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Selection by Consequences

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Summary. Selection by consequences is a causal mode found only in living things, or in machines made by living things. It was first recognized in natural selection, but it also accounts for the shaping and maintenance of the behavior of the individual and the evolution of cultures. In all three of these fields, it replaces explanations based on the causal modes of classical mechanics. The replacement is strongly resisted. Natural selection has now made its case, but similar delays in recognizing the role of selection in the other fields could deprive us of valuable help in solving the problems which confront us.

The history of human behavior, if we may take it to begin with the origin of life on Earth, is possibly exceeded in scope only by the history of the universe. Like astronomer and cosmologist, the historian proceeds only by reconstructing what may have happened rather than by reviewing recorded facts. The story presumably began, not with a big bang, but with that extraordinary moment when a molecule came into existence which had the power to reproduce itself. It was then that selection by consequences made its appearance as a causal mode. Reproduction was itself a first consequence, and it led, through natural selection, to the evolution of cells, organs, and organisms which reproduced themselves under increasingly diverse conditions.

What we call behavior evolved as a set of functions furthering the interchange between organism and environment. In a fairly stable world it could be as much a part of the genetic endowment of a species as digestion, respiration, or any other biological function. The involvement with the environment, however, imposed limitations. The behavior functioned well only under conditions fairly similar to those under which it was selected. Reproduction under a much wider range of conditions became possible with the evolution of two processes through which individual organisms acquired behavior appropriate to novel environments. Through respondent (Pavlovian) conditioning, responses prepared in advance by natural selection could come under the control of new stimuli. Through operant conditioning, new responses could be strengthened ("reinforced") by events which immediately followed them.

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A Second Kind of Selection

Operant conditioning is a second kind of selection by consequences. It must have evolved in parallel with two other products of the same contingencies of natural selection—a susceptibility to reinforcement by certain kinds of consequences and a supply of behavior less specifically committed to eliciting or releasing stimuli. (Most operants are selected from behavior which has little or no relation to such stimuli.)

When the selecting consequences are the same, operant conditioning and natural selection work together redundantly. For example, the behavior of a duckling in following its mother is apparently the product not only of natural selection (ducklings tend to move in the direction of large moving objects) but also of an evolved susceptibility to reinforcement by proximity to such an object, as Peterson has shown (*1*). The common consequence is that the duckling stays near its mother. (Imprinting is a different process, close to respondent conditioning.)

Since a species which quickly acquires behavior appropriate to a given environment has less need for an innate repertoire, operant conditioning could not only supplement the natural selection of behavior, it could replace it. There were advantages favoring such a change. When members of a species eat a certain food simply because eating it has had survival value, the food does not need to be, and presumably is not, a reinforcer. Similarly, when sexual behavior is simply a product of natural selection, sexual contact does not need to be, and presumably is not, a reinforcer. But when, through the evolution of special susceptibilities, food and sexual contact become reinforcing, new forms of behavior can be set up. New ways of gathering, processing, and ultimately cultivating foods and new ways of behaving sexually or of behaving in ways which lead only eventually to sexual reinforcement can be shaped and maintained. The behavior so conditioned is not necessarily adaptive; foods are eaten which are not healthful, and sexual behavior strengthened which is not related to procreation.

Much of the behavior studied by ethologists—courtship, mating, care of the young, intraspecific aggression, defense of territory, and so on—is social. It is within easy range of natural selection because other members of a species are one of the most stable features of the environment of a species. Innate social repertoires are supplemented by imitation. By running when others run, for example, an animal responds to releasing stimuli to which it has not itself been exposed. A different kind of imitation, with a much wider range, results from the fact that contingencies of reinforce-

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ment which induce one organism to behave in a given way will often affect another organism when it behaves in the same way. An imitative repertoire which brings the imitator under the control of new contingencies is therefore acquired.

The human species presumably became much more social when its vocal musculature came under operant control. Cries of alarm, mating calls, aggressive threats, and other kinds of vocal behavior can be modified through operant conditioning, but apparently only with respect to the occasions upon which they occur or their rate of occurrence (*2*). The ability of the human species to acquire new forms through selection by consequences presumably resulted from the evolution of a special innervation of the vocal musculature, together with a supply of vocal behavior not strongly under the control of stimuli or releasers—the babbling of children from which verbal operants are selected. No new susceptibility to reinforcement was needed because the consequences of verbal behavior are distinguished only by the fact that they are mediated by other people (*3*).

The development of environmental control over the vocal musculature greatly extended the help one person receives from others. By behaving verbally people cooperate more successfully in common ventures. By taking advice, heeding warnings, following instructions, and observing rules, they profit from what others have already learned. Ethical practices are strengthened by codifying them in laws, and special techniques of ethical and intellectual self-management are devised and taught. Self-knowledge or awareness emerges when one person asks another such a question as "What are you going to do?" or "Why did you do that?" The invention of the alphabet spread these advantages over great distances and periods of time. They have long been said to give the human species its unique position, although it is possible that what is unique is simply the extension of operant control to the vocal musculature.

A Third Kind of Selection

Verbal behavior greatly increased the importance of a third kind of selection by consequences, the evolution of social environments or cultures. The process presumably begins at the level of the individual. A better way of making a tool, growing food, or teaching a child is reinforced by its consequence—the tool, the food, or a useful helper, respectively. A culture evolves when practices originating in this way contribute to the success of the practicing group in solving its problems. It is the effect on the group, not the reinforcing consequences for individual members, which is responsible for the evolution of the culture.

In summary, then, human behavior is the joint product of (i) the contingencies of survival responsible for the natural selection of the species and (ii) the contingencies of reinforcement responsible for the repertoires acquired by its members, including (iii) the special contingencies maintained by an evolved social environment. (Ultimately, of course, it is all a matter of natural selection, since operant conditioning is an evolved process, of which cultural practices are special applications.)

Similarities and Differences

Each of the three levels of variation and selection has its own discipline—the first, biology; the second, psychology; and the third, anthropology. Only the second, operant conditioning, occurs at a speed at which it can be observed from moment to moment. Biologists and anthropologists study the processes through which variations arise and are selected, but they merely reconstruct the evolution of a species or culture. Operant conditioning is selection in progress. It resembles a hundred million years of natural selection or a thousand years of the evolution of a culture compressed into a very short period of time.

The immediacy of operant conditioning has certain practical advantages. For example, when a currently adaptive feature is presumably too complex to have occurred in its present form as a single variation, it is usually explained as the product of a sequence of simpler variations, each with its own survival value. It is standard practice in evolutionary theory to look for such sequences, and anthropologists and historians have reconstructed the stages through which moral and ethical codes, art, music, literature, science, technology, and so on, have presumably evolved. A complex operant, however, can actually be "shaped through successive approximation" by arranging a graded series of contingencies of reinforcement (*4*).

A current question at level i has parallels at levels ii and iii. If natural selection is a valid principle, why do many species remain unchanged for thousands or even millions of years? Presumably the answer is either that no variations have occurred or that those which occurred were not selected by the prevailing contingencies. Similar questions may be asked at levels ii and iii. Why do people continue to do things in the same way for many years, and why do groups of people continue to observe old practices for centuries? The answers are presumably the same: either new variations (new forms of behavior or new practices) have not appeared or those which have appeared have not been selected by the prevailing contingencies (of reinforcement or of the survival of the group). At all three levels a sudden, possibly extensive, change is explained as due to new variations selected by prevailing contingencies or to new contingencies. Competition with other species, persons, or cultures may or may not be involved. Structural constraints may also play a part at all three levels.

Another issue is the definition or identity of a species, person, or culture. Traits in a species and practices in a culture are transmitted from generation to generation, but reinforced behavior is "transmitted" only in the sense of remaining part of the repertoire of the individual. Where species and cultures are defined by restrictions imposed upon transmission—by genes and chromosomes and, say, geographical isolation, respectively—a problem of definition (or identity) arises at level ii only when different contingencies of reinforcement create different repertoires, as selves or persons.

Traditional Explanatory Schemes

As a causal mode, selection by consequences was discovered very late in the history of science—indeed, less than a century and a half ago—and it is still not fully recognized or understood, especially at levels ii and iii. The facts for which it is responsible have been forced into the causal pattern of classical mechanics, and many of the explanatory schemes elaborated in the process must now be discarded. Some of them have great prestige and are strongly defended at all three levels. Here are four examples:

A prior act of creation. (i) Natural selection replaces a very special creator and is still challenged because it does so. (ii) Operant conditioning provides a similarly controversial account of the ("voluntary") behavior traditionally attributed to a creative mind. (iii) The evolution of a social environment replaces the supposed origin of a culture as a social contract or of social practices as commandments.

Purpose or intention. Only past consequences figure in selection. (i) A particular species does not have eyes in order that its members may see better; it has them because certain members, undergoing variation, were able to see better and hence were more likely to transmit the variation. (ii) The consequences of operant behavior are not what the behavior is now for; they are merely similar to the consequences which have shaped and maintained it. (iii) People do not observe particular practices in order that the group will be more likely to survive; they observe them because groups which induced their members to do so survived and transmitted them.

Certain essences. (i) A molecule which could reproduce itself and evolve into cell, organ, and organism was alive as soon as it came into existence without the help of a vital principle called life. (ii) Operant behavior is shaped and brought under the control of the environment without the intervention of a principle of mind. (To suppose that thought appeared as a variation, like a morphological trait in genetic theory, is to invoke an unnecessarily large *saltum*.) (iii) Social environments generate self-knowledge ("consciousness") and self-management ("reason") without help from a group mind or Zeitgeist.

To say this is not to reduce life, mind, and Zeitgeist to physics; it is simply to recognize the expendability of essences. The facts are as they have always been. To say that selection by consequences is a causal mode found only in living things is only to say that selection (or the "replication with error" which made it possible) defines "living." (A computer can be programmed to model natural selection, operant conditioning, or the evolution of a culture but only when constructed and programmed by a living thing.) The physical basis of natural selection is now fairly clear; the corresponding basis of operant conditioning, and hence of the evolution of cultures, has yet to be discovered.

Certain definitions of good and value. (i) What is good for the species is whatever promotes the survival of its members until offspring have been born and, possibly, cared for. Good features are said to have survival value. Among them are susceptibilities to reinforcement by many of the things we say taste good, feel good, and so on. (ii) The behavior of a person is good if it is effective under prevailing contingencies of reinforcement. We value such behavior and, indeed, reinforce it by saying "Good!" Behavior toward others is good if it is good for the others in these senses. (iii) What is good for a culture is whatever promotes its ultimate survival, such as holding a group together or transmitting its practices. These are not, of course, traditional definitions; they do not recognize a world of value distinct from a world of fact and, for other reasons to be noted shortly, they are challenged.

Alternatives to Selection

An example of the attempt to assimilate selection by consequences to the causality of classical mechanics is the term "selection pressure," which appears to convert selection into something that forces a change. A more serious example is the metaphor of storage. Contingencies of selection necessarily lie in the past; they are not acting when their effect is observed. To provide a current cause it has therefore been assumed that they are stored (usually as "information") and later retrieved. Thus, (i) genes and chromosomes are said to "contain the information" needed by the fertilized egg in order to grow into a mature organism. But a cell does not consult a store of information in order to learn how to change; it changes because of features which are the product of a history of variation and selection, a product which is not well represented by the metaphor of storage. (ii) People are said to store information about contingencies of reinforcement and retrieve it for use on later occasions. But they do not consult copies of earlier contingencies to discover how to behave; they behave in given ways because they have been changed by those contingencies. The contingencies can perhaps be inferred from the changes they have worked, but they are no longer in existence. (iii) A possibly legitimate use of "storage" in the evolution of cultures may be responsible for these mistakes. Parts of the social environment maintained and transmitted by a group are quite literally stored in documents, artifacts, and other products of that behavior.

Other causal forces serving in lieu of selection have been sought in the structure of a species, person, or culture. Organization is an example. (i) Until recently, most biologists argued that organization distinguished living from nonliving things. (ii) According to Gestalt psychologists and others, both perceptions and acts occur in certain inevitable ways because of their organization. (iii) Many anthropologists and linguists appeal to the organization of cultural and linguistic practices. It is true that all species, persons, and cultures are highly organized, but no principle of organization explains their being so. Both the organization and the effects attributed to it can be traced to the respective contingencies of selection.

Another example is growth. Developmentalism is structuralism with time or age added as an independent variable. (i) There was evidence before Darwin that species had "developed." (ii) Cognitive psychologists have argued that concepts develop in the child in certain fixed orders, and Freud said the same for the psychosexual functions. (iii) Some anthropologists have contended that cultures must evolve through a prescribed series of stages, and Marx said as much in his insistence upon historical determinism. But at all three levels the changes can be explained by the "development" of contingencies of selection. New contingencies of natural selection come within range as a species evolves; new contingencies of reinforcement begin to operate as behavior becomes more complex; and new contingencies of survival are dealt with by increasingly effective cultures.

Selection Neglected

The causal force attributed to structure as a surrogate of selection causes trouble when a feature at one level is said to explain a similar feature at another, the historical priority of natural selection usually giving it a special place. Sociobiology offers many examples. Behavior described as the defense of territory may be due to (i) contingencies of survival in the evolution of a species, possibly involving food supplies or breeding practices; (ii) contingencies of reinforcement for the individual, possibly involving a share of the reinforcers available in the territory; or (iii) contingencies maintained by the cultural practices of a group, promoting behavior which contributes to the survival of the group. Similarly, altruistic behavior (i) may evolve through, say, kin selection; (ii) may be shaped and maintained by contingencies of reinforcement arranged by those for whom the behavior works an advantage; or (iii) may be generated by cultures which, for example, induce individuals to suffer or die as heroes or martyrs. The contingencies of selection at the three levels are quite different, and the structural similarity does not attest to a common generative principle.

When a causal force is assigned to structure, selection tends to be neglected. Many issues which arise in morals and ethics can be resolved by specifying

the level of selection. What is good for the individual or culture may have bad consequences for the species, as when sexual reinforcement leads to overpopulation or the reinforcing amenities of civilization to the exhaustion of resources; what is good for the species or culture may be bad for the individual, as when practices designed to control procreation or preserve resources restrict individual freedom; and so on. There is nothing inconsistent or contradictory about these uses of "good" or "bad," or about other value judgments, so long as the level of selection is specified.

An Initiating Agent

The role of selection by consequences has been particularly resisted because there is no place for the initiating agent suggested by classical mechanics. We try to identify such an agent when we say (i) that a species adapts to an environment, rather than that the environment selects the adaptive traits; (ii) that an individual adjusts to a situation, rather than that the situation shapes and maintains adjusted behavior; and (iii) that a group of people solve a problem raised by certain circumstances, rather than that the circumstances select the cultural practices which yield a solution.

The question of an initiating agent is raised in its most acute form by our own place in this history. Darwin and Spencer thought that selection would necessarily lead to perfection, but species, people, and cultures all perish when they cannot cope with rapid change, and our species now appears to be threatened. Must we wait for selection to solve the problems of overpopulation, exhaustion of resources, pollution of the environment, and a nuclear holocaust, or can we take explicit steps to make our future more secure? In the latter case, must we not in some sense transcend selection?

We could be said to intervene in the process of selection when as geneticists we change the characteristics of a species or create new species, or when as governors, employers, or teachers we change the behavior of persons, or when we design new cultural practices; but in none of these ways do we escape from selection by consequences. In the first place, we can work only through variation and selection. At level i we can change genes and chromosomes or contingencies of survival, as in selective breeding. At level ii we can introduce new forms of behavior—for example, by showing or telling people what to do with respect to relevant contingencies—or construct and maintain new selective contingencies. At level iii we can introduce new cultural practices or, rarely, arrange special contingencies of survival—for example, to preserve a traditional practice. But having done these things, we must wait for selection to occur. (There is a special reason why these limitations are significant. It is often said that the human species is now able to control its own genetics, its own behavior, and its own destiny, but it does not do so in the sense in which the term control is used in classical mechanics. It does not for the very reason that living things are not machines: selection by consequences makes the difference.) In the second place, we must consider the possibility that our behavior in intervening is itself a product of selection. We tend to regard ourselves as initiating agents only because we know or remember so little about our genetic and environmental histories.

Although we can now predict many of the contingencies of selection to which the human species will probably be exposed at all three levels and can specify behavior that will satisfy many of them, we have failed to establish cultural practices under which much of that behavior is selected and maintained. It is possible that our effort to preserve the role of the individual as an originator is at fault, and that a wider recognition of the role of selection by consequences will make an important difference.

The present scene is not encouraging. Psychology is the discipline of choice at level ii, but few psychologists pay much attention to selection. The existentialists among them are explicitly concerned with the here and now, rather than the past and future. Structuralists and developmentalists tend to neglect selective contingencies in their search for causal principles such as organization or growth. The conviction that contingencies are stored as information is only one of the reasons why the appeal to cognitive functions is not helpful. The three personae of psychoanalytic theory are in many respects close to our three levels of selection; but the id does not adequately represent the enormous contribution of the natural history of the species; the superego, even with the help of the ego ideal, does not adequately represent the contribution of the social environment to language, self-knowledge, and intellectual and ethical self-management; and the ego is a poor likeness of the personal repertoire acquired under the practical contingencies of daily life. The field known as the experimental analysis of behavior has extensively explored selection by consequences, but its conception of human behavior is resisted, and many of its practical applications rejected, precisely because it has no place for a person as an initiating agent. The behavioral sciences at level iii show similar shortcomings. Anthropology is heavily structural, and political scientists and economists usually treat the individual as a free initiating agent. Philosophy and letters offer no promising leads.

A proper recognition of the selective action of the environment means a change in our conception of the origin of behavior which is possibly as extensive as that of the origin of species. So long as we cling to the view that a person is an initiating doer, actor, or causer of behavior, we shall probably continue to neglect the conditions which must be changed if we are to solve our problems (*5*).

References and Notes

1. N. Peterson, *Science* **132**, 1395 (1960).
2. The imitative vocal behavior of certain birds may be an exception, but if it has selective consequences comparable with those of cries of alarm or mating calls, they are obscure. The vocal behavior of the parrot is shaped, at best, by a trivial consequence, involving the resemblance between sounds produced and sounds heard.
3. B. F. Skinner, *Verbal Behavior* (Appleton, New York, 1957).
4. Patterns of innate behavior too complex to have arisen as single variations may have been shaped by geologic changes due to plate tectonics [B. F. Skinner, *Acta Neurobiol. Exp.* **35**, 409 (1975); reprinted in *Reflections on Behaviorism and Society* (Prentice-Hall, Englewood Cliffs, N.J., 1978)].
5. _____, *Beyond Freedom and Dignity* (Knopf, New York, 1971).

References and Notes

[1] **Control of Behavior by Presentation of an Imprinted Stimulus**

Neil Peterson

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