Preface: It was not there in the Big Bang, but . . .

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After long decades of mutual ignorance, the human sciences now seem to expect of the biological sciences, and particularly of physiology, neurocognition, and genetics, that they might explain the mechanisms of behavior and psychological states. It has also come to be expected of biology that it will provide, from the descriptive or experimental study of animal behavior, models that might point to useful conceptual and methodological tools. In this field, too, successes have been commensurate with the stakes, to the extent that sometimes the biological sciences have had a profound impact on the study of human psychology. This is notably true in the case of the conditioning model for animal psychophysiology or that of imprinting for ethology. However, even if such contributions are important, they only concern behavioral mechanisms—their "hows," their proximate causes. It is less obvious that biology has been able to address the question of "why." Indeed, a kind of sanitary cordon has long been firmly maintained around the subject of humankind, where there has been an emotional and ideological refusal to consider that human behavior might have any ultimate causality other than a cultural one. However, the theory of evolution, through its predictive and explanatory power as well as the spectacular progress achieved in molecular biology, seems at last to have broken through this barrier around the nature of humanity.

Had the social sciences known that sociality long preceded the hominids, whose main merit may have been simply to discover *culture*, they would have been called cultural sciences (which would indeed have spared us a number of debates). If it is too late to change the terminology, it must at least be admitted that the objective of the social sciences concerns only a very special kind of sociality (naturally, one dear to our hearts). However, after having read through a book such as this, it will become evident to the reader that at the beginning of the third millennium, the knowledge we now have makes the barrier between the biological and the human, between evolution and culture, ever more illogical. The ability to build a culture and to transmit it in a Lamarckian manner is the result of a long historical process through several major steps whose principal actor was natural selection.

In parallel with the interest in biological mechanisms, it has progressively become legitimate to ask why human psychology is the way it is. This in no way diminishes a proper interest in the functioning of our mental system, but rather the questioning helps us explore the evolutionary origin and the very nature of both our psychological functioning and our behavior, and thus may help us to better understand their finality, the situation of humankind in the animal kingdom, and finally, what is specifically human in our species. One can also imagine that the "why" question may provide (inter alia) some new insights into human behaviors that are deemed, by the norms of handbooks, schools, or cultures, quite pathological. Evolutionary biology is fully involved in explanations at that level also. Thus, a better understanding of the evolutionary significance of culture requires us first to know how to place it in the whole history of life on our planet.

Whereas no culture can exist without societies, nearly all animal societies *seem* to exist without culture. Sociobiology, the field that investigates the biological and evolutionary bases of social behaviors, studies hundreds of animal species which, like the human one, live in societies. Each of them shares with our own species a common ancestor that goes proportionally farther back the greater the phyletic distance between that species and ourselves. Thus, bees and humans share a common ancestor (which was neither insect nor vertebrate, and which was not social), and this common ancestor is more ancient than that which man has in common with the tyrannosaurus (certainly a reptile); it is older still than that shared by rats and humans (a more primitive mammal) and finally, even more distant from ourselves than the anthropoid primate whose heritage we share with the chimpanzee. If bees, tyrannosaurs, rats, chimpanzees, and humans are (or were) all social in their way, only the humans and the chimpanzees share a common ancestor recent enough to have been social.

As I pointed out earlier, man (let us say the genus *Homo*) did not in any way discover social life; he inherited it from an ancestor that he shares with many other primates, most likely with all monkeys. This comes down to saying that sociality is a life system that appeared independently several times during the course of evolution and considering just the five examples mentioned here, it can be stated that sociality appeared at least four times. In insects alone, sociobiologists count a minimum of fourteen independent occurrences of the phenomenon of sociality. Furthermore, not one of the ancestors common to all or part of those fourteen groups of social insects was already social. Despite everything, social life is rare in the animal kingdom. In insects, it concerns only 2 percent of the million or so species identified. In the midst of this ocean of solitary species, a rarity among rarities, human beings (the last living species of the genus *Homo*) have the unique characteristic of systematically setting up cultural societies that are sophisticated to a degree that is beyond the reach of other animals.

This does not mean, however, that social animals are mere automatons directly piloted by their genes.

As will be seen in this book, animal social cultures exist that are far less elaborate than those in man. In an even greater number of species, behavioral traditions can be transmitted from one generation to another by a nongenetic heredity, especially through parental behavior. These are passive transmissions, without motivation to learn or to be taught. A typical example has been described for the rat by Canadian physiologists[1] who demonstrated that highly manipulative mothers[2] induce in their offspring a lowering of stress when they are faced with an unknown environment—a property that becomes transmissible from the outset to the next generation. So the young adult females that went through such an experience in their youth present, as their mothers did a strong manipulative profile. It is thus possible, through adoptions, to reverse the fate of a rat. For example, an individual that would have become a stressed adult if it had been raised by its own only weakly manipulative mother will turn into an unstressed adult rat if it has been adopted by a highly manipulative mother. Resistance to stress can thus be nongenetically transmitted from generation to generation, even if the formal mechanism itself is obviously gene dependent. The transmission of the "stressed rat" or "unstressed rat" character is of the Lamarckian type, but it may be the only feature it has in common with an authentic culture in the human sense of that term. More surprisingly, some among the more recognized primatologists are reluctant to acknowledge the existence of culture in chimpanzees on the grounds of the absence of a pedagogical motive (the motivation to transmit and to receive knowledge). Readers of this book will find sufficient information to form their own opinions on the matter.

That we should find in animals few, or even no, premises or preludes to human culture should in no way prevent us from asking whether the social (noncultural) level that lies beneath the cultural level has an influence upon the latter, perhaps in the same way as the drift of continents is influenced by the underlying magma. A reflection upon the conditions under which sociality emerges could lead to conclusions that might cast some light upon the case of the human species, suggesting perhaps that the cultural exception has built itself upon a preexisting social base, modifying it in many ways. The qualitative jumps that in evolution occurred several times (sociality) or only once (culture) inevitably correspond to genetic aptitudes or predispositions that appeared, were selected, and have been maintained over time. This does not mean that experience does not have a role to play in the elaboration of individual social behavior or, even less, that the content of culture is determined by genes!

On the other hand, however, life in a cultural society that has universal rules (mutualism, value systems, hierarchies, religions, rites, superstitions, gathering and transmission of knowledge, etc.) implies that the framework of such rules should have appeared and been transmitted in the Darwinian manner, whereas the expression of such rules within each culture depends upon a Lamarckian transmission, that is to say, a nongenetic one. Animal sociobiology pointed out that "true" altruism, namely, altruism that is not preferentially oriented toward relatives, may only be selected and maintained when it is reciprocal.[3] The best strategy being to cheat rather than to avoid cheating, reciprocal altruism can occur only in particular conditions. One is the absence of cheaters because cheating is simply not in the program of the species. An example is the mutualistic supersocieties of ants in which several queens give birth to corresponding matrilines of workers who cooperate without preference for relatives.[4] The "complete confidence" which apparently rules an ant society might well explain why such supersocieties have appeared independently several times within this single family of Hymenoptera. Concerning the higher vertebrates, the story must be different, because cheating is widespread. Here, the higher cognitive level suggests that cheating has rather been negatively selected because of the cost imposed by sanctions against cheaters. Besides the cognitive capacities needed to punish cheaters (the recognition and remembering of the conduct of the cheater in the previous situation and the capacity to decide to inflict a sanction), the reciprocally altruistic vertebrate may live long enough to have a chance to punish a cheater in a reversed situation. Surprisingly, the effect of life-span on the probability of reciprocal altruism being selected in a vertebrate phylum is often underestimated. Although there already exist several evolutionary explanations for religion,[5] one may hypothesize that the widespread human belief about life after death was selected to postpone (and sometimes make endless) the time limit within which cheaters may expect to be punished. If so, this would explain why humans are highly reciprocal altruists and, possibly, why our ancestors won against other hominid competitors who did not have such an efficient mechanism for preventing cheating against one's own group. Of course, this is speculation. However, it gives an example of how evolutionary thinking may also contribute, among other things, to understanding human traits that are eminently cultural.

The discoveries of evolutionary biology applied to animal societies lead to an important observation. No species has passed directly from the solitary stage to the social. Indeed, in all cases social animals hail from ancestors who had a solitary parental life, thus a family structure both linked and limited to reproduction. Other things being equal, society is to culture what family is to society. *Family is the basic structure common to all societies*. Without it there would never have been either society or culture. This is no ideological or moral statement, but the mere observation of a zoologist. During reproduction time, many solitary species form labile family structures without attaining the level of a stable group that the social level implies. It is among these species that some animals and arthropods have sometimes crossed the Rubicon that leads to sociality. Most parental (familial) species never became, nor will ever become social;

like butterflies, they do not (and cannot) make up family groups. Family has always preceded society in the same manner as, with hominids, society long preceded culture. The theory of kin selection provides us with an explanation for this observation. The family brings together, in the same place and at the same time, individuals who share a large number of genes, thus considerably improving the likelihood that an altruistic act will indirectly have a genetic effect that is beneficial for its author. The evolutionist approach thus allows one to apprehend the family in the strict sense as a presocial structure that is in no way restricted to humans and that can be defined as a compulsory parental system organized between partners in reproduction and having the characteristic of gathering in time and space individuals who share a high number of genes. Society is, basically, a "superfamily" whose members maintain close ties beyond the period of reproduction. A perennial structure thus appears in the populations of a species. In the case of the human lineage, the step was made so long ago that humankind is not a good model to study if one is seeking to understand the emergence of societies. To try to understand sociality from the perspective of the human model would be rather like a botanist trying to describe the formation of a tree trunk by observing a blossom opening out at the tip of the finest twig of its branches. Better to stay at the level of the trunk itself!

Evolutionary biology is capable of explaining why social life, when it appears within a population of a species, generally gets the better of other populations of the same species that have stuck to the ancestral solitary parental formula. For understanding that, it is necessary to go back to the origins of sexuality; in other words, long before the appearance of the first family structure. Sexuality is a costly practice because of the random character of the survival of the young. However, it contains within itself a far higher adaptive advantage: that of increasing the genetic variability of descendants and thus conferring better resistance to disease. This probably justified the origin, as soon as sexuality came about, of a new evolutionary adventure: a strategy that seeks to form fewer female gametes but to endow them with better cytoplasmic reserves. Producing fewer ovules but producing them better and with a greater likelihood of success became possible provided that the production of spermatozoids was maintained at its original level, and provided that there was a correlative selection of new mechanisms that allowed them to be deposited close to the ovules. By beating the "genetic cards" at each generation, sexuality accelerated the emergence of interindividual differences, thus precipitating the rhythm of evolution and expanding biodiversity. There came a moment when, at different levels of the evolutionary tree, the improvement of the fertility rate could only progress through innovations in some domain other than that of physiological improvements, namely, behavior.

On the one hand, a set of coevolutionary processes affecting the sexual organs of higher plants and the behavior of animals (insects and certain birds or mammals) led to the latter becoming go-betweens in exchange for food (hence pollination). Parallel with this, animals started their own evolutionary process in which behavioral traits occupied center stage. The savings thus obtained were sometimes only slight and made no further evolutionary progress, as in the case of female butterflies which, instead of laying their eggs haphazardly in full flight, began to deposit them on the leaves of the plants on which the future caterpillars would feed. In many other groups, the result was made more spectacular through the emergence, on several occasions, of the parental strategy, and there we reach our starting point for social evolution: the family. We encounter this in fish (sea horses in which the males gather the young in an incubatory pouch); in amphibians (the male of the *Pipa* toad gathers its offspring in its dorsal pouches); in reptiles (the *Maiasaura*, meaning "good mother lizard," a large herbivorous dinosaur, would tend her brood of about fifteen young gathered in a nest 1 m deep by 2 m wide); in all birds; in all mammals; in some rare mites, spiders, and crustaceans; and finally in different insect taxa such as cockroaches, bees, ants, termites, and beetles. The adaptive value of the family is to be found in the fact that the offspring are protected more effectively and for a longer time and will only be left to fend for themselves much later. The investment made has a better guarantee of success and the parents disperse their genes more safely. Such is the *raison d'être* of the family, from an evolutionary point of view, of course. It is an aspect not to be neglected without forgetting that in turn the family was the starting point of the evolutionary adventure that led to sociality and then to culture.

Previously, before the family level, there were several other critical evolutionary steps that were also characterized by the pooling of entities of the previous level in a new, cooperative, emerging system. These cooperons[6] or major transitions[7] were successively the self-replicating macromolecules of life, the prokaryote cell, the eukaryote cell, the multicellular organism, the family, the societies, the societies of societies (ants and hominids), and finally culture. Each of these highly qualitative evolutionary steps emerged from one or another form of cooperation or synergy.[8] Does this common trait depend on a general law of the universe? We should have the answer once we become capable of really understanding the organization of extraterrestrial life. But that's another story . . .

Notes

1. D. Francis, J. Diorio, D. Liu, and M. J. Meaney, Nongenomic transmission across generations of maternal behavior and stress responses in the rat. *Science* 286(5) (1999).

2. These female rats display significantly more licking, grooming, and transporting behaviors toward their offspring.

3. R. Trivers, The evolution of reciprocal altruism. *Quarterly Review of Biology* 46 (1972): 35–57.

4. See for example, R. Blatrix and P. Jaisson, Absence of kin discrimination in a ponerine ant. *Animal Behavior* 64 (2002): 261–268.

5. P. Boyer, Religion explained. In *the evolutionary origins of religious thought* (Harper Collins, New York, 2002).

6. P. Jaisson, *La fourmi et le sociobiologiste* (Odile Jacob, Paris, 1993).

7. J. Maynard Smith and E. Szathmáry, *The major transitions in evolution* (W. H. Freeman, New York, 1995).

8. P. Corning, *Nature's magic: synergy in evolution and the fate of humankind* (Cambridge University Press, Cambridge, 2003).

"The Big Bang is an enormously successful theory." So what does this theory teach us? What really happened at the birth of our universe, and how did it take the shape we observe today?Â There could be other branes lurking out there in 11-dimensional space, the idea goes. A collision between two branes could have jolted the universe from contraction to expansion, spurring the Big Bang we see evidence of today. Looking for gravitational waves. "The Big Bang is a moment in time, not a point in space," said Sean Carroll, a theoretical physicist at the California Institute of Technology and author of "The Big Picture: On the Origins of Life, Meaning and the Universe Itself" (Dutton, 2016). Thus, it's possible that the universe at the Big Bang was teeny-tiny or infinitely large, Carroll said, because thereâ€™s no way to look back in time at the stuff we canâ€™t even see today.Â No one knows exactly what was happening in the universe until 1 second after the Big Bang, when the universe cooled off enough for protons and neutrons to collide and stick together. Many scientists do think that the universe went through a process of exponential expansion called inflation during that first second. The Big Bang would therefore not have been a Big Bang but a Big Bounce. There are a number of possibilities, one of which is the â€˜cyclic Universeâ€™ posited by physicists Steinhardt and Neil Turok, in which the Universe undergoes repeated bounces, possibly an infinite number of them, and therefore has no beginning. Crucially, though, a long pre-Big Bang phase provides plenty of time for properties of the Universe to equalise, just as a long time allows a bath of cold water to come to an even temperature after hot water is added.Â In the Big Bang, a very big Universe was very small and therefore it is necessary to unify quantum theory and Einsteinâ€™s theory of gravity in order to predict what went on. Such a unification has so far proved elusive. Far-ranging and provocative, The Big Bang Never Happened is more than a critique of one of the primary theories of astronomy -- that the universe appeared out of nothingness in a single cataclysmic explosion ten to twenty billion years ago.Â A mesmerizing challenge to orthodox cosmology with powerful implications not only for cosmology itself but also for our notions of time, God, and human nature -- with a new Preface addressing the latest developments in the field.Â And there is a real need now to determine an alternative to the Big Bang, as expressed by many of these reviews. The history of the Big Bang theory began with the Big Bang's development from observations and theoretical considerations. Much of the theoretical work in cosmology now involves extensions and refinements to the basic Big Bang model. The theory itself was originally formalised by Belgian Catholic priest, mathematician, astronomer, and professor of physics Georges LemaÃ®tre.