

---

THE DILEMMA  
OF HUMAN NATURE:  
THE BIOLOGICAL AND CULTURAL  
EVOLUTION OF MANKIND

---

BRUNO ESTAÑOL

---

In memory of Eduardo Césarman, who may have approved of these ideas.

In memory of the friend, teacher, medical doctor and intellectual.

ABSTRACT. As human being we are part of nature; from one side, we are made by the same physical material as the natural world at large, from the other, we share with plants and animals the very biological matter and the same prodigious molecule: DNA. The great amount of biological information within humans determines much of their nature. The invention of written language allows Mankind to store information outside its corporal body: extra-biological information. This information have been accumulated and have make possible art, science, philosophy, religion, to sum up, culture. In such way Man became a symbolic animal and thus can transcend biological determinism, at least partially, since he continues to be a semi-domesticated animal.

KEY WORDS. Human nature, human evolution, information, extra-biological information, language, culture, aggression, entropy.

---

---

THE BIOLOGICAL EVOLUTION OF MANKIND

It has been said that the twentieth century was the century of physics and that the twentieth-first century will be the century of biology. It seems probable that this shift in paradigm will lead to a change in our understanding of human nature. Anyhow, let us acknowledge that most of the advancements in the field of biology are related to methods and processes of inquire of a "physicalistic" trend.

Nowadays human beings are considered in most cultural and scientific circles to be a product or, at least, an integral part of nature. Throughout much of history human beings—or rather, human animals—have been thought of as occupying a *supernatural* place in the cosmos. Some have even affirmed that we are composed of God's breath. Furthermore, as

---

Laboratory of Clinical Neurophysiology, Salvador Zubirán National Institute of Medical and Nutritional Sciences, Mexico. Editorial Council of Ludus Vitalis. / bestanol@hotmail.com

Pascal would have it, we may be existentially halfway between the angels and the beasts. Over the course of history Man has considered himself as placed in a position of superiority with respect to nature or, at least, he has felt separate or estranged from nature. Our collective delirium is easily corrected when we consider that not only are we an integral part of nature, but we are actually composed of the very elements present in matter throughout the universe. If we want to be lyrical about it, we might say that we are made up of stardust. The physical make-up of Man must be regarded as the necessary point of departure for any reflection on human nature. If carbon atoms didn't arise during the formation of the stars and planets, then it is most unlikely that life would have arisen at all. Therefore, let us recall that Man is composed of physical materials, albeit highly organized ones, and it is precisely this complex organization or order of material elements that we think of when we refer to Man's biological nature; more simply stated, his bodily nature.

The origin of life happened relatively recently in the history of the universe. The universe, according to our most recent estimations, is approximately 15 billion years old, while the appearance of living organisms came only some 3.5 billion years ago, and for most of that time there was no evolution beyond the single-celled life forms. Multi-cellular organisms have only enjoyed an existence of some half-billion years.

We are still not sure exactly about how life came to be. It is highly doubtful that the chance play of molecules could have given rise to even the simplest of procariotic bacteria (i.e., bacteria whose DNA is dispersed throughout the cytoplasm as opposed to being concentrated in a cellular nucleus). It is likely that at the dawn of life certain exceptional conditions were in effect, allowing for enormous production of energy, so as to generate the self-ordering units we refer to as living organisms. The rise of life on earth may have been facilitated by the presence of massive energy sources such as volcanoes and atmospheric electricity. Another factor may have been the comets and meteors that are known to have collided with our planet, coming from the far-distant locations of the solar system. Even so, assuming that life reached earth from such distances, the mystery of how it came to be in the first place remains. In any case, once life appeared on earth, it gradually became more and more complex. Unicellular forms gave rise to multi-cellular forms over billions of years, and eventually ganglia were born, and, of course, our central nervous systems composed of them.

The central nervous system of multi-cellular animals—especially that of mammals, and more particularly of primates—is enormously complex in design. About five million years ago the line that would engender hominids split off from that of the anthropoidal monkeys such as the chimpanzee and the orangutan. Some three million years ago, the first

hominid capable of walking erect appeared on the face of the earth, followed by the first tool-making Man: *Homo erectus*. The presence of fossilized wood coals in the caves of Chou Kou Tien, China, allowed us to be certain that this hominid had mastered the use of fire. Furthermore, the most promethean of hominids came later: we are known as *Homo sapiens*. Such creature have dared to defy the gods and in many cases we have succeeded: we can manoeuvre gravity with our airplanes; we have traveled to the moon; we have learned to master atomic energy, and we have mapped DNA, which is the key to the intricate structure of living organisms and the functioning of the human brain.

If the nature of Man is biological, then we ought to know something about the nature of living organisms in general. As the French biologist Jean Rostand pointed out, we are made of the same materials as the slimiest of bacteria, and our own DNA is not so different from that of lizards, frogs, plants and insects. Moreover, as human beings we are immersed in the great chain of life. From the smallest procariotic bacteria to the largest whale we all are codependent on the molecules of DNA as the bearer of the information of our species. All living organisms are genetically related to each other, and this phenomenon is known as the Great Chain of Being. The idea of a chain also implies the interdependence among all living things in relation to the acquisition of energy. Life requires a certain defiance of entropy, as noted by the Erwin Schrödinger in his book *What is Life?* But our flagrant violation of the second law of thermodynamics may only be maintained transitorily, upon exchanging matter and energy with the world around us. Living organisms receive such matter and energy from the world around them and in such way they mount an offensive against biological entropy. Prigogine correctly called living organisms “dissipative structures in non-equilibrium.” Thermodynamic equilibrium with the environment is none other than death. Living beings maintain an internal order based upon genomes contained within DNA molecules. According to Ludwig Von Bertalanffy, living organisms are open systems which in order to remain alive must harness vast amounts of energy from their surroundings and in turn give off heat. It is because living organisms give off heat that they are known as “dissipative structures;” those organisms are essentially anti-thermodynamic systems.

A failure to assimilate sufficient quantities of “free energy,” in the sense that Gibbs lends to the concept, results in the death of the organism. Where does this energy hail from? Ultimately all the energy that living organisms on earth tap into originates from the sun. Plants are capable of harnessing luminous energy by way of photosynthesis, and they store it in high-energy phosphate molecules known as ATP, which, in turn, may be used to manufacture other molecules such as complex carbohydrates. Such molecules are as important for life as DNA and as the membranes that delimit

living organisms with respect to their environment. Next, a group of animals known as herbivores enter the scene and capture the energy contained in plants upon ingesting them. Within the herbivores' bodies, this energy is converted into proteins of high complexity. At the top of the food chain are the carnivores and omnivores, among them human beings, that feed on meat and thereby receive their energy from the one contained within herbivores. All living creatures are energetically interdependent, and our own struggle as humans is centered on the need to deplete in order to obtain the fuel required to resist entropy with respect to our environment, and this explains the mechanism of aggression or violence as it applies to our survival. Animals require food in order to obtain the energy with which to perpetuate life, and they never cease to need such nourishment. Living beings are bound by a cycle of consuming and releasing energy. No animal, not even humans, can transcend this energy condemnation, and this conviction is undoubtedly essential to the character or nature of Mankind.

And so we ask ourselves along with Max Scheler: What is the place of Man in the cosmos? What does the biological nature of Man teach us about ourselves? What is our relationship to other animals and living organisms in general? Certainly it is not the case that we are the center of the universe. The planet earth is not even the center of the universe. Man is not the absolute culmination of the process of evolution, and in a large measure he is not even in control of his own destiny. The genetic differential between Man and chimpanzee is less than 1.5 per cent. How was it then that this arrogant primate gained supremacy over all the other species? Without coming down on either side of the debate over the African or multiple origin of *Homo sapiens*, we know that throughout the majority of our history—some 150 million years—we were simply wandering about the geography of the planet in search of nourishment. In this sense, we are not so different from the rest of the animals on earth, the majority of which spend the larger part of the day searching for food, evading other predators, or engaged in activities associated with reproduction. The long nomadic period when we were dedicated to hunting and gathering is but a faint memory today. The human primate wandered the African savannas searching incessantly for roots and vegetables, and only rarely enjoyed a meat dish. He was nearly always in danger of dying of hunger or while hunting, and surely diseases and the extreme temperatures also threatened his life. Another threat was being devoured by other carnivorous animals. The important thing is that our understanding of the structure and function of the human brain is inextricable from the study of the biological evolution of Man, particularly that of the central nervous system. Scholars such as Rodolfo Llinás have written volumes on the subject.

## THE CULTURAL EVOLUTION OF MANKIND

Some 50 000 years ago a sort of miracle occurred: Man invented the bow and arrow. Perhaps it was this invention in particular that jumpstarted our cultural evolution. Others may argue that it was the discovery of fire and the technique of manipulating fire that set us on the road to developing culturally. For example, it was the domination of fire that enabled Man to work in the dark while all the other primates were necessarily sleeping the night away. The invention of the bow and arrow allowed for hunting at a safer distance, in other words, less risk while hunting and a better probability of a successful kill. Surely in this way Man gained access to greater sources of free energy and, in short, he was better able to survive as a species because of such technological dexterity. Technology has been Man's accomplice since the time of hunting and gathering. Humans are universally dependent on technology; the bow and arrow, it has been demonstrated, was invented in diverse places by diverse peoples. The rise of technology is anterior to the rise of science, and the rise of science, as we shall see, was a function of our accumulation of knowledge.

Humans lived in the days of hunting and gathering in small tribes primitive hoards. Their languages were probably limited to the sphere of survival. Practically all time the available to *Homo sapiens* was applied to the search for nourishment. Man shed his fur and became a nude monkey. His shedding of fur may have been related to the evolution of more efficient means of managing heat retention, since the overheating of the body can lead to brain damage and death. Therefore, Man had to develop means by which to regulate the flow of heat to and from his body. It is generally held that the ins and outs of hunting and gathering influenced hominids toward an increased capacity for memorization in order to recall the best places and methods for finding nourishment and this led to the enlargement of the brain. A few hold that the brain had to increase in size in order to cope with the oppressive temperatures of the African savannas. Let us not forget, however, that hunting and gathering was also practiced by other hominids before us: such as the tool manipulating *Homo habilis*, and the pyrotechnical *Homo erectus* and *Homo neandertalensis*. The life of a hunter and gatherer must have been terribly fragile, always at risk of dying from lack of nourishment, or while hunting, or from excessive heat, or when the hunter became the hunted. As Thomas Hobbes was so fond of saying: *Life was nasty, short and brutal*.

The invention and practice of agriculture brought about not only a quantitative but also a qualitative change in human life. Our textbooks tell us that some ten to twelve thousand years ago agriculture was born in the Middle East. On the other hand, we know that agriculture was developed independently in many distinct places and among many distinct peoples. Sumeria, Egypt, China, Europe, Asia and the Americas can all boast of

having independently developing methods of agricultural production. The discovery of agriculture revolutionized human life. For the first time, we had access to a secure and regular supply of nourishment; in fact, it is equally possible that for the first time we experienced surpluses of food. Simultaneous to the discovery of agriculture we find evidence of the domestication of animals; such was neither altruistic nor benevolent: humans domesticated other animals in order to butcher and consume them, and to assist us in our survival labors, while still later they would be trained for use in warfare. Horses were used for transportation and dogs for herding sheep. It is conceivable that some animals began to interact spontaneously with humans in order to have access to food sources, thereby facilitating their eventual domestication: such may have been the case of dogs and cats. The important thing to remember is that the invention of agriculture and the domestication of animals is more or less a simultaneous event.

These phenomena were certainly crucial to the beginnings of our cultural evolution. Man could finally abandon his itinerant lifestyle and begin to settle down, growing closer to the land which now provided him with a relatively stable nourishment. Man became sedentary. *Homo sapiens* had access for the first time to a guaranteed source of food. The chances of dying on the hunt, or from climatic shock or starvation were drastically reduced. This change, seemingly so simple, is what led to some very significant and complex developments. One of the most important of such outcomes was the dawn of the diversification of human activities, especially in the realm of labor. Individuals became specialists in home building, bread baking, the manufacture of shoes and clothing, the art of cooking, the pastoral professions, the curing of wounds and diseases, and, of course, at this time we also witness the birth of the priestly orders, those who claimed to be in touch with the gods and the spirits in order to protect their societies from calamity. Religion is a common denominator of all sedentary civilizations on the face of the earth. Yet another consequence of agriculture is that the number of people living together began to multiply. Additionally, the diversification of human activities led to the diversification of language. There were many more things to name, not only those that had to do strictly with hunting and gathering.

It is likely that fully structured languages came into being at this time. It is believed that our vocabularies were severely limited when we were simply hunters and gatherers. Doubtless our vocabularies grew by leaps and bounds along with the rise of civilization, labor specialization and diversification. We believe that structured languages originated along with agriculture; but let us recall that culture was still almost entirely oral in those days, and hence it was relatively restricted. Knowledge was fragile and it vanished when those individuals who had it perished. Some five or

six thousand years ago Man invented writing. What is writing if not an extra-corporeal code whereby humans have been able to safeguard their knowledge, and above all, transmit it from generation to generation? In this fashion Man becomes the first animal capable of storing information outside his body. The late Eduardo Césarman and I have referred to this concept of written culture as “extra-biological information,” as opposed to “biological information,” which is stored in the brain or in the central nervous system or in the immune system or in the genetic material. Only humans can be thought of as being able to store information extra-biologically and our cultural evolution experienced a quantum leap with the onset of the written word. Writing makes it possible to accumulate vast amounts of information, and so enables the systematized practice of philosophy, religion, science and literature. Technological innovations can now be accumulated and transmitted effectively. Many were the ancient civilizations that took that step from agriculture to writing. Among them were the Sumerians, Babylonians, Egyptians, Hebrews, Hindus, Arabs, Chinese, and Mayans, as well as the Phoenicians, Greeks and Romans. Many of their languages are still in use today. Like the innovations of the bow and arrow, and agriculture, writing also developed independently among diverse civilizations—which is not to say that there was not also significant cultural diffusion taking place.

How was it possible that the brain of an animal biologically designed to roam the African steppes hunting and gathering could have generated such an astonishing invention as writing? Writing is a system of signs, and these signs represent sounds. And these sounds represent in turn all the natural and artificial objects in the known world, any concrete or abstract concepts we can imagine. So writing turns Man into a fully symbolic animal. Writing is in this sense actually “meta-linguistic,” that is, it is a language that represents another language. Hence it is a phenomenon produced by mental abstraction. This should be considered a quantum leap in the evolution of Man. For the first time, an animal is capable of storing information outside his body. All animals store information in their DNA and in their nervous systems, and this is known as biological information. Now, for the first time, one can speak of extra-biological storage and extra-biological information. This was a superb development in the development of culture, and culture can now be thought of as all the information that is recorded in written form, as well as all that is present in manufactured objects such as buildings, paintings or sculptures; in short, all the information and knowledge which we store outside our bodies. Let us recall now that the noun ‘culture’ comes from the verb ‘to cultivate’, which is linked to the tilling of the soil, then culture has its origin in the invention of agriculture.

So Man evolved as a symbolic animal and his retention of information has taken three forms: (1) those memories which are stored in the DNA; (2) those memories which are stored in written form or contained in objects of art and utility, in short, "extra-biological" information; (3) individual memories, or those which are stored in the brain of a single human being. The grand accumulation of information made possible by the technology of writing has greatly increased our cultural cache and has stimulated our cultural evolution. Edward Wilson has written about the distinction between cultural and biological evolution, and he reminds us that they operate along different time lines. The time necessary for the biological development of Man is enormous in comparison to the relatively brief period in which Man has evolved culturally.

It is said that the knowledge we have acquired about the brain in the past ten years surpasses all the knowledge on the subject accumulated during the span of human history. Let us not forget to mention mathematics as a form of written code that is also very efficient, elegant and precise; but without the invention of the written word, formal mathematics would never have existed. While writing developed independently at many different times and in many different parts of the world, thereby attesting to its universality in our species, let us recall that the forms of the written word vary greatly from place to place. What this means is that our linguistic codes and alphabets are arbitrary in nature. In this fashion Man, whose physical nature was determined by his biological evolution, came to discover that by accumulating vast amounts of information and codifying it systematically, using language and writing, he could produce a parallel evolution in the cultural sphere. Nevertheless, for all our civilized ways, the fact remains that we are natural creatures, and so, even the highest elements of our culture are marked by biological factors.

Culture is essentially storage of information. Most information may be stored and used when needed, such as the energy we store and consume in our bodies. Scholars such as Shannon have carefully studied the relationship between information and energy consumption. The loss of information may be considered concordant with entropy. In contrast, the storage of information may be considered to be defiant of entropy. Therefore life itself, an open-energetic system, may be classified as an effort against entropy. Accordingly, human cultural production may be classified as an open-informational system erected in defiance of entropy. The written word as a means of storing information is infinitely more effective than the natural memory retention of an individual human brain. The invent of the printing press signified an exponential boost to the quantity of information preserved in the written form, while currently our compact disks and computer appliances can store more information than ever thought possible. Obviously the individual human brain cannot compete

with books and computers for cultural efficiency in the sense of overall memory or storage capacity. Humans have compensated for their relatively weak capacity to store information by becoming increasingly better organized and more specialized: our specialists being those that are adept at recalling information related to a given field of interest. The trouble is that we possess a lot of information now, but too much of that information is fragmented and dispersed.

At the same time, we must recognize that modern Man retains much more information in his brain than was ever before possible, and we know more nowadays because there is more information available to us than ever before. Nevertheless, individuals such as those of the Renaissance who could assimilate and integrate huge amounts of information are increasingly scarce in today's world. We seem to be more gifted at analysis than at synthesis. In this sense, much of what we know tends to be underutilized or remain fragmented. According to the lexicon of information theory, we can say that these vast amounts of improperly exploited information have been converted into "noise". Today we are constantly bombarded with what may be termed "informational noise," causing inefficient functioning of our brains, that results in chaos or informational entropy. If life is defiant to entropy, which is to say that it combats equilibrium in the thermodynamic sense of the word, being as it is, our struggle is one against death. Life is also defiant of ignorance, in the sense that our struggle to obtain matter and energy from our environment can also be thought of as the acquisition and accumulation of information so that we may avoid cultural stagnation. Cultural death and biological death go hand in hand. So let us recall that "informational noise" results in the damaging of information itself, and in the long run those individuals who voluntarily or involuntarily are exposed to "informational noise" may themselves become damaged.

It is equally important to point out here that the great asymmetries that exist between peoples and nations are no longer simply about an unjust distribution of land, food or capital; rather, other resources are coming into the balance such as petroleum and electricity, and there is a parallel competition for information. The rich countries of the world have at their disposal enormous quantities of scientific, technological and cultural information, whereas the poor countries must largely do without such advantages. The informational gap to which I am referring may prove to be even larger in the future.

It is also very important to point out that many of our biologically determined behaviors, particularly those in the realm of sex and aggression, are still problematic, and our attempts to use culture to soften or correct them have been largely fruitless, or, in fact, even counterproductive. We are neither completely biological nor completely cultural beings.

We are not existentially at the halfway point between the angel and the beast, but we certainly are more technologically advanced than the other beasts on this planet. The relationship between culture and biology is a fascinating one. Within the realm of medicine and the life-sciences we tend to lend more weight to genetic factors than to cultural ones. Those of us in the scientific community tend to believe that nature generally has the upper hand over culture. Nevertheless, let us recall that there is a dialectical relationship between nature and culture that will probably continue as long as our species survives.

The technological evolution of Man has been astonishing, but what about our moral evolution? Only a fool would argue that we haven't made great progress in the realm of material production in recent years. But the main problem of *Homo sapiens* is that we haven't yet learned to overcome our addiction to aggression. As long as human beings have been living together there have been rules and regulations designed to curb their aggressions against one another. Perhaps the *Code of Hammurabi* is the oldest book having such explicit jurisprudential ambitions. The religions of the world also seem to be concerned with laws and pacts aimed at diminish or at least regulate the use of violence. Despite all this, human history is clearly one of wars and of continuous violence practiced against individuals, societies and countries. Joyce summed it up brilliantly when he said that *History is a nightmare from which we are unable to awake*. Throughout most of history violent disputes were over matters of land and food; as we evolved culturally our wars came to focus on a whole collection of factors either in isolation or in combination, such as differences of religion or political ideology, matters of ethnicity or economics, the possession of fuel resources such as petroleum, or issues concerning access to and the use of valuable information. To date, Man has applied his greatest technological innovations to the art of killing his neighbor. No society has ever been able to eradicate violence, war, theft, crime or murder; no society has ever been able to achieve lasting harmony within diversity.

Our phenomenal cultural evolution has not necessarily included a proportional moral and ethical one. Culture has historically not been able to compensate for our biologically determined aggressive impulses; competition over scarce resources has continuously pushed us to murderous deeds. The urge toward violence has many cousins, some of which include the hunger for power and domination. Violence is typically exercised from the top of the pyramid down, that is, projected from the heights of power onto the powerless: be this in an economic, social, political, religious or any other sense. Man has used all the technological and scientific innovations at his disposal in order that he might wage and win wars; in other words, for the purposes of aggression and destruction. For all our good intentions *Homo sapiens* has not been able to evolve into *Homo ethicus* or

Moral Man. The biblical phrase, *Man does not live on bread alone*, implies that while he diligently goes about satisfying his material or biological needs, he must not neglect his spiritual needs, else he face an extinction far more devastating than the loss of an individual life. It is not only a duty, but rather a necessity for Man to acquire information to confronted it against the tendencies of ignorance and violence. Education is the key in our struggle to defeat entropy manifested as violence and ignorance at the social and informational levels, respectively. In conclusion, Man continues to be a semi-domesticated animal.

REFERENCES

- Césarman E. (1986), *Termodinámica de la vida*. México, D.F.: Ediciones Gernika.
- Estañol B., Césarman E. (1997), *El telar encantado. El enigma de la relación mente cerebro*. México, D.F.: Miguel Angel Porrúa, Librero y Editor.
- Estañol B., Césarman E. (1998), *Como perro bailarín. Origen y límites del lenguaje*. México, D.F.: Miguel Angel Porrúa, Librero y Editor.
- Estañol B., Césarman E. (1999), *El Laberinto y la ilusión*. México, D.F.: Miguel Angel Porrúa, Librero y Editor.
- Estañol B., Césarman E. (2001), "Biological and extrabiological memory," *Ludus Vitalis* IX(16): 177-180.
- Estañol B., Césarman E. (1997), "Algunas reflexiones sobre el origen del lenguaje", *Ludus Vitalis*, num. especial 1, *Senderos de la evolución humana*, pp. 113-120.
- Estañol B., Césarman E. (1994), "Cerebro y supervivencia", *Ludus Vitalis* II(2): 39-62.
- Mora Francisco. (2001), *El reloj de la sabiduría. Tiempos y espacios en el cerebro humano*. Madrid: Alianza Ensayo.
- Ayala F. J. (1980), *Origen y evolución del hombre*. Madrid: Alianza Editorial.
- Ayala F. J. (1994), *La naturaleza inacabada*. Madrid: Biblioteca Científica Salvat.
- Eckhardt R. B. (1987), "Was plio-pleistocene brain hominid expansion a pleiotropic effect of adaptation for heat stress?" *Anthrop. Anz.* 45: 193-201.
- Fialkowski K. R. (1978), "Early hominid, brain evolution and heat stress: A hypothesis," *Stud. Phys. Anthropol.* 4: 87-92.
- Fialkowski K. R. (1986), "A mechanism for the origin of the human brain: A hypothesis," *Curr. Anthropol.* 27: 288- 290.
- Llinás Rodolfo, (2001), *I of the Vortex. From Neurons to Self*. Boston: MIT Press.