Human Nature

BIOLOGY PRECEDES, CULTURE TRANSCENDS: AN EVOLUTIONIST'S VIEW OF HUMAN NATURE

by Francisco J. Ayala

Abstract. I will, first, outline what we currently know about the last 4 million years of human evolutionary history, from bipedal but small-brained *Australopithecus* to modern *Homo sapiens*, our species, through the prolific toolmaker *Homo habilis* and the continent wanderer *Homo erectus*. I shall then identify anatomical traits that distinguish us from other animals and point out our two kinds of heredity, the biological and the cultural.

Biological inheritance is based on the transmission of genetic information, in humans very much the same as in other sexually reproducing organisms. But cultural inheritance is distinctively human, based on transmission of information by a teaching and learning process that is in principle independent of biological parentage. Cultural inheritance makes possible the cumulative transmission of experience from generation to generation. Cultural heredity is a swifter and more effective (because it can be designed) mode of adaptation to the environment than the biological mode. The advent of cultural heredity ushered in cultural evolution, which transcends biological evolution.

I will, finally, explore ethical behavior as a model case of a distinctive human trait, and seek to ascertain the causal connections between human ethics and human biology. My conclusions are that (1) moral reasoning—that is, the proclivity to make ethical judgments by evaluating actions as either good or evil—is rooted in our biological nature; it is a necessary outcome of our exalted

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intelligence, but (2) the moral codes that guide our decisions as to which actions are good and which ones are evil are products of culture, including social and religious traditions. This second conclusion contradicts those evolutionists and sociobiologists who claim that the morally good is simply that which is promoted by the process of biological evolution.

Keywords: biological versus cultural evolution; human biological nature; human uniqueness; moral norms; moral sense.

APE TO HUMAN

Humankind is a biological species that has evolved from other species that were not human. In order to understand human nature, we must know our biological makeup and whence we come, the story of our humbler beginnings. For a century after the publication of Darwin's *On the Origin of Species* in 1859, the story of evolution was reconstructed with evidence from paleontology (the study of fossils), biogeography (the study of the geographical distribution of organisms), and the comparative study of living organisms: their morphology, development, physiology, and the like. Since the mid-twentieth century we have, in addition, molecular biology, the most informative and precise discipline for reconstructing the ancestral relationships of living species.

Our closest biological relatives are the great apes, and among them the chimpanzees, who are more closely related to us than they are to the gorillas, and much more closely than to the orangutans. The hominid lineage diverged from the chimpanzee lineage 5–7 million years ago (mya), and it evolved exclusively in the African continent until the emergence of *Homo erectus*, somewhat before 1.8 mya. The first known hominid, *Ardipithecus ramidus*, lived 4.4 mya, but it is not certain that it was bipedal or in the direct line of descent to modern humans, *Homo sapiens*. The recently described *Australopithecus anamensis*, dated 3.9–4.2 mya, was bipedal and has been placed in the line of descent to *Australopithecus afarensis*, *Homo habilis*, *H. erectus*, and *H. sapiens*. Other hominids, not in the direct line of descent to modern humans, are *Australopithecus africanus*, *Paranthropus aethiopicus*, *P. boisei*, and *P. robustus*, who lived in Africa at various times between 3 and 1 mya, a period when three or four hominid species lived contemporaneously in the African continent.

Shortly after its emergence in tropical or subtropical eastern Africa, *H. erectus* spread to other continents. Fossil remains of *H. erectus* are known from Africa, Indonesia (Java), China, the Middle East, and Europe. *H. erectus* fossils from Java have been dated 1.81 ± 0.04 and 1.66 ± 0.04 mya, and from Georgia between 1.6 and 1.8 mya. Anatomically distinctive

H. erectus fossils have been found in Spain, deposited before 780,000 years ago, the oldest in southern Europe.

The transition from *H. erectus* to *H. sapiens* occurred around 400,000 years ago, although this date is not well determined owing to uncertainty as to whether some fossils are *erectus* or "archaic" forms of *sapiens*. *H. erectus* persisted for some time in Asia, until 250,000 years ago in China and perhaps until 100,000 years ago in Java, and thus was coetaneous with early members of its descendant species, *H. sapiens*. Fossil remains of Neandertal hominids (*Homo neanderthalensis*) appeared in Europe around 200,000 years ago and persisted until 30,000 or 40,000 years ago. The Neandertals had, like *H. sapiens*, large brains. A few years ago they were thought to be ancestral to anatomically modern humans, but now we know that modern humans appeared at least 100,000 years ago, long before the disappearance of the Neandertals. Moreover, in caves in the Middle East, fossils of modern humans have been found dated 120,000–100,000 years ago, as well as Neandertals dated at 60,000 and 70,000 years ago, followed again by modern humans dated at 40,000 years ago. It is unclear whether the two forms repeatedly replaced one another by migration from other regions, or whether they coexisted in some areas. Recent genetic evidence indicates that interbreeding between *sapiens* and *neanderthalensis* never occurred.

There is considerable controversy about the origin of modern humans. Some anthropologists argue that the transition from *H. erectus* to archaic *H. sapiens* and later to anatomically modern humans occurred consonantly in various parts of the Old World. Proponents of this *multiregional model* emphasize fossil evidence showing regional continuity in the transition from *H. erectus* to archaic and then modern *H. sapiens*. In order to account for the transition from one species to another (something that cannot happen independently in several places), they postulate that genetic exchange occurred from time to time between populations, so that the species evolved as a single gene pool, even though geographic differentiation occurred and persisted, just as geographically differentiated populations exist in other animal species as well as in living humans. This explanation depends on the occurrence of persistent migrations and interbreeding between populations from different continents, of which no direct evidence exists. Moreover, it is difficult to reconcile the multiregional model with the contemporary existence of different species or forms in different regions, such as the persistence of *H. erectus* in China and Java for more than 100,000 years after the emergence of *H. sapiens*. Other scientists argue instead that modern humans arose first in Africa or in the Middle East somewhat before 100,000 years ago and from there spread throughout the world, replacing elsewhere the preexisting populations of *H. erectus* or archaic *H. sapiens*.

Some proponents of this African replacement model claim further that the transition from archaic to modern *H. sapiens* was associated with a very narrow bottleneck, consisting of only two or a very few individuals who are the ancestors of all modern mankind. This particular claim of a narrow bottleneck is supported, erroneously as I will soon show, by the investigation of a peculiar small fraction of our genetic inheritance, the mitochondrial DNA (mtDNA). The African (or Middle East) origin of modern humans is, however, supported by a wealth of recent genetic evidence and is therefore favored by many evolutionists.

THE MYTH OF THE MITOCHONDRIAL EVE

The genetic information we inherit from our parents is encoded in the linear sequence of the DNA's four nucleotide components (represented by A, C, G, T) in the same fashion as semantic information is encoded in the sequence of letters of a written text. Most of the DNA is contained in the chromosomes inside the cell nucleus. The total amount of DNA in a human cell nucleus consists of 6,000 million nucleotides, half in each set of 23 chromosomes inherited from each parent. A relatively small amount of DNA, about 16,000 nucleotides, exists in the mitochondria, cell organelles outside the nucleus. The mtDNA is inherited in a peculiar manner, that is, exclusively along the maternal line. The inheritance of the mtDNA is a gender mirror image of the inheritance of the family name. Sons and daughters inherit their mtDNA from their mother, but only the daughters transmit it to their progeny, just as sons and daughters receive the family name of the father, but only the sons transmit it to their children.

Analysis of the mtDNA from ethnically diverse individuals has shown that the mtDNA sequences of modern humans coalesce to one ancestral sequence, the *mitochondrial Eve* that existed in Africa about 200,000 years ago (Wilson and Cann 1992, 68–73). This Eve, however, is not the one mother from whom all humans descend but an mtDNA molecule (or the woman carrier of that molecule) from whom all modern mtDNA *molecules* descend.

Some science writers, and even some scientists, have drawn the inference that all humans descend from only one, or very few, women,[1] but this is based on a confusion between gene genealogies and individual genealogies. Gene genealogies gradually coalesce toward a unique DNA ancestral sequence (in a similar fashion as living species, such as humans, chimpanzees, and gorillas, coalesce into one ancestral species). Individual genealogies, on the contrary, increase by a factor of two in each ancestral generation: an individual has two parents, four grandparents, and so on.[2] Coalescence of a gene genealogy into one ancestral gene, originally present in one individual, does not disallow the contemporary existence of many other individuals who are also our ancestors and from whom we have inherited the other genes.

This conclusion can be illustrated with an analogy. My family name is shared by many people who live in Spain, Mexico, the Philippines, and other countries. A historian of our family name has concluded that all Ayalas descend from Don Lope Sánchez de Ayala, grandson of Don Vela, vassal of King Alfonso VI, who established the domain (*señorío*) de Ayala in the year 1085, in the now Spanish Basque province of Alava. Don Lope is the Adam from whom we all descend on the paternal line, but we also descend from many other men and women who lived in the eleventh century, as well as earlier and later.

The inference warranted by the mtDNA analysis is that the mitochondrial Eve is the ancestor of modern humans in the *maternal line*. Any person has a single ancestor in the maternal line in any given generation. Thus, a person inherits the mtDNA from the mother, from the maternal grandmother, from the great grandmother on the maternal line, and so on. But the person also inherits other genes from other ancestors. The mtDNA that we have inherited from the mitochondrial Eve represents one-four-hundred-thousandth of the DNA present in any modern human (16,000 out of 6 billion nucleotides). The rest of the DNA, 400,000 times more than the mtDNA, we have inherited from other contemporaries of the mitochondrial Eve.

From how many contemporaries? The issue of how many human ancestors we had in the past has been elucidated by investigating the genes of the human immune system (Ayala 1995b). The genes of the human leukocyte antigen (HLA) complex exist in multiple versions, which provide people with the diversity necessary to confront bacteria and other pathogens that invade the body. The evolutionary history of some of these genes shows that they coalesce into ancestral genes 30–60 mya, that is, long before the divergence of humans and apes. (Indeed, humans and apes share many of these genes.) The mathematical theory of gene coalescence makes it possible to estimate the number of ancestors that must have lived in any one generation in order to account for the preservation of so many diverse genes through hundreds of thousands of generations. The estimated *effective* number is about 100,000 individuals per generation. This effective number of individuals is an average rather than a constant number, but it is a peculiar kind of average (a *harmonic mean*), compatible with much larger but not much smaller numbers of individuals in different generations. Thus, through millions of years our ancestors existed in populations that were 100,000 individuals strong, or larger. Population bottlenecks may have occurred on rare occasions. But the genetic evidence indicates that human populations never consisted of fewer than several thousand individuals.

Human Uniqueness

The most distinctive human anatomical traits are erect posture and large brain. We are the only vertebrate species with a bipedal gait and erect posture; birds are bipedal, but their backbone is horizontal rather than vertical. Brain size is generally proportional to body size; relative to body mass, humans have the largest (and most complex) brain. The chimpanzee's brain weighs less than a pound, a gorilla's slightly more. The human male adult brain is 1,400 cubic centimeters (cc) in volume and about three pounds in weight.

Evolutionists used to raise the question whether bipedal gait or the large brain came first, or whether they evolved consonantly. The issue is now resolved. Our *Australopithecus* ancestors had, since 4 mya, a bipedal gait but a small brain, about 450 cc, a pound in weight. Brain size starts to increase notably with our *Homo habilis* ancestors, about 2.5 mya, who had a brain about 650 cc and also were prolific toolmakers (hence the name *habilis*). Between 1 and 2 million years afterwards, there lived *Homo erectus*, with adult brains up to 1,200 cc. Our species, *Homo sapiens*, has a brain about three times as large as that of *Australopithecus*, 1,300–1,400 cc, or some three pounds of gray matter. Our brain is not only much larger than that of chimpanzees or gorillas but also much more complex. The cerebral cortex, where the higher cognitive functions are processed, is in humans disproportionally much greater than the rest of the brain when compared to that of apes.

Erect posture and a large brain are not the only anatomical traits that distinguish us from nonhuman primates, even though they may be the most obvious. Our most distinctive anatomical features include the following (of which the last six items are not detectable in fossils):

- Erect posture and bipedal gait (entail changes of the backbone, hipbone, and feet)
- Opposing thumbs and arm and hand changes (make possible precise manipulation)
- Large brain
- Reduction of jaws and remodeling of face
- Changes in skin and skin glands
- Reduction in body hair
- Cryptic ovulation (and extended female sexual receptivity)
- Slow development
- Modification of vocal tract and larynx
- Reorganization of the brain

Humans are notably different from other animals not only in anatomy but also, and no less importantly, in their behavior, both as individuals and socially. Distinctive human behavioral traits include the following:

- Subtle expression of emotions
- Intelligence: abstract thinking, categorizing, and reasoning
- Symbolic (creative) language
- Self awareness and death awareness
- Toolmaking and technology
- Science, literature, and art
- Ethics and religion
- Social organization and cooperation (division of labor)
- Legal codes and political institutions

Humans live in groups that are socially organized, and so do other primates. But primate societies do not approach the complexity of human social organization. A distinctive human social trait is culture, which may be understood as the set of non–strictly biological human activities and creations. Culture includes social and political institutions, ways of doing things, religious and ethical traditions, language, common sense and scientific knowledge, art and literature, technology, and in general all the creations of the human mind. The advent of culture has brought with it cultural evolution, a superorganic mode of evolution superimposed on the organic mode, and which has in the last few millennia become the dominant mode of human evolution. Cultural evolution has come about because of cultural change and inheritance, a distinctively human mode of achieving adaptations to the environment and transmitting the adaptations through the generations.

Cultural Heredity

There are in humankind two kinds of heredity: the biological and the cultural, which may also be called organic and superorganic, or *endosomatic* and *exosomatic* systems of heredity. Biological inheritance in humans is very much like that in any other sexually reproducing organism; it is based on the transmission of genetic information encoded in DNA from one generation to the next by means of the sex cells. Cultural inheritance, on the other hand, is based on transmission of information by a teaching-learning process, which is in principle independent of biological parentage. Culture is transmitted by instruction and learning, by example and imitation, through books, newspapers, and radio, television and motion pictures, through works of art, and by any other means of communication. Culture is acquired by every person from parents, relatives, and neighbors, and from the whole human environment.

Cultural inheritance makes possible for people what no other organism can accomplish—the cumulative transmission of experience from generation to generation. Animals can learn from experience, but they do not transmit their experiences, their discoveries (at least not to any large extent), to the following generations. Animals have individual memory, but they do not have a social memory. Humans, on the other hand, have developed a culture because they can transmit their experiences cumulatively from generation to generation.

Cultural inheritance makes possible cultural evolution, that is, the evolution of knowledge, social structures, ethics, and all other components that make up human culture. Cultural inheritance makes possible a new mode of adaptation to the environment that is not available to nonhuman organisms—adaptation by means of culture. Organisms in general adapt to the environment by means of natural selection, by changing over generations their genetic constitution to suit the demands of the environment. But humans, and humans alone, can also adapt by changing the environment to suit the needs of their genes. (Animals build nests and modify their environment also in other ways, but the manipulation of the environment by any nonhuman species is trivial compared to humankind's.) For the last few millennia humans have been adapting the environment to their genes more often than their genes to the environment.

In order to extend its geographical habitat, or to survive in a changing environment, a population of organisms must become adapted, through slow accumulation of genetic variants sorted out by natural selection, to the new climatic conditions, different sources of food, different competitors, and so on. The discovery of fire and the use of shelter and clothing allowed humans to spread from the warm tropical and subtropical regions of the Old World to the whole earth, except for the frozen wastes of Antarctica, without the anatomical development of fur or hair. Humans did not wait for genetic mutants promoting wing development; they conquered the air in a somewhat more efficient and versatile way by building flying machines. People travel the rivers and the seas without gills or fins. Humans have started exploring outer space without waiting for mutations providing them with the ability to breathe with low oxygen pressures or to function in the absence of gravity; astronauts carry their own oxygen and specially equipped pressure suits. From their obscure beginnings in Africa, humans have become the most widespread and abundant species of mammal on earth. It was the appearance of culture as a superorganic form of adaptation that made humankind the most successful animal species.

Cultural adaptation has prevailed in humankind over biological adaptation because it is a more rapid mode of adaptation and because it can be directed. A favorable genetic mutation newly arisen in an individual can be transmitted to a sizable part of the human species only through innumerable generations. However, a new scientific discovery or technical achievement can be transmitted to the whole of mankind, potentially at least, in less than one generation. Moreover, whenever a need arises, culture can directly pursue the appropriate changes to meet the challenge. On the contrary, biological adaptation depends on the accidental availability of a favorable mutation, or of a combination of several mutations, at the time and place where the need arises.

Biology to Culture

Erect posture and a large brain are distinctive anatomical features of modern humans. High intelligence, symbolic language, religion, and ethics are some of the behavioral traits that distinguish us from other animals. The account of human origins that I have sketched implies a continuity in the evolutionary process that goes from our nonhuman ancestors of 8 million years ago through primitive hominids to modern humans. A scientific explanation of that evolutionary sequence must account for the emergence of human anatomical and behavioral traits in terms of natural selection together with other distinctive biological causes and processes. One explanatory strategy is to focus on a particular human feature and seek to identify the conditions under which this feature may have been favored by natural selection. Such a strategy may lead to erroneous conclusions as a consequence of the fallacy of selective attention: some traits may have come about not because they are themselves adaptive but rather because they are associated with traits that are favored by natural selection.

Geneticists have long recognized the phenomenon of *pleiotropy*, the expression of a gene in different organs or anatomical traits. It follows that a gene that becomes changed owing to its effects on a certain trait will result in the modification of other traits as well. The changes of these other traits are epigenetic consequences of the changes directly promoted by natural selection. The cascade of consequences may be, particularly in the case of humans, very long and far from obvious in some cases. Literature, art, science, and technology are among the behavioral features that may have come about not because they were adaptively favored in human evolution but because they are expressions of the high intellectual abilities present in modern humans: what may have been favored by natural selection (its *target*) was an increase in intellectual ability rather than each one of those particular activities.

I now will briefly explore ethics and ethical behavior as a model case of how we may seek the evolutionary explanation of a distinctively human trait. I select ethical behavior because morality is a human trait that seems remote from biological processes. My goal is to ascertain whether an account can be advanced of ethical behavior as an outcome of biological evolution, and if such is the case, whether ethical behavior was directly promoted by natural selection or has rather come about as an epigenetic manifestation of some other trait that was the target of natural selection.

I will argue that ethical behavior (the proclivity to judge human actions as either good or evil) has evolved as a consequence of natural selection, not because it was adaptive in itself but rather as a pleiotropic consequence of the high intelligence characteristic of humans. However, I will first point out that the question of whether ethical behavior is biologically determined may refer to either (1) the *capacity* for ethics (i.e., the proclivity to judge human actions as either right or wrong), which I will refer to as "ethical behavior," or (2) the moral *norms* or moral codes accepted by human beings for guiding their actions. I will deal here with the first of these questions and argue that the capacity for ethics is a necessary attribute of human nature and thus a product of biological evolution. With respect to the second question, I will briefly assert my conviction that moral norms are products of cultural evolution, not of biological evolution.

My thesis is grounded on the argument that humans exhibit ethical behavior because their biological makeup determines the presence of the three necessary, and jointly sufficient, conditions for ethical behavior: namely, the abilities to anticipate the consequences of one's own actions, to make value judgments, and to choose between alternative courses of action. I thus maintain that ethical behavior came about in evolution not because it is adaptive in itself but as a necessary consequence of humanity's eminent intellectual abilities, which are an attribute directly promoted by natural selection. I nevertheless maintain, contrary to many distinguished evolutionists, that the norms of morality are not derived from biological evolution. It is true that natural selection and moral norms sometimes coincide on the same behavior; that is, the two are consistent. But this isomorphism between the behaviors promoted by natural selection and those sanctioned by moral norms exists only with respect to the consequences of the behaviors; the underlying causations are completely disparate.

BIOLOGICAL ROOTS OF THE MORAL SENSE

I have noted that the question of whether ethical behavior is biologically determined may refer to either one of the following issues: (1) Is the capacity for ethics—the proclivity to judge human actions as either right or wrong—determined by the biological nature of human beings? (2) Are the systems or codes of ethical norms that are accepted by human beings biologically determined? A similar distinction can be made with respect to language. The issue of whether our capacity for symbolic language is determined by our biological nature is different from the question of whether the particular language we speak (English, Spanish, or Japanese) is biologically necessary.

The first question posed is more fundamental; it asks whether or not the biological nature of *Homo sapiens* is such that humans are necessarily inclined to make moral judgments and to accept ethical values, to identify certain actions as either right or wrong. Affirmative answers to this first question do not necessarily determine what the answer to the second question should be. Independently of whether or not humans are necessarily ethical, it remains to be determined whether particular moral prescriptions are in fact determined by our biological nature, or whether they are chosen by society, or by individuals. Even if we were to conclude that people cannot avoid having moral standards of conduct, it might be that the choice of the particular standards used for judgment would be arbitrary, or that it depended on some other, nonbiological criteria. The need for having moral values does not necessarily tell us what these moral values should be, just as the capacity for language does not determine which language we speak.

The thesis that I propose is that humans are ethical beings by their biological nature. Humans evaluate their behavior as either right or wrong, moral or immoral, as a consequence of their eminent intellectual capacities, which include self-awareness and abstract thinking. These intellectual capacities are products of the evolutionary process, but they are distinctively human. Thus, I maintain that ethical behavior is not causally related to the social behavior of animals, including kin and reciprocal altruism.

A second thesis that I put forward is that the moral norms according to which we evaluate particular actions as morally either good or bad (as well as the grounds that may be used to justify the moral norms) are products of cultural evolution, not of biological evolution. The norms of morality belong in this respect to the same category of phenomena as the languages spoken by different peoples, their political and religious institutions, and the arts, sciences, and technology. The moral codes, like these other products of human culture, are often consistent with the biological predispositions of the human species, dispositions we may to some extent share with other animals. But this consistency between ethical norms and biological tendencies is not necessary or universal: it does not apply to all ethical norms in a given society, much less in all human societies.

Moral codes, like any other dimensions of cultural systems, depend on the existence of human biological nature and must be consistent with it in the sense that they could not counteract it without promoting their own demise. Moreover, the acceptance and persistence of moral norms is facilitated whenever the norms are consistent with biologically conditioned human behaviors. But the moral norms are independent of such behaviors in the sense that some norms may not favor, and in fact may hinder, the survival and reproduction of the individual and the individual's genes, which are the targets of biological evolution. Discrepancies between accepted moral rules and biological survival are, however, necessarily limited in scope or they would otherwise lead to the extinction of the groups accepting such discrepant rules.

I argue that the question of whether ethical behavior is determined by our biological nature must be answered in the affirmative. By "ethical behavior" I mean here to refer to the urge to *judge* human actions as either good or bad, which is not the same as *good behavior* (i.e., *doing* what is perceived as good instead of what is perceived as evil). Humans exhibit ethical behavior by nature because their biological constitution determines the presence in them of the three necessary, and jointly sufficient, conditions for ethical behavior. These conditions are: (*a*) the ability to anticipate the consequences of one's own actions; (*b*) the ability to make value judgments; and (*c*) the ability to choose between alternative courses of action. I shall briefly examine each of these abilities and show that they exist as a consequence of the eminent intellectual capacity of human beings.

The ability to anticipate the consequences of one's own actions is the most fundamental of the three conditions required for ethical behavior. Only if I can anticipate that pulling the trigger will shoot the bullet, which in turn will strike and kill my enemy, can the action of pulling the trigger be evaluated as nefarious. Pulling a trigger is not in itself a moral action; it becomes so by virtue of its relevant consequences. My action has an ethical dimension only if I do anticipate these consequences.

The ability to anticipate the consequences of one's actions is closely related to the ability to establish the connection between means and ends; that is, to see a means precisely as a means, as something that serves a particular end or purpose. This ability to establish the connection between means and their ends requires the ability to anticipate the future and to form mental images of realities not present or not yet in existence.

The ability to establish the connection between means and ends happens to be the fundamental intellectual capacity that has made possible the development of human culture and technology. The evolutionary roots of this capacity may be found in the evolution of bipedal gait, which transformed the anterior limbs of our ancestors from organs of locomotion into organs of manipulation. The hands thereby gradually became organs adept for the construction and use of objects for hunting and other activities that improved survival and reproduction, that is, that increased the reproductive fitness of their carriers.

The construction of tools, however, depends not only on manual dexterity but also on perceiving them precisely as tools, as objects that help to perform certain actions, that is, as means that serve certain ends or purposes: a knife for cutting, an arrow for hunting, an animal skin for protecting the body from the cold. The hypothesis I am propounding is that natural selection promoted the intellectual capacity of our biped ancestors because increased intelligence facilitated the perception of tools as tools, and therefore their construction and use, with the ensuing amelioration of biological survival and reproduction.

The development of the intellectual abilities of our ancestors took place over 2 million years or longer, gradually increasing the ability to connect means with their ends and, hence, the possibility of making ever more complex tools serving remote purposes. The ability to anticipate the future, essential for ethical behavior, is therefore closely associated with the development of the ability to construct tools, an ability that has produced the advanced technologies of modern societies and that is largely responsible for the success of humankind as a biological species.

The second condition for the existence of ethical behavior is the ability to make value judgments, to perceive certain objects or deeds as more desirable than others. Only if I can see the death of my enemy as preferable to his or her survival (or vice versa) can the action leading to his or her demise be thought of as moral. If the alternative consequences of an action are neutral with respect to value, the action cannot be characterized as ethical. The ability to make value judgments depends on the capacity for abstraction, that is, on the capacity to perceive actions or objects as members of general classes. This makes it possible to compare objects or actions with one another and to perceive some as more desirable than others. The capacity for abstraction, necessary for perceiving individual objects or actions as members of general classes, requires an advanced intelligence such as exists in humans and apparently in them alone. Thus, I see the ability to make value judgments primarily as an implicit consequence of the enhanced intelligence favored by natural selection in human evolution. Nevertheless, valuing certain objects or actions and choosing them over their alternatives can be of biological consequence; doing this in terms of general categories can be beneficial in practice.

Moral judgments are a particular class of value judgments, namely, those where preference is dictated not by one's own interest or profit but by regard for others, which may cause benefits to particular individuals (altruism) or take into consideration the interests of a social group to which one belongs. Value judgments indicate preference for what is perceived as good and rejection of what is perceived as bad; *good* and *bad* may refer to monetary, aesthetic, or all sorts of other kinds of values. Moral judgments concern the values of right and wrong in human conduct.

The third condition necessary for ethical behavior is the ability to choose between alternative courses of action. Pulling the trigger can be a moral action only if I have the option not to pull it. A necessary action beyond our control is not a moral action: the circulation of the blood or the digestion of food are not moral actions.

Whether or not there is free will has been much discussed by philosophers, and this is not the appropriate place to review the arguments. I will only advance two considerations based on our commonsense experience. One is our profound personal conviction that the possibility of choosing between alternatives is genuine rather than only apparent.[3] The second consideration is that when we confront a given situation that requires action on our part, we are able mentally to explore alternative courses of action, thereby extending the field within which we can exercise our free will. In any case, if there were no free will, there would be no ethical behavior; morality would be only an illusion. The point that I wish to make here, however, is that free will is dependent on the existence of a well-developed intelligence, which makes it possible to explore alternative courses of action and to choose one or another in view of the anticipated consequences.

In summary, my proposal is that ethical behavior is an attribute of the biological makeup of humans and is in that sense a product of biological evolution. But I see no evidence that ethical behavior developed because it was adaptive in itself. I find it hard to see how *evaluating* certain actions as either good or evil (not just choosing some actions rather than others, or evaluating them with respect to their practical consequences) would promote the reproductive fitness of the evaluators. Nor do I see how there might be some form of *incipient* ethical behavior that would then be further promoted by natural selection. The three necessary conditions for there being ethical behavior are manifestations of advanced intellectual abilities.

It rather seems that the likely target of natural selection may have been the development of these advanced intellectual capacities. This development was favored by natural selection because the construction and use of tools improved the strategic position of our biped ancestors. Once bipedalism evolved and tool using and toolmaking became possible, those individuals more effective in these functions had a greater probability of biological success. The biological advantage provided by the design and use of tools persisted long enough so that intellectual abilities continued to increase, eventually yielding the eminent development of intelligence that is characteristic of *Homo sapiens*.

Concluding Remarks about Moral Codes

There are many theories concerned with the rational grounds for morality, such as deductive theories that seek to discover the axioms or fundamental principles that determine what is morally correct on the basis of direct moral intuition. There also are theories, like logical positivism or existentialism, that negate rational foundations for morality, reducing moral principles to emotional decisions or to other irrational grounds. Since the publication of Darwin's theory of evolution by natural selection, philosophers as well as biologists have attempted to find in the evolutionary process the justification for moral norms. The common ground to all such proposals is that evolution is a natural process that achieves goals that are desirable and thereby morally good; indeed, it has produced humans. Proponents of these ideas claim that only evolutionary goals can give moral value to human action: whether a human deed is morally right depends on whether it directly or indirectly promotes the evolutionary process and its natural objectives.

Herbert Spencer (1893) was perhaps the first philosopher who sought to find the grounds of morality in biological evolution. More recent attempts include those of the distinguished evolutionists J. S. Huxley and C. H. Waddington and of Edward O. Wilson, founder of sociobiology as an independent discipline engaged in discovering the biological foundations of social behavior (see T. H. Huxley and J. S. Huxley 1947; J. S. Huxley 1953; Waddington 1960; Wilson 1975, 1978). I have argued elsewhere (Ayala 1987) that the moral theories proposed by Spencer, Huxley, and Waddington are mistaken and fail to avoid the naturalistic fallacy.[4] These authors argue, in one or another fashion, that the standard by which human actions are judged good or evil derives from the contribution the actions make to evolutionary advancement or progress. A blunder of this argumentation is that it is based on value judgments about what is or is not progressive in (particularly human) evolution (Ayala 1982). There is nothing objective in the evolutionary process itself that makes the success of bacteria, which have persisted for more than 3 billion years and in enormous diversity and numbers, less progressive than that of the vertebrates, even though the latter are more complex (see Gould 1996). Nor are the insects, of which more than 1 million species exist, less successful or less progressive from a purely biological perspective than humans or any other mammal species. Moreover, the proponents of evolution-grounded moral codes fail to demonstrate why the promotion of biological evolution should by itself be the standard to measure what is morally good.

The most recent and most subtle attempt to ground the moral codes on the evolutionary process emanates from the sociobiologists, particularly E. O. Wilson, who starts by proposing that "scientists and humanists should consider together the possibility that the time has come for ethics to be removed temporarily from the hands of the philosophers and biologicized" (Wilson 1975, 562). The sociobiologists' argument is that our perception that morality exists is an epigenetic manifestation of our genes, which so manipulate humans as to make them believe that some behaviors are morally "good," so that people behave in ways that are good for their genes. Humans might not otherwise pursue these behaviors (altruism, for example), because their genetic benefit is not apparent (except to sociobiologists after the development of their discipline) (see Ruse 1986a; 1986b; Ruse and Wilson 1986).

As I have argued elsewhere, the sociobiologists' account of the evolution of the moral sense is misguided (Ayala 1987; 1995a). As I have argued above, we make moral judgments as a consequence of our eminent intellectual abilities, not as an innate way to achieve biological gain. Moreover, the sociobiologists' position may be interpreted as calling for the supposition that those *norms* of morality should be considered supreme that achieve the most biological (genetic) gain (because that is, in their view, why the moral sense evolved at all). This, in turn, would justify social preferences, including racism and even genocide, that many of us (sociobiologists included) judge morally obtuse and even heinous.

The evaluation of moral codes or human actions must take into account biological knowledge, but biology is insufficient for determining which moral codes are, or should be, accepted. This may be reiterated by returning to the analogy with human languages. Our biological nature determines the sounds that we can or cannot utter and also constrains human language in other ways. But a language's syntax and vocabulary are not determined by our biological nature (otherwise there could not be a multitude of tongues); they are products of human culture. Likewise, moral norms are not determined by biological processes but by cultural traditions and principles that are products of human history.

NOTES

1. Lee Berger, a paleoanthropologist at the University of Witwatersrand in Johannesburg, announcing that two fossil human footprints had been discovered along Langebaan Lagoon, 100 kilometers north of Capetown, stated, "Whoever left these footprints has the potential of being the ancestor of all modern humans. If it was a woman, she could conceivably even be Eve." He was of course referring to the mitochondrial Eve, not to the biblical Eve (Gore 1997, 92–99). Other examples are cited in Ayala 1995b.

2. The theoretical number of ancestors for any one individual becomes enormous after some tens of generations, but inbreeding occurs: after some generations, ancestors appear more than once in the genealogy.

3. Confucius put it thus: "One may rob an army of its commander-in-chief; one cannot deprive the humblest man of his free will" (Confucius [c. 500 B.C.E.] 1996).

4. The "naturalistic fallacy" consists in identifying what *is* with what *ought to be*. This error was already pointed out by Hume: "In every system of morality which I have hitherto met with I have always remarked that the author proceeds for some time in the ordinary way of reasoning . . . when all of a sudden I am surprised to find, that instead of the usual copulations of propositions, *is* and *is not*, I meet with no proposition that is not connected with an *ought* or *ought not*. This change is imperceptible; but is, however, of the last consequence. For as this *ought* or *ought not* expresses some new relation or affirmation, it is necessary that it should be observed and explained; and at the same time a reason should be given, for what seems altogether inconceivable, how this new relation can be a deduction from others, which are entirely different from it" (Hume [1740], 1978).

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