1 Selection by consequences

Abstract: Human behavior is the joint product of (i) contingencies of survival responsible for natural selection and (ii) contingencies of reinforcement responsible for the repertoires of individuals, including (iii) the special contingencies maintained by an evolved social environment. 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. Reproduction, a first consequence, led to the evolution of cells, organs, and organisms reproducing themselves under increasingly diverse conditions. The behavior functioned well, however, only under conditions similar to those under which it was selected.

Reproduction under a wider range of consequences became possible with the evolution of processes through which organisms acquired behavior appropriate to novel environments. One of these, operant conditioning, is a second kind of selection by consequences. New responses could be strengthened by events which followed them. When the selecting consequences are the same, operant conditioning and natural selection work together redundantly. But because a species which quickly acquires behavior appropriate to an environment has less need for an innate repertoire, operant conditioning could replace as well as supplement the natural selection of behavior.

Social behavior is within easy range of natural selection, because other members are one of the most stable features of the environment of a species. The human species presumably became more social when its vocal musculature came under operant control. Verbal behavior greatly increased the importance of a third kind of selection by consequences, the evolution of social environments or cultures. The effect on the group, and not the reinforcing consequences for individual members, is responsible for the evolution of culture.

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.

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 (1960) has shown. 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 reinforcement 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. (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.)

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 (Skinner, 1957).

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. (Patterns of innate behavior too complex to have arisen as single variations may have been shaped by geologic changes due to plate tectonics: Skinner 1975a.)

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 fe

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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 salient.) (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

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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 contin-
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tural 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, its own destiny, but it does not 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 (Skinner 1971).
POSTSCRIPT

It is curious that the notion of selection by consequences should have appeared so late in the history of human thought. Selection is found only in living things, and that is no doubt relevant, but people have been interested in living things as long as in nonliving. A possible explanation is that the effect of selection is somewhat delayed. We see the product but not the process; hence, we are likely to attribute the product to a current product of the selective contingencies rather than to the contingencies themselves.

A creative act is a kind of surrogate of selection; purpose is another. Biologists have dealt with their supposed place in the origin of species. Psychologists show less agreement about their place in the origin of behavior. Cognitive psychologists, for example, tend to call operant behavior “goal-directed,” but goal-directedness is only a current surrogate of a history of reinforcing consequences. The intentionality of modern philosophy also serves as a surrogate of a personal history.

The reason why selection by consequences has been so long neglected may be the reason it is still so widely misunderstood.

COMMENTARIES AND RESPONSES

Skinner on selection: A case study of intellectual isolation

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Ask yourself the following question: Would “Consequences” have been published in Science in 1981 if the author had been anonymous? The answer would be a resounding no, and it would not be difficult to confirm this assertion experimentally now, some years later. Surely the editors of Science must have had good reasons for publishing his article. We can only guess the reasons, but I doubt we would be far wrong.

First and foremost, B. F. Skinner is a major figure in modern psychology. Almost anything he has to say in the realm of behavior is of widespread interest whether one’s opinion is that it is right or wrong, and with or without adequate documentation. He has made enormous contributions to the field and demonstrated the awe-inspiring control the experimenter can have over the behavior of an animal under specified conditions.

That very control seems to have shaped Skinner’s perception of the biological world. It has also produced a vision of human behavior that can be disquieting. In “Consequences” Skinner asserts that a person is not “an initiating doer, actor, or cause of behavior.” He states further that it is possible to “construct and maintain new selective contingencies” by reinforcing the “good” behavior of such a person. Taken at face value that sounds harmless enough, except for two things: Someone else decides what is good behavior, and we have no clear prescription for how that decision might be reached or who makes it. The definition of good behavior appears simply to evolve by trial and error at three levels, and perhaps it has. That is the major thesis of “Consequences.”

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The first level is that of Darwinian natural selection. That kind of selection is treated superficially and conventionally. (I return to his views on natural selection below.) The second kind of selection is that of operant conditioning, and the third is that of cultural evolution, the course of both being molded by their consequences. His treatment of the last two levels does not find universal acceptance.

I take exception to Skinner’s portrayal of selection at the level of operant conditioning. For one, I prefer to call this level that of phenotypic modification or intra-individual adaptation; the terminology is not important. What is important is that individual adaptability is a much richer set of phenomena than is even remotely embraced by operant conditioning.

Ectothermic animals, for instance, acclimate to the temperature at which they are found; the thermal preferendum of an individual depends on its thermal acclimation, which varies with the season and microhabitat (Hutchison & Maness 1979). Sexual maturity, and its attendant changes in behavior, can occur at radically different ages in platypus and platypuses, depending on dominance relationships that are independent of the respondent’s behavior (Borowsky 1978). The maternal digger wasp learns how much to provision her nest site in one trial, without the benefit of overt reinforcement, and the appropriate response is delayed several hours (Baerends 1941). Early experience appears to have pervasive effects on behaviors that are first manifest only in adulthood. One such phenomenon is sexual imprinting; attempts to fit it into a conditioning paradigm present difficulties and suggest a prudecratian resolution.

The manner in which Skinner contrasts natural selection and conditioning as two distinct kinds of selection also has a major fault. Genetic and experiential factors are conveyed as being fundamentally separate. This separation is inherent in the way Skinner relegates biologists’ interests to unlearned behavior and evolutionary phylogenies. The rigidity is also apparent in his insistence that “most operants are selected from behavior which has little or no relation to” eliciting or releasing stimuli. An epigenetic approach provides a more realistic view.

Evidence is growing rapidly that there are evolved predispositions for animals to learn to respond in particular ways to particular kinds of stimulation. The example most appropriate to Skinner’s essay, and also the most debatable, is that of language. People learn a given language, and conditioning doubtless plays a role. But humans may also be predisposed to speak, and the structure of language may have properties that transcend the process of operant conditioning (Lennieberg & Lenneberg 1975). This possibility is ignored in Skinner’s essay.

The range of interaction between experience and species-specific constraints on learning is nowhere better and more convincingly documented than in the elegant comparative studies on the acquisition of song among birds (Green & Marler 1979). Likewise, sexual imprinting is proving increasingly to involve both constraints and plasticity; recognizing one’s species is an ability that requires little experience. Rather, imprinting’s function seems to be the learning of closeness of relationship (P. Bateson 1980). Finally, I disagree with Skinner’s easy and almost casual equating of genetic with fixed behavior.

I do agree with Skinner on the other hand, that cultures have evolved because of the consequences of their practices. Many will differ with us on this.

A major weakness of “Consequences” is that it has been written in a vacuum. Skinner’s remarks on natural selection show a lack of understanding as well as total isolation from the noisy arguments that have been heard throughout the land for the last 20 years about group versus individual selection. It is almost embarrassing to read in a 1981 paper that “what is good for the individual or culture may have bad consequences for the species” – or, when writing about the origins of behavior and clearly not about humans, “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.” Lest I be misunderstood, let me point out that I am not saying that group selection is inconceivable (see D. S. Wilson 1975; 1980) but that this loose application of the species-benefit argument reveals a fundamental failure to understand modern theorizing about natural selection.

This confusion is apparent in the conclusion of “Consequences.” Skinner argues with regard to altruism that selection operates at three different levels, paralleling his opening remarks. The three kinds of selection are (i) biological (here kin selection), (ii) psychological (through reinforcement of individual behavior), and (ii) cultural (as in inducing heroism). He claims that “the contingencies of selection at the three levels are quite different, and the structural similarity does not attest to a common generative principle.”

What we have here is a failure to distinguish between proximate and ultimate mechanisms (E. O. Wilson 1975). The hero is taught to behave that way, which is the proximate mechanism. In the small societies in which heroism must have evolved, the hero’s kin enjoyed improved reproductive fitness superior to that of individuals who were not so easy to train. This is kin selection, the ultimate causation. A common generative principle is reasonable.

I was equally taken aback by the absence of references to highly relevant literature closer to home for Skinner. In a classic paper Pringle (1951) explored the parallels between learning and natural selection. Campbell (1975) has written on almost the same theme as Skinner and is often cited. Pringle’s and Campbell’s treatments are more sophisticated than the essay before us. Skinner has also overlooked the literature on constraints on learning and the ethologists’ resolution of the nature-nurture issue.

Why, indeed, should Science have published this essay? Perhaps the editors felt that we should know Skinner’s mind well, including the box within which it operates, precisely because his writings have been so influential, extending into the sociopolitical arena. Skinner should respond to this type of criticism and not just by asserting that he is not understood. He should acknowledge these other fields by learning more about them than is found in the secondary literature. It may yet be possible to bring this great thinker out of the walls he has erected around his intellect.

BFS: I am sorry that in the four or five thousand words that were available to me when I wrote “Consequences” I have not covered the field of natural selection to Barlow’s satisfaction. I am also sorry that he appears not to be aware of the extent of current research on operant conditioning. I am happy that he agrees with me on the evolution of culture, but he seems to miss its relevance to the question of who is to decide what is good behavior.

So far as the point of “Consequences” is concerned, it does not matter in the least whether any of the behavior Barlow mentions is the product of natural selection, operant conditioning, the evolution of cultural practices, or any combination thereof. The same issues arise: the need to abandon the concept of a creator, purpose, essences like life, mind, and zeitgeist as contemporary surrogates of histories of selection, and values. I repeat: All these issues demand attention regardless of whether the consequences are found in natural selection, operant conditioning, or the evolution of cultures. Although there is lively controversy at all three levels, the basic notion of selection by consequences survives and raises the questions I addressed.

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On the status of causal modes

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The modern Western world grew up being thoroughly familiar with two traditional causal modes. We knew about the mental mode, the world of ideas and feelings and the associations among ideas and feelings. We knew how to explain behavior in terms of ideation and volition. We also knew about the mechanical mode, the world of machines and billiard balls, projectiles and things in orbit. We knew how to explain behavior in terms of neural impulses and muscle contractions. These modes were familiar; they did not enjoy a great deal of practical success, but they were familiar.

Not so familiar were some other explanatory modes that had been around since antiquity. There was Aristotle’s fourfold approach, which showed up from time to time, and which is still fashionable among Jesuit scholars. And there was the empirical approach of Hume. Hume observed, rightly, that we really do not know how the mind works, or even what is really happening on the billiard table. All that we can actually know is that our observations are orderly and, with experience, predictable. If we have observed this following that many times before, then we can count on this following that again. Psychologists have never been very comfortable with Aristotle’s approach, nor, for a long time, did they take very kindly to Hume’s empirical approach. In the heady days of early behaviorism, the mechanistic bias precluded any alternative to a mechanical mode of causation. All other modes were dismissed, so that behavior could be explained only in terms of neural impulses and muscle contractions.

It is greatly to his credit, I think, that Skinner has always stood opposed to this mechanistic bias. In one of his earliest publications Skinner (1931) considered the question of how one knows that one is looking at a reflex. How can we tell that this regularly elicited response really is a reflex? Do we know this because of our underlying knowledge of the neural mediation involved: the afferent, the synapse, and the efferent? No, not at all. We know we have a reflex for simple, empirical, Hume-like reasons: The stimulus regularly elicits the reaction. Back in those days, back at the beginning of Skinner’s career, such an empirical orientation was not very popular, but he stuck with it, defended it ably, and continued to promote it. And gradually the empirical causal mode began to catch on.

But meanwhile subtle changes could be seen in Skinner’s behavior. He pointed out that just as an elicited response is perfectly well explained by citing the antecedent eliciting stimulus, so an emitted response can be perfectly well explained by citing the consequent reinforcing stimulus (Skinner 1937). Only a mechanist would insist upon the emitted response having an elicitor. Deny the mechanists their fundamental assumption, and you have behavior explained by its consequences. Adhere to a purely empirical mode of causation, and you have operators being explained by their reinforcers. If you have a stream of operators, and a stream of reinforcers, these streams turn out to be so well correlated that you do not even have to have a “theory” to explain the correlation (Skinner 1950). If the stream of reinforcers really controls the behavior, then you have the behavior under control and you do not have to be bothered by the question of how it is mediated, because you have your own kind of causal mode.

It may be noted that there is nothing teleological about control by consequences, because by the time you actually get behavior under control there will be a history of