will have the nanoparticles displaced by blood circulation or when these small particles penetrate the skin. A study has proved that

fullerenes change the metabolism of brain oxygenation in trout and similar effects of nanotechnology on health should be observed for other living beings [22]. Notwithstanding many participate of the idea that a total control can be achieved in the use of DNA to build up nanomechanical devices combining them with semiconductors to use the capabilities of DNA for self-assembling as well as the physical properties of semiconductors [16]. Nanotechnological devices can easily penetrate blood circulation and deposit in living beings, catalyzing carcinogenic reactions and affecting food chains due to the uncontrolled dispersion of nanomaterials on the environment. The interactions between encapsulating polymers used in nanomedicine and DNA cells is an evidence of the need for a preventive approach on nanomedicines development.

Chapman prefers to introduce synthetic fibers because there is a better control on their production as long as this process is less complicated than the process employed in biological processes. Substances produced in this way could never exist on earth and are produced controlling temperature and pressure of closed systems, which cannot be done in biological processes. The same happens in chemical agriculture that employs synthetic chemicals changing the farm into a factory where only one product is produced and all the rest is considered as residuals. All these attitudes are considered by Chapman as morally wrong because they are caused by the need for control instead of a compromise with nature. Also, they use products whose effects on environment are still unknown and promote the concentration of richness reducing the freedom of individuals. For all these reason, Chapman considers that artificial technologies, namely nanodrugs, are unreliable in terms of ethical concerns [17].

Among the most important goals in the area of nanotoxicology are the development of an universal aerosol to detect nanodusts in the air, development of instruments to detect nanomaterial in waters and to determine if nanoparticles with fiber shape are harmful [18]. Craighead has explained why biosensors use the principle of shifting of the resonance frequency of oscillators due to the change in mass. The vibrating element is covered with reactive antibodies to the microorganism to detect in such a way that the oscillating frequency changes when the microorganisms to detect are adhered. Nanomechanical resonant systems can oscillate to high frequencies and can be used as radiofrequency devices to be used as biosensors [19].

The effect of nanoproducs on environment is still unknown, mainly their effect on hydrological systems such as sewage. For this reason, the Agency for Environment Protection of USA considered the residuals of the Samsung washing machine with silver nanoparticles as pesticide to be regulated. These silver nanoparticles are very effective bactericides that could attack beneficial bacteria once these nanoparticles are thrown in sewage and later deposited on ecosystems [20] affecting this way to human beings [23] since these particles can pass through the tissues that protect human brains. This

case indicates that nanotechnology has entered into the stage where a new technology has to be subject to strong regulations as a previous stage to its introduction to global markets.

Oberdöster[21] has elaborated a protocol that could be implanted to regulate the effects of nanoparticles on human health, focusing on the experimental data that show the negative influence of the nanoparticles on human metabolism and on environment where these nanoparticles are discharged. Several projects investigate the toxicological effect of nanoproducs, namely those developed by the Center for Environmental Nanotechnology of Rice University. By 2003 this Center studied a group of nanomaterials whose effects were studied by the National Toxicology Program. Another research program on occupational effects for workers dedicated to produce nanomaterials, implemented for five years by the NIOSH Nanotechnology and Health and Safety Research Program. All these studies indicate the advent of a stage where nanoproducs will be severely regulated, with protocols that include their interaction with environment and the experimental study of the effect of this products on human health in order to approve their distribution worldwide.

V. CONCLUSION

Nanodrugs should be designed following protocols that take on account emergent properties of human health. Cartesian automaton model of human body should be carefully employed and invasive treatments should be avoided in favor of an integral approach. As is explained in this article, Descartes had an integral approach to Human Body since he recognized that mind and body were inextricable united and altogether generated emergent behaviors to the same primitive level of thought and extension. Unfortunately successive misunderstandings of Descartes followers influenced medicine into a reductionist idea of human body that considered him like an automaton that should be repaired replacing its defective parts. Strong regulations of nanodrugs design are expected that take on account environmental, social and health complex impacts of these advanced drugs, as has always happened with products built with a new technology.

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