Science and the New Humanism

Science and purpose are related to man's unique ability as an ethical animal to control his evolution.

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Man's unique characteristic among animals is his ability to direct and control his own evolution, and science is his most powerful tool for doing this. We are a product of two kinds of evolution, biological and cultural. We are here as a result of the same processes of natural selection that have produced all the other plants and animals. Over 2000 million years ago certain carbon compounds, among many believed to have formed spontaneously, possessed the unusual ability to utilize energy from the environment to reproduce themselves.

Examples of such reproducing molecules known today are polymers of the nucleic acids. We know that self-replicating DNA and RNA molecules comprising the genes and viruses have carried information in the form of a chemical code from one generation to the next to instruct each species how to propagate and project itself over vast stretches of time. Organic or biological evolution has operated on phenotypes by natural selection, eliminating those forms that were not adapted to conditions of their particular time and place. Thus, by a very wasteful system of elimination, we now have the rich variety of successful plants and animals, including ourselves, we see about us.

A second kind of evolution is psychosocial or cultural evolution. This is unique to man. Its history is very recent; it started roughly a million years ago with our hominid tool-making ancestors. It accelerated markedly in the last 100,000 years with the emergence of *Homo sapiens*. Our ape-like ancestors managed to make crude weapons and tools. This gave them an advantage over other animals in spite of their lack of fighting teeth, of claws or horns, of tough hide and speed of locomotion. Our ancestors became dominant through the rapid evolution of a remarkable cerebral cortex which has doubled in size in the last million years. This rapid development may have been a result of the advantages that accrued to these animals by natural selection when they applied their brains to solving problems. Success had a feedback action aiding selection for survival of the more competent individuals, who could make superior tools and weapons and communicate with each other effectively. With advancing cortical development came the use of words as symbols for ideas. Thus, man with his unique ability to speak and later to write could pass on newly acquired information from father to son and from leader to follower. In this way a new dimension of evolution was added. Agriculture was invented roughly 10,000 years ago, and city-states, 5000 years ago. The whole history of invention, including that of social institutions, is the core of this special evolution. In the last 300 years the ever-accelerating developments through science are a continuation of this psychosocial evolution, which, in terms of progress, is thousands of times faster than biological evolution resulting from genetic mutations.

Mutations and New Ideas

There is a suggestive analogy between biological evolution through mutations of genes, on the one hand, and social evolution through novel ideas, on the other. For example, a creative scientist is one who has many ideas and who is free to test and develop them. Many of these he discards as worthless, but some withstand the rigor of experimental testing and may constitute valuable advances. Several writers have pointed out that new ideas—that is, new insights—are analogous to new mutations of genes.

Henry A. Murray (*1*) has coined the term *idene* in relation to social evolution as an analog to *gene* in biological evolution. We know that most genetic mutations are lethal and harmful; a very few constitute the basis of biological progress by appearing at a time when the environment happens to confer an advantage on the organism possessing that mutation. There is environmental selectivity to favor not only the rare gene mutation responsible for biological progress, but also social environmental selectivity to favor new ideas contributing to social progress. Like mutant genes, an idea may be before its time—that is, the social climate may not be right for its acceptance.

Many ideas are harmful and may even be lethal to the individual and to a society, especially when they become institutionalized. Here one might mention as examples the institutions of slavery, of ritual human sacrifice, of racism, of Nazism and other rigid authoritarian political systems, including various forms of chauvinistic nationalism. Just as mutant genes may be lethal for a species and lead to its extinction, so ideas in the minds of men may produce a catastrophy such as a nuclear war, which could in time, if the arms race continues, be lethal to the human species. The nation-state is a relatively recent social invention, and its primary function has been to give security to its nationals. It became obsolete in 1945 with the advent of nuclear weapons, although few people are aware that this has happened. If its sovereignty continues to be uncontrolled by enforceable supranational law, it may, in our post-1945 environment containing nuclear weapons, produce its own destruction, along with widespread genocide.

Thus, ideas and the institutions they generate may be considered related to social evolution as genes and their phenotypes are related to biological evolution, and selective processes operate upon both. Societies are built by ideas, and, within limits, the more new ideas there are competing with each other for social acceptance, the more effective social evolution is likely to be. Freedom of individuals to express and develop many ideas is necessary for progress in social evolution, just as many mutations must be screened by natural se-

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lection for the development of an improved or a new species of plant or animal. In the case of social evolution the impact of ideas is measurable in years or at least in centuries, while in biological evolution the time scale for mutant genes to establish new forms is measurable in millions of years.

While novelty in the form of mutations and ideas is necessary, respectively, for biological and social progress, the environmentally tested genes and ideas must have stability and continuity to maintain stable species and stable societies to resist the effects of lethal genes and idenes. In other words, conservation as well as plasticity and novelty is necessary for progress. The application of the behavioral and social sciences to testing the values men live by has, I believe, marked potentialities for the advancement of cultural evolution.

The Ethics of Science

Quite aside from the justification of science in terms of its contributions to technology and medicine, we hold a basic assumption that science is concerned with discovering truth, and that truth is intrinsically good. The idea that truth makes men free is an article of faith of Western culture.

Philipp Frank (*2*) has pointed out that there is widespread belief that the rising contempt for tolerance and peace throughout the world is somehow related to the rising influence of scientific thought, and the declining influence of ethics, religion, and art as a guidance of human actions. He argues, however, that there is hardly a doubt that the causes of war can be traced back frequently to religious or quasi-religious political creeds and rarely, if ever, to the doctrines of science. The humanities, including religion and ethics, have been for centuries the basis of education, and the result has been, conservatively speaking, no decline in the ferocity of men.

On the other hand, the scientists have never had a chance to shape the minds of several generations. Therefore, Frank feels it would be more just to attribute the failure of our institutions to produce a peace-loving generation to the failure of ethical and religious leaders, than to construe it as a responsibility of the scientists. As a matter of fact, scientists have an interesting operational ethic of their own which, if more widely understood and developed, could, I believe, have far-reaching repercussions for the common good.

What is the nature of this ethic? Anatol Rapoport (*3*) has pointed out that the ethical principles inherent in scientific practice are the conviction that there exist objective truth and rules for discovering it; moreover, that on the basis of objective truth unanimity is both possible and desirable. But this unanimity must be achieved by independent arrival at convictions, not through coercion, personal argument, or appeal to authority. He considers that this conviction represents a respectable chunk of any ethical system, and that it could well be spread more extensively. Science, like all other systems of thought, seeks answers to questions which men hold to be of importance. But, whereas in other outlooks answers are accepted that harmonize with particular world views and mythologies peculiar to different special cultural groups, science seeks answers which are reducible to everyone's experience. It thus taps the communality of human experience at its roots and is shared by all participants, irrespective of creed, color, class, or nationality.

Every system of knowledge, including scientific knowledge, rests on some system of fiction. But scientific knowledge, by definition, alone can survive the shattering of its fictions, and when they are shattered it becomes, paradoxically, more organized rather than disorganized and demoralized. Thus, nearly all of our scientific theories have changed in the last 100 years—in physics, chemistry, biology, medicine, and psychology. The fictions—that is, the hypotheses and theories—of science are not sacrosanct.

The concept of the dignity and brotherhood of man which is common to many ethical systems is a condition necessary to the pursuit of truth. Science leaves no room for the rationalization of quasi-ethical totalitarian ideologies and racial hatreds. These are maintained by coercion and by exclusion of experience and are supported by sacrosanct fictions which are shattered once scientific inquiry is turned upon them.

Another commentator on these matters is Jacob Bronowski (*4*), who shows that, contrary to popular belief, the activities of science and the people who practice it are far from ethically neutral. He points out that we can only practice science if we value the truth. When we practice science we look for new facts by grouping the facts we have into concepts and organizing hypotheses to account for them, and we judge the concepts and hypotheses by determining whether they turn out to be true in the sense of conforming to the facts and whether they lead on to the discovery of new facts. This procedure is meaningless unless we are deeply concerned with the elimination of the false. This activity presupposes that truth is an end in itself. But truth as developed by scientific activity can also become a source of social values. It can do so, however, only when a whole society, or a large part of it, accepts the assumption that no belief will survive, regardless of its attraction in terms of wishful thinking, if it conflicts with factual truth. This means the setting up of the discovering of truth as a major social end, not only for the individual but for society as a whole. No society, of course, has ever been really dedicated to this end. But there are varying degrees of such concern. In a scientifically oriented society the quest for truth is the important thing, even though we know that ultimate, final truth with a capital T is not to be found.

Bronowski considers that a society that believes that it has found ultimate, final truth—for example, in some political ideology or religion—is an authoritarian society and simply imposes its view of the truth by force if it has the power to do so. Such a society resists all change, for what is there to change for? He points out that this is in contrast to a scientifically oriented society in which progress is a result of the search for truth, since the very search itself demands that the society shall evolve.

The individual who seeks the truth must be independent and free from coercion, and the society that values the truth must safeguard his independence. In a scientifically oriented society, excellence, independence, and originality are esteemed assets and must be protected by respect for the right of dissent. Bronowski considers that the high spots in our Western civilization have been great moments of dissent—the Declaration of Independence, the writings of Milton, the sermons of John Wesley. In science the open challenges of men like Copernicus, Galileo, Newton, Darwin, and Einstein have brought fresh insights and surges of social progress in their wakes. Dissent is thus an instrument of social evolution. All scientists must be heretics and dissenters against accepted views in science if

science itself is to advance. Freedom is thus essential to a scientific society, one in evolution. It is merely a nuisance to be discouraged in a static, authoritarian society.

The international society of scientists has stability, binding together Englishmen, Germans, Japanese, Indians, Americans, and Russians in unity of spirit. Bronowski asks if the foregoing considerations lend support to the myth that science is inhuman and impersonal and that the activity of science generates no values to unite those engaged in it.

We have considered the role of science in advancing psychosocial evolution and the ethical principles involved in the practice of science. Unfortunately the general "fallout" from these ethical practices for the common good, so far has not been great. Scientists often are as unwise in their human relations as anyone else, and there often is little carry-over of their pursuit of truth in the field and laboratory to everyday affairs. Many compartmentalize their thinking. Their interpersonal relations, religion, politics, and science are walled off from each other. Thus, for example, excellent scientific work is done in Communist countries by men dominated by authoritarian Marxist dogma. This work, however, must be done in fields that do not conflict with politics. But the prestige of science and the emphasis on scientific education in the Soviet Union have had, in my opinion, an eroding action on the dogmatism of communism, as it must have in time on all dogmatism. Whatever the reasons, since Stalin's death the virus of communism has become considerably attenuated in the U.S.S.R., and this is the main source of the present contention between the Soviet Union and Communist China.

Mechanisms, Freedom, and Purpose

Many are antagonistic to the humanistic claims of science. They regard science from a 19th-century view as materialistic and mechanistic and devoid of cultural significance. They assume that, by its nature, science precludes concepts of freedom and purpose so fundamental to our value system. Because of this widespread view of science, I would like to comment on some changes in concepts of mechanisms, purpose, and freedom that have come about in recent years.

It is true that a scientist operates under the tacit assumption that there is order underlying all phenomena that he studies. Otherwise his work would be pointless. He hopes to find the nature of this order. He also assumes that all forms of order are determined—that is to say, are caused—and his job is to discover these determinants or causes. If he is studying behavior of either animate or inanimate systems, he seeks the mechanisms of the behavior. I know of no scientist today who works outside of a deterministic framework. Thus, the student of human behavior may be interested in neurophysiological mechanisms and how they produce behavior; or he may be a psychiatrist not interested in the brain but concerned with psychological mechanisms. He wants to know what events occurred in the life of his patient, especially in his childhood, to produce his patterns of neurotic behavior, and he speaks of psychodynamic mechanisms. The social scientist is also concerned with mechanisms. He may be interested in the failure of established mechanisms to control our balance of payments, or in the effects of tariffs on international exchange, or in the mechanisms involved in currency inflation. As a historian he may be interested in the causes of the decline and fall of the Roman Empire. In this broad sense science is primarily concerned with understanding mechanisms.

Ideas about the nature of purpose and of mechanism have changed from those of the 19th century. The principle of negative feedback, whereby energy or information (and I use them here interchangeably) released from part of a system returns to regulate and control further release of energy or information by the system, is the basic principle involved in cybernetic mechanisms (*5*). Examples of these mechanisms are automatic engine governors, the thermostat that regulates the heating of one's house, the guided missile that bounces its own radar waves back from the target and uses this feedback to regulate its steering and the power to make it home on its target. Computers involve a remarkable complex of feedback processes, including the utilization of information storage and its appropriate retrieval, which corresponds to memory and recall in man. Purpose can be defined operationally in terms of mechanisms controlled by negative feedback (*6*). Purpose so defined is built into the guided missile, the computer, and the thermostat, enabling these mechanisms to accomplish ends of various degrees of complexity. Problem-solving computers can play a good game of chess, translate one language into another, and increase their capacity to discriminate as a result of past experience—that is, computers can learn. Objection may well be raised to calling such mechanisms purposive, since their purpose has been built into them by man. But man himself and his behavior are an emergent product of purely fortuitous mutations and evolution by natural selection acting upon them. Nonpurposive natural selection has produced purposive human behavior, which in turn has produced purposive behavior of the computers.

While feedback devices of control have developed rapidly in engineering in the past 20 years as a product of social evolution, biological evolution by natural selection brought these mechanisms to a high order of perfection some hundreds of millions of years ago, and the engineers have been copying, in principle, some of these processes. Cybernetic mechanisms are dominant ones of nerve nets and central nerve ganglia or brains (*6*, *7*).

All coordinated behavior, conscious or unconscious, uses such mechanisms; without them organized purposive behavior would be impossible. By definition these mechanisms controlled by their own feedback are purposive mechanisms. Thus, the behavior of the organism as a whole in adjusting to its external environment is controlled by information fed back to it in response to its own behavior. In the case of ourselves, words are spoken and acts are performed that produce responses from our environment, and from our fellows as part of the environment. Acts that they then perform in response to ours serve to further modify our behavior. Feedback to the organism of information from its external environment determines learning and conditioning by way of rewards and punishments, as reinforcing and aversive conditions.

To some students of behavior, free will is an epiphenomenon—an illusion —since all behavior may be regarded as the resultant of our phylogenetic development and the individual's day-to-day experiences. However, the fact is that we can never hope to know in detail the meaning to an individual of his plethora of past experiences, nor can we know the details of his genetic makeup and its impact on his brain function; for all practical purposes much of his behavior must remain rela-

tively undetermined, both to himself and to others. Thus, man may be considered to have free will.

While matter and energy have become conceptually fused and the old materialism based upon naive concepts of physics is no longer tenable, the question of whether or not one has freedom to choose is not resolved by anything inherent in the newer physics. Heisenberg's principle of indeterminancy, which has been used by some as an escape from the deterministic dilemma, is not a valid way out. In my opinion arguments about physical indeterminancy have not contributed to a resolution of this problem. However, the concept of logical indeterminancy, recently called to my attention by a paper of Donald M. Mackay's (*8*), may possibly offer an escape from the ancient dilemma. The concept may be illustrated as follows. Let us assume that I am an omnipotent physiologist with a complete knowledge of the physiology, chemistry, and molecular activities of your brain at any given moment. With this knowledge I can then predict precisely what you will do as a result of the operation of your brain's mechanisms, since your behavior, including your conscious and verbal behavior, is completely correlated with your neural functioning. But this only applies if I do not tell you my prediction. Suppose that I tell you what you will do as a result of my complete knowledge of the state of your brain. In doing this I shall have changed the physiology of your brain by furnishing it with this information. This makes it possible for you then to behave in a way quite different from my prediction. This independence from prediction is precisely what most people mean by free choice. If I were to try to allow beforehand for the effects of telling you my prediction, I would be doomed to an endless regression—logically, as Mackay points out, chasing my own tail in an effort to allow for the effects of allowing for the effects of allowing for the effects, indefinitely (*9*).

Conclusion

In all human relations, accountability is a necessity. Empirically I cannot see how a modern society emancipated from magic, superstition, and animism can function unless the individuals believe that they are free and responsible for their actions, and unless society can hold them responsible. Certainly our deepest convictions tell us we are free to make choices. The creation and advancement of civilizations appear to require this assumption.

Our highly developed ability to think and relate past and future events, to make tools, and to speak and write, has made us the dominant animal, but, unlike animals well-armed by biological evolution and equipped with instincts to control their lethal fangs, claws, horns, and tusks, our only control of our aggressions in the nuclear age is our ability to think intelligently, to foresee the consequences of our acts, and to control our acts in terms of reason and our ethical principles. Ethical thinking is hard to change, but history teaches us that it does change. There are a number of human institutions and practices that have been abolished that were supported in the past by the thoughts and ethics of the very best men of their times. These include slavery, infanticide, burning of witches, gladiatorial circuses, and human religious sacrifices. War must also be abolished in this nuclear age or it will abolish us.

Man has not used science to any significant extent to test and direct his value systems for the common good. Our beliefs, for the most part, are based on myths and parochial traditions we learned hit-or-miss from parents and other prestigious persons before we were 7 years old. As Brock Chisholm has pointed out, these emotionally charged beliefs and value systems are the results of accidents of birth in time, place, race, class, and nation. Intense and often irrational group loyalties leave no room in conscience for considerations of the great human problems of our time. Racial discrimination, chauvinistic nationalism, and objection to population control by methods of contraception represent value systems based on archaic and parochial notions at variance with what science has learned about the nature of human conduct necessary to advance cultural evolution in the nuclear age.

As George Gaylord Simpson has pointed out (*10*), biological evolution is not in itself a moral process. The word *moral* is simply irrelevant in this connection. But evolution has produced a moral and ethical animal. Man is not the "darling of the gods," as he thought he was before Darwin. He is responsible to himself and for himself, and he is unique among animals in being able to direct and control his own evolution.

References and Notes

1. H. A. Murray, personal communication.
2. P. Frank, in *Modern Science and Its Philosophy* (Harvard Univ. Press, Cambridge, Mass., 1949), p. 260.
3. A. Rapoport, *Science* **125**, 796 (1957).
4. J. Bronowski, in *New Knowledge in Human Value*, A. H. Maslow, Ed. (Harper, New York, 1959).
5. Negative feedback blocks and thus controls a process; positive feedback adds more energy to the process. Typically, an explosion is the consequence of positive feedback.
6. F. S. C. Northrup, *Science* **107**, 411 (1948).
7. H. Hoagland, *ibid.* **109**, 157 (1949).
8. D. M. Mackay, *Faith and Thought* **90**, 103 (1958).
9. See Mackay (*8*) for further discussion of this possible escape to freedom from rigid determinism.
10. G. G. Simpson, from a report in *Time*, of an address delivered in 1960.