ETHOLOGY AND ETHICS—THE BIOLOGY OF RIGHT AND WRONG

by Hudson Hoagland

The question, how can man know right from wrong, can be interpreted in many ways. For example, how can he make the right turn at the crossroads to go to Portsmouth instead of the wrong turn that would land him in Podunk? How can he hold his tennis racket in the right way so as to stroke the ball properly instead of the wrong way that causes him to flub his shots? How can he perform correctly and avoid error in acts of skill or in finding his way through life? However, what I presume is meant by the question, is how does man know how to act ethically instead of unethically in relation to his fellows? This, of course, is a special case of knowing right from wrong. It is a special case of the general problem of how animals, including man, adjust effectively, that is, rightly or correctly rather than wrongly, to what they encounter in their environments; and this brings in the role of adaptation in directing both biological and psychosocial evolution. Thus it brings us to a consideration of our innate potentialities and of our plasticity in using these potentialities appropriately in relation to changing situations so that our conduct may be right and not wrong.

In any behavior pattern of any animal, both genetic endowment and learning by experience may be involved—always the former and usually the latter—and this is so from amoeba to man. The degree to which an animal can learn by experience is directly related to the complexities of its nerve net, or brain. Thus while ants with their tiny brains can learn mazes, most of their highly complex social behavior is innate and instinctive. In ourselves, on the other hand, most of our behavior patterns are learned from day-to-day experience, but our capabilities and the organization of many subconscious drives are also innate and are transmitted from generation to generation by the alphabet and code of information of our germ plasm. This alphabet is in the

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form of a chemical code of structured molecules in the germ plasm, and constitutes a blueprint to instruct the oncoming generation how to produce offspring resembling the parents. We share this code with all living things even down through bacteria and into the pseudo-living world of the viruses. Human relations are determined in part by our phylogenetic memory, as transmitted by our genetic code in terms of our psychophysiology and resulting conduct, reflecting behavior capacities and differences in personality.

Over the past hundred thousand years, men have learned much about co-operating together in a variety of ways, by ingenious social inventions incorporated into institutions. Co-operation involving traditions, customs, and laws has given us our concepts of right and wrong, of ethics and morals. These concepts, of course, vary from culture to culture as would be expected.

I believe that man's concepts of morality are based on his belief that they make more effective ways for people to live together. Wrong conduct is believed to threaten the group—clan, tribe, nation, or ideology and/or the individual within the group who believes he has a stake in the social system. That which people call morally right promotes, or is believed to promote, the group's welfare and hopefully enables the individual to realize his potentialities, although in some societies the group's welfare conflicts with the individual's. These generalizations apply to animal as well as to human societies. I can see no reason to assume the existence of absolute or transcendental sanctions of conduct. Human societies have been built upon the assumption that man is free to make choices and is responsible for his choices. This assumption may or may not be true in relation to the ancient problem of free will and determinism. But that is not the point. Men operate as responsible agents, and their conduct determines, for better or for worse, the nature of their societies and their concepts of good and evil as they emerge from the practices of living together.

To discuss this humanistic approach, let me begin by briefly reviewing our genetic memory, its code, and evolution in relation to adaptive behavior. I will then go on to consider aspects of the physiology of behavior and, finally, to discuss the roots of ethics and morals in animal conduct and the implications of these things for the theme of our conference.

Evolution of Right Behavior

Since 1900, the science of genetics has made great advances and given us a mechanism for the understanding of biological evolution. The con-

cept of evolution by natural selection, formulated in 1859 in Darwin's *Origin of Species* and subsequently modified and clarified by many writers, had a profound impact on our thinking. The facts of evolution show that the great variety of millions of species of living organisms with us today is the result of the elimination of thousands of other forms that failed to adapt and so survive in the course of competition with each other and with a changing environment.

Chance variations in the germ plasm in plants and animals, which gave their offspring certain advantages in competition with others in their environments, enabled the offspring to survive, and those not so well adapted perished, with the result that today all contemporary plants and animals are the successful distillate of this process of natural selection. The environment does not impose inheritable changes upon the phenotype or adult organism by acting upon it directly. Giraffes do not get long necks by stretching for leaves on tall trees. Rather, the environment challenges the species, and it may or may not be able to adapt itself to the challenge—and so survive and reproduce or fail and perish. The genes, the units of heredity, in eggs and sperm, may suffer random change, called "mutations," by effects of ionizing radiations or, more rarely, by chemicals acting directly on the germ plasm, or by thermal molecular agitation that may chance to modify the chemical structure of the units of heredity, and these mutations are inherited.

It has been known for over a century, from the studies of Mendel, that at each generation the genes are repeatedly segregated and reassorted in their combinations in offspring as a result of sexual reproduction. New constellations of gene patterns occur on each mating, with resulting individual variations in offspring even from the same parents (except for identical twins). Individuals differ with varying endowments ranging over extensive probability curves. Thus human intelligence, which is in part genetically determined, ranges in a bell-shaped curve from idiot to genius; and other human anatomical, physiological, and psychological attributes follow similar statistical distributions.

The discoveries since 1900 of genetic mutations and, in recent decades, discoveries in molecular biology have established a further important basis for the nature of variations in plants and animals. The large nucleoprotein molecules of deoxyribonucleic acid (DNA), which constitute the hundreds of thousands of genes in egg and sperm, are subject from time to time to modifications in their chemical structures for reasons mentioned above. Any change in the structure of the molecules

composing the genes produces a mutation, and all mutations are inherited. Mutations occur by chance, which is another way of saying that we do not know specifically what causes any one of them.

Approximately 99 per cent of all mutations are either neutral, lethal, or deleterious, rendering the organism less likely to survive in its environment. This is reasonable, since we would not expect that the dropping of a monkey wrench into an elaborate working machine would improve it. But a very small fraction of 1 per cent of mutations are advantageous and are the source of evolutionary progress. Since mutations are mostly deleterious, surviving forms of plants and animals are the result of screening by natural selection from a host of forms that failed and perished.

Present organisms are a remarkable elaboration of devices to deal with their environments, and they present an elegant panorama of orderliness and adaptability of form and function. This has led to the view that such efficiency and beauty of structures and subtleties of "right" behavior in contrast to "wrong" behavior must be the product of supernatural design and engineering. But, from the point of view of natural selection, no such assumptions are required to account for order in the living world, since only those organisms which were able efficiently to adapt to their environments could have survived and reproduced over the more than two billion years of evolution by natural selection.

Emergent Properties

At different levels of complexity of atomic and molecular organization, properties of aggregates emerge which are entirely new. Lloyd Morgan and others have considered this emergence of the entirely novel from combinations of simpler units under the name of "emergent evolution." Thus sodium is a highly reactive metal and chlorine a poisonous gas, but when the two combine they give us table salt with quite different physical and chemical properties from either sodium or chlorine alone. There is, for example, nothing in the structure of hydrogen and oxygen as gases that would have enabled us to predict the properties of water had there been no experience with chemistry or with water in the first place. The emergence of new properties with complexity of organization is not confined to these simple chemical examples.

To go to the other end of the organization spectrum, mental processes are the result of the functioning of a highly complicated network of nerves, and consciousness itself appears to be an emergent aspect of the evolution of the nervous system. Mental phenomena may thus be

regarded as the integrated properties of nervous systems in the sense that magnetism is a property of the structure and organization of iron atoms. In this way we may also consider natural radioactivity to be a property of the unstable internal organization of heavy atoms of radium and uranium, as the properties of table salt are emergents of the combined atoms of sodium and chlorine. Reproduction in this emergent sense appears to be a property of DNA and RNA molecules and their special chemical configurations, enabling them to synthesize proteins from amino-acid building blocks. In considering the relationship of mind and body, it is meaningless, in an ultimate sense, to attempt to isolate the mental and spiritual from the physicochemical events going on in the brain. They are two aspects of the same phenomenon, although we have developed quite different techniques and languages for dealing with biochemical and physiological processes of the brain, on the one hand, and with subjective psychological events on the other.

Julian Huxley argues that mind cannot be a useless epiphenomenon. It would not have evolved unless it had been of biological advantage in the struggle for survival. He holds that the mind-intensifying organization of animals' brains, based on the information received from the sense organs and operating through the machinery of interconnected neurones, is of advantage for the simple reason that it gives a fuller awareness of both outer and inner situations; it therefore provides a better guidance for behavior in the chaos and complexity of the situations with which animal organisms are confronted. Consciousness endows the organism with better operational efficiency.

Brain Mechanism and Moral Behavior

In 1963, at the IRAS conference, I discussed aspects of brain mechanisms and behavior and will now briefly summarize some of what I said then.[1] The human cerebral cortex has doubled in size in the last half million years, thus making it perhaps the example of the most rapid evolution of an organ by natural selection. This cortex has given man his great advantage over all other animals and put us on top. But man's ancient brain—his limbic area, his hypothalamus, hippocampus, basal ganglia, and thalamus have changed little, if at all, from that of his prehominid ancestors. Man's values and morals, his ideas of right and wrong, depend upon the way his brain works—how his cortex succeeds in controlling his primitive, emotionally charged drives or, to use Freudian terms, how his superego controls his id.

Surgical brain lesions, chemical agents, and electrical stimulation delivered to the brain can profoundly modify mood, emotion, and ag-

gressiveness in animals, including man. Neurophysiologists have shown that there are specific regions in the hypothalamus and limbic areas which, if stimulated electrically, will produce highly aversive reactions, that is, pain, fear, avoidance, and flight, on the part of animals, whereas adjacent regions will produce signs of profound pleasure if stimulated electrically by small shocks. The satisfactions we derive from "right" actions and the unhappiness from "wrong," incorrect, and bungled actions may involve these mechanisms. It is also possible that we may be able to facilitate learning by chemical means. This can be dangerous, but it may result in rational chemical procedures, combined with psychotherapy, for removing pathological ego defenses and facilitating the establishment of healthy reconditioning, that is, right conduct.

In summary, the behavior of each of us is determined by our past history, phylogenetic, ontogenetic, and day-to-day history, that is, by our genes, and by experience that modifies our brain chemistry and physiology, including their correlated conscious and subconscious processes. Behavior—normal and pathological, social and asocial, good and bad—is a product of the correlated action of molecular events in our brain and their mental concomitants, events based on the past experience of our species transmitted from generation to generation by the molecular DNA code of our genes and our personal psychosocial experience from birth to death. I believe that our ideas of good and bad, along with all the rest of behavior, are determined indirectly by genetic capacities and directly by experiencing.

This viewpoint identifies man with the continuity of other animals despite the unusual characteristics of our species. In his social and ethical life, in terms of concepts of good and evil, I believe that there is some continuity through evolution with behavior patterns of other animals and that these can aid us in understanding ourselves.

In the next section I would like to say why I think this is so.

Biological Foundations of Ethics and Altruism

Ethical behavior is traditionally defined in such a way as to preclude its consideration in relation to animals other than man. Thus, to pick a few dictionary definitions, ethics is defined as the science of ideal human conduct in relation to ends to be sought to attain the highest good, or it is the basis of one's duty and moral obligations, or it is a system of moral principles and practices referable to human behavior.

Despite this, I think it is appropriate to consider observable behavior and to ask whether animals display conduct that in man we call "ethical" or "altruistic." Perhaps another more general definition

might be that ethical behavior is co-operative behavior of members of a society that aids the survival of the society and at the same time gives security and opportunity to its members to realize their potentialities. This definition can apply equally to animal and human societies.

We know that man is an animal—albeit an unusual one. We are one of many forms that have evolved by the same screening by natural selection that has produced all the other forms of organisms we see about us. Are the roots of our ethics and morals to be found in animal behavior? I think it would be most surprising if they were not. Despite risks of anthropomorphizing, when we observe some of the social behavior of animals and compare it objectively to human social behavior in comparable situations, it is hard to think that the role of the behavior and its motivations are very dissimilar.

This is especially emphasized when we consider comparative anatomy and physiology and the great similarities in brain anatomy, physiology, and biochemistry among all mammals. Thus the similarities in brain structure—gross, microscopic, and molecular—of man and ape are far greater than are the relatively small differences, and many of our behavior patterns are also very much like those of apes. The famous student of animal behavior, Konrad Lorenz, discouraged with human skulduggery, once remarked that man appears to be the missing link between anthropoid apes and human beings.

Most animals are social animals, and many are highly gregarious. For those who have observed animal behavior, man is not the only political animal. Social togetherness has had survival value for the individual and for the species, and gregarious behavior patterns are determined both by genetic factors and by learning and conditioning, with the relative role of nature and nurture in relation to behavior patterns depending upon the zoölogical classification of the animal and the specific behavior under consideration. Rudiments of altruistic behavior are seen in animals. The sacrifice of life of mother animals in protecting their young, the protection of members of the herd by the organized behavior of its members, even at the cost of their own lives, are forms of conduct that in us would be called brave and altruistic behavior. Thus, adult yaks and other species of horned animals, when attacked by wolves, may form a defensive circle with the calves inside. Baboons are quite properly very much afraid of leopards, but they are relatively safe in their herd structure. There are reliable reports of leopards being killed by male baboons in protecting their herds by "ganging up" on a leopard. The protection of the young is, of course, characteristic

of mammals and of birds, even at the cost of the life of the parent. Defense of territory by groups is also characteristic of some forms ranging from insects to man. Anyone who has interfered with a wasp's nest or sat on an anthill has had firsthand experience with this type of group territorial defense. Such behavior has survival value, preserving the group and the species in a hostile world.

John Paul Scott, a foremost American student of animal behavior, notes:

> Some kind of care-dependency relationship is characteristic of any highly developed animal society. Among the social insects its role is so large that other social relationships are almost non-existent. Worker ants spend most of their time gathering food for the young, feeding and cleaning them, and building elaborate nests for their protection. They extend this kind of relationship to each other. When two ants meet they touch each other's bodies with their antennas, and one which has fed recently will regurgitate a drop of honey dew for the other. In this way the members of the colony take care of each other as well as the larvae. This relationship of *trophallaxis,* so characteristic of social insects, is a complex one, based on investigative, ingestive, and care-giving behavior. . . .
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> Worker ants ordinarily get along well with members of their own colony and will attack ants of a different species or of different colonies which attempt to enter the nest. As indicated earlier, this is not a hereditary trait, since the slave-making ants are able to rear workers of other species and make them a part of the colony. An interesting series of experiments demonstrates what happens to a developing ant. If larvae of different species are taken out of their nests and raised together by the hand of a careful entomologist, no antagonism is shown between them. How then do the ants in natural colonies identify strangers? If an ant which normally arouses the antagonism of a different species is bathed in an alcohol solution and then in the body juices of the foreign species, it will not be attacked by the normally hostile species but will be attacked and killed by its own kind. Presumably a newly-hatched ant quickly learns to associate peaceful behavior with the chemical taste and odor of its own colony. In this way the young ant apparently sets up a permanent social bond with members of its own anthill. The taste or smell of the colony is associated with mutual feeding or protection, and other tastes or smells with an attack. There is no opportunity for an ant to become socialized to another species, since death follows any contact with other colonies. Ant fights are not a matter of learning to avoid or dominate another individual but solely a matter of extermination. Occasionally one comes across examples of inter-colony conflict on a large scale. The ants may go on fighting for a couple of days, leaving the ground littered with corpses.[2]

Symbiosis among plants and animals is of great significance in survival of the species as well as the individual. The remarkable ecological aids afforded by plants and animals to each other, even between widely different species, can teach us much about the essential value

of co-operation. In a very real sense, all of us animals are parasites on the plant world. Plants, by photosynthesis, use the sun's energy to produce sugars and other carbohydrates that we eat. The animals we carnivores also eat have received their nourishment from plants.

A few of the thousands of examples of symbiosis are the relationships between the bacterial flora of our intestines which share our food and in turn aid our digestive processes; certain coelenterates ingest a fungus which then proceeds to thrive and by photosynthesis furnishes the animal with sugars for its food that it could not obtain otherwise. The pollination of flowers by insects illustrates symbiosis. Thus bees fertilize plants in exchange for nectar they obtain from them and convert into honey. The tic birds remove insects and so get food from the skins of rhinoceroses and crocodiles, and actually pick the teeth of the crocodiles. They thus benefit, but they also aid the crocodile by sounding an alarm and by flying off with much noise when the environment of the large animal is invaded. Examples of this kind are legion.

Evolutionary progress may in a sense be measured by the development of complex multicellular plants and animals from primitive single-cell forms. The service of individual cells in special organs and tissues to the functioning of the total organism characterizes the metazoan, including man, and emphasizes the dependence of each cell upon the activities of all the others. The remarkably stable and complex social organizations of ants, bees, and termites, in which each individual plays its special role in maintaining the ancient structures of their societies, are outstanding examples of the mutual support of groups by their members. These hundred-million-year-old complex insect societies are really examples of social conservatism. They have survived because the social structures and behaviors have aided adaption of the animals in survival, that is, they have promoted "right" conduct. But who among us wants to be an ant?

Right Conduct in Fighting

Students of animal behavior have had some interesting things to say about the fighting behavior of animals that are relevant to the question of ethics. Intraspecies fights of animals often have the formal characteristics of a duel, but seldom a duel to the death. For example, rattlesnakes can seriously harm each other by biting, but their fighting does not involve biting; rather, they rear up and come in contact with about a third of their lengths off the ground. They then engage in a kind of Indian wrestling match in which each one tries to push the other's

head toward the ground. When one of them succeeds, the fight is over, the loser crawls away, and dominance is thus established and accepted. The oryx antelope has rapier-sharp horns, but when bulls fight they never try to stab or gore each other. They stand, heads up and flank-to-flank, and then turn to face each other like duelists. They clash with the upper third of their horns in contact and engage in a fencing match, always avoiding use of the points. The winner is the one that pushes his rival about most effectively and thus establishes his dominance. Rats also engage in ritualized fighting behavior involving a kind of boxing and kicking match, although on occasion they do fall upon each other with their teeth. This behavior is innate, since rats brought up in the dark and without any contact with their kind will immediately indulge in the correct fighting ritual when put with socially reared rats, and these ritualized fights occur between members of the same social group. These fights are mostly between males to establish their positions in the social hierarchy. Fights between rats of different colonies can, however, be exceedingly vicious and to the death, and rats, men, and ants are the only animals which really wage war in which groups try to exterminate each other. Dominance gives animals preference rights to food and choice of hunting and breeding territory. Choice of females is there too, but this rates below these other matters. Of course territorial contests and dominance status are conspicuous in most species of birds.

Konrad Lorenz and other ethologists have pointed out that in general the more heavily armed animals, especially the carnivores, in fighting for dominance, seldom do each other serious damage; and this is in sharp contrast to the less armed animals, such as rabbits and turtledoves who, when confined together, kill each other in combat. Fights between wolves result in a slashing fencing match with their formidable teeth, but little damage is done. When one wolf recognizes that he is out-matched, he bares his neck to the fangs of his rival. This gesture of submission stops the fight. The winning wolf simply cannot bite the proffered neck, and although he may growl and snarl and threaten, the contest is over. Free in the wild, powerful, social carnivores, such as wolves and lions, do not attack the young or the females of their group despite annoyance and provocation. Restraint in the use of their lethal weapons is of course essential for survival of the animal group and for the species. If the younger or weaker challenging animals, especially females, were killed, species survival would be jeopardized. A similar state of affairs pertains to birds that are armed with lethal beaks and talons. Many birds, when they fight,

recognize surrender signals and no longer press the combat. Defeated gulls and herons, for example, bow their heads and expose the vulnerable back of the head to the rival's beak. Further attack is stopped. Rabbits, on the other hand, are conspicuously unarmed, have no surrender signals, and if they cannot run away they may fight to the death. Lorenz describes most cruel and exhaustive fights between closely caged male doves. No signal of surrender is made or recognized by these birds, and the exhausted loser is literally pecked to death by the nearly exhausted victor. Caged hawks or eagles would not behave this way. As an observer of animal fights, Lorenz has remarked that the biblical admonition to turn the other cheek has taken on a new meaning for him. It is not to get the cheek slapped but, like the wolf that exposes its neck to the victor, it may block further aggression.

Konrad Lorenz, as far back as 1935—of course, before the dawn of the nuclear nightmare—concluded an article on morals and weapons of animals with the prophetic words: "The day may come when two warring factions will be faced with the possibility of each wiping the other out completely. The day may come when the whole of mankind is divided into two such opposing camps. Shall we then behave like doves or like wolves? The fate of mankind will be settled by the answer to this question."

Right Behavior in the Care of the Young

Chimpanzees are probably closer to us in their physiology, biochemistry, and psychology than any other animal, and in recent years there have been two outstanding observers of their behavior. One of these is Jane Goodall, and the other is Adrian Kortlandt. These investigators have spent time in the jungle observing colonies of these apes. Kortlandt did so from cover without mingling with the group. The apes finally got used to his blind in an orchard and paid no more attention to him. Miss Goodall, on the other hand, lived with the animals. They became so adapted to her presence that they usually ignored her when she was in their midst. Both observers comment on the way in which the young chimpanzees are pampered and cared for by the mothers up to the age of three or four years. They remain dependent upon the mother and are obedient to her commands despite their highly playful and adventuresome natures. The young may take great liberties with tough old males, slapping them on the buttocks and pulling their hair and ears. The senior animals show great indulgence to the youngsters. They have been observed to swing them and play with them as a man would with a young child, displaying great pa-

tience in the process—far more than most human fathers would do with children, especially those not his own. Grooming among apes and monkeys is a general practice, and the grooming procedures of who grooms whom first, and when, reflect the social status of the animals. Grooming has all the appearance of being a truly altruistic act. Miss Goodall describes the sharing of food by chimpanzees, some examples of which clearly indicate what, in us, would be generosity and altruistic behavior. The wise old leader of the group is watched and obeyed by the young adults, and the child apes are remarkably responsive to commands from their mothers. This constitutes "right" behavior for survival in a hostile jungle. The much longer period of childhood dependence in humans is an extension of the period of instruction to enable the young to discriminate between right and wrong conduct, and allow time to educate offspring in a far more complex world than is faced by other animals.

I have mentioned the defense of the young by parents. Female animals who are not parents frequently care for the young. This is seen with elephants, lionesses, wolves, and most monkeys and apes, to mention only a few examples. This appeal of children to adults even transcends species boundaries. We all recognize the appeal of young animals for us, be they kittens, cubs, puppies, baby chicks, ducklings, or what not. A mother dog deprived of her puppy will raise young kittens or rats and protect them as her own. Thus species boundaries break down in the face of infancy. A remarkable picture appearing in *Life* magazine shows a dog and his devoted playmate, a full-grown leopard. The dog was mature and the leopard was a kitten when they were introduced. He became the kitten's protector with the result that a striking friendship exists. The little dog is still the dominant partner, although the leopard could kill him with a swipe of his paw.

Frank Fremont-Smith, writing a guest editorial in the *Saturday Review,* has speculated on the young child as a universal symbol for a peaceful world. He suggests that the Soviet Union might devise a way of guaranteeing the future of the children of the United States, while we at the same time become the protectors of children in the Soviet Union. The implementation of such a plan, unfortunately, is remote. After all, nation-states in the nuclear age cannot give security to their own children, let alone to those of a potential enemy. Perhaps in a more humane world of law enforcible against war by a form of world government, these biological and deep roots of altruism can help our species survive. Be that as it may, Fremont-Smith's editorial does

point up the universal and biological basic altruism inherent in the relation between infants and adults.

We started this discussion with a relativistic view to the effect that our ideas of right and wrong depend upon the particular culture into which we have accidentally been born and the resulting emotional charges that prestigious persons have imparted to us, especially in our early years when we are most receptive.

C. H. Waddington in his book *The Ethical Animal*[3] has considered that the long-range objectives of the control of behavior are ethical systems, the values of which may be judged in relation to their ability to further a desirable evolutionary direction. Human culture, he points out, is based on a mechanism that requires people to be brought up in such a way that they accept beliefs given them by others, such as parents and other influential persons in authority. Of course, such beliefs are subject to later testing and rejection or retention, but before this can happen ideas must be transmitted as a form of social heredity.

The molding of the newborn human individual into a being ready to believe what it is told seems to involve many very peculiar processes, which at present may be explained as the formation of the superego and the repression of the id, to use Freudian terminology. A frequent result of the process seems to be that people believe uncritically too much and too strongly. The process that evolution has provided us with seems often to lead to overemotional commitment to belief, especially those beliefs inculcated early in life—beliefs that are often irrational reflections of parochial, parental, and cultural prejudices.

Waddington argues that many of the world's evils and social ills stem from overactivity of the superego, leading to the acceptance of socially regressive beliefs with undesirable impact upon politics, religion, and group identifications. Intense and fanatical loyalties stemming from early acceptance of authoritarian communications have repeatedly led to misery, bigotry, and wars.

Our early learning about what is right and wrong bears points of resemblance to susceptibility of young animals to parents or their surrogates, and also to the phenomenon known as "imprinting." At certain periods in early life, most animals are highly susceptible to parental influence and to what might be referred to as tender, loving care (TLC, for short). Thus studies have shown that puppies, monkeys, kittens, goats, and other young animals, if reared during critical periods in total isolation from other animals, including man, fail to develop as normal adults. In fact, many of them fail to reach adult-

hood. They become neurotic, subject to all sorts of infections, and, when made part of a group later, are usually rejected by its members. These critical periods vary in length and in time of onset from species to species but are species specific. Humans, too, have periods of maximum dependence on mother contact and response very early in life. Deprivation of TLC at this critical period may have dire consequences for subsequent development.

If the young animals receive normal parental care or, failing this, if they are played with by other animals or by people during these critical periods, they make good adjustments later in life. Moreover, these periods are so circumscribed that parental deprivation a week or so after the termination of such a period has little effect on the animals' later development. The experiments of Harry Harlow with young monkeys is instructive. He made two kinds of models of "mothers" out of chicken wire. He arranged nursing bottles on each of the wire models, but over one of them he put terry cloth. While the baby monkeys deprived of normal mothering would nurse from each of these artificial mothers, they became attached to and cuddled with the terry-cloth mother exclusively, and when frightened by such things as a toy teddy bear or toy snake in the cage, would run at once to the terry-cloth mother and cling to it.

The phenomenon of imprinting was first described by Konrad Lorenz, a truly remarkable man, who has revolutionized much of our thinking about animal behavior and pioneered the science of ethology. Lorenz, and others subsequently, have shown that at critical periods in the life of young birds and mammals they will follow any large animal or even an inert moving object that does not attack or frighten them and that passes near them. This is usually their mother, and the imprint to follow must happen during a susceptible early age span. Lorenz feigned the role of the mother and, by walking or swimming past goslings, ducklings, and other animals at the critical period, found, like the Pied Piper of Hamlin, that they assiduously followed him, trailing along in line behind and adopting him as the mother figure. This mother relationship to a human being, if not interrupted, may continue on into adulthood. The imprinting of ideas of right and wrong on children by parents is brought to mind.

Norms of Right and Wrong Produced Both by Genes and Culture

While our culture does determine our sense of right and wrong in terms of accepted ethical norms, we also have instinctive responses

determined by the genetic establishment of innate patterns of nerve pathways in our brains. These patterns function in a much less rigid fashion than they do in other animals owing to the wealth of our intracortical association pathways that give much plasticity to our behavior. For example, territoriality is characteristic of animals from insects on up the scale. Territorial possessiveness is instinctive and in general unlearned, as experiments have demonstrated. May not man's sense of property rights and possessiveness also be in part instinctive? One sees it appear very early in childhood, despite parental objections to possessiveness and amid often futile parental urges to share toys, food, etc., with other children.

And what about the human pecking order? Roles of dominance and submission in our social groupings may well have genetic roots correlated with personality types. Certainly human relations of male and female are genetically determined, and are also overlaid with extensive learned regulation of sex by taboos, laws, and social mores aimed at protecting the family, its offspring, and society.

Conclusions

Let us assume the naturalistic philosophy of how to tell right from wrong that I have tried to outline. What does this mean in terms of daily behavior? What difference does it make to the way we behave?

The biological sciences today give us a magnificent perspective in terms of evolutionary progress from the emergence of reproductive molecules in the Precambrian slime to man with his magnificent imagination and achievements. These evolutionary advances are exciting, deeply moving, and humbling to contemplate. Man is the only animal that can direct his own evolution—and this is a profoundly significant thought. To date he has not consciously directed his biological evolution, although he has done this for domesticated plants and animals. He has, however, directed his much more rapid and plastic psychosocial revolution as is testified by the wealth of inventions covering fields such as religion, education, law, the arts, science, and technology. In the last three hundred years, the development of science has produced man's most powerful tool to control and direct his own evolution, both biological and social.

This naturalistic and humanistic view directly controls one's attitude toward the great issues of our time. Thus the problem of aggression and nuclear war, when seen in the perspective of animal aggressions and hierarchical dominance and fights over territoriality takes on new light. Since the Hiroshima bombing, a new factor has

been introduced by man into the human environment, a factor to which we must adapt or perish. So far we have shown little realization that this is so. Men still talk and act in terms of concepts of lawless national sovereignty and unilateral, international relations as if nuclear weapons did not exist. Animals that have been unable to adapt to changes in their environments have always become extinct, and so may we. It may well be that our cerebral cortex will turn out to have been a phylogenetic tumor, capable of inventing incredibly powerful weapons of destruction but unable to control the primitive aggressions and drives of our ancient limbic brain.

Another great problem of our time is the population explosion. Man appears to be the only animal at the present time that has lost his built-in mechanisms of population control. I have discussed this matter in an article in *Daedalus*,[4] and space does not permit us to go into it here. Suffice it to say, we have much to learn from how animals control their populations and the dire consequences that befall them when they fail to do so. Here is a major issue of right and wrong. To those of us with a naturalistic view, it is simply immoral to overpopulate beyond the ability to give optimal care and opportunity to offspring, and this is in contrast to some religions which hold that it is immoral to limit populations by efficient methods of birth control. Many other problems of our time can be explored against the background of a naturalistic philosophy, with results that I think are hopeful for man's future. This philosophy in its influence on our decisions about right and wrong has the merit of consistency with what science knows about the dynamic nature of man, and these views are very different from those of medieval theology and philosophy, which still constitute much of what we teach our children. To me, ethics and morals founded on man's responsibility to man, based upon his realistic identification with the world of living organisms, offers more hope for his future than the traditional appeals to myths and supernaturalism.

NOTES

1. Hudson Hoagland, "The Brain and Crises in Human Values," *Zygon* (June, 1966), pp. 140–57. Since this summary is very brief, the reader who has not read the earlier paper may wish to do so because of its importance for the present thesis.
2. John Paul Scott, *Animal Behavior* (Chicago: University of Chicago Press, 1958), pp. 175, 177.
3. New York: Atheneum Publishers, 1961.
4. Hudson Hoagland, "Mechanisms of Population Control," *Daedalus* (Summer, 1964), pp. 812–29.