

Levels of Selection: A Place for Cultural Selection

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Skinner discussed the principle of “selection by consequences” as a causal mode at three different levels: (i) phylogeny, (ii) ontogeny, and (iii) culture. After many decades of vigorous resistance, following the identification of mediating genetic mechanisms, the principle is now broadly accepted at the phylogenetic level. A comparable general acceptance of the role of operant selection at the ontogenetic level may depend on a corresponding identification of mediating neural mechanisms. Skinner’s treatment of cultural selection has sparked additional discussions: First, in their open peer commentaries on Skinner’s paper, both Harris and Dawkins criticized him for not stating sufficiently clearly what is selected, and what does the selection. Second, even colleagues who readily accept the role of selection in operant conditioning as well as in phylogenetic selection, have argued against the need for a third kind of selection, at the cultural level. Third, some processes in DNA replication may serve as interesting analogues for processes involved in the replication of cultural practices. Fourth, some shortcomings of selection by consequences at the lower levels may explain the important function of higher levels. Finally, Darwin and Skinner expressed contrasting views on the shortcomings of selection by consequences, and the need for corrective measures is briefly discussed.

Keywords: Natural selection, operant reinforcement, cultural transmission, DNA, neural mechanisms, replication, corrective measures.

Already in his book, *Science and Human Behavior*, Skinner (1953) described similarities between natural selection and operant reinforcement, and suggested a third level of selection: “There is still a third kind of selection which applies to cultural practices” (p. 430). In his article titled *Selection by Consequences*, Skinner (1981; reprinted in the current issue) made several important points: (1) Selection by consequences is a causal mode that was first discovered at the phylogenetic level only recently in the history of science, when Darwin accounted for the origin and evolution of species through the principle of natural selection. (2) The prin-

ciple of natural selection replaced traditional explanations based on the push-and-pull principles of classical mechanics and was strongly resisted. (3) Similar types of selection have been described to account for (a) the shaping and maintenance of behavior in the course of the lifetime of the individual (i.e., operant conditioning) and (b) the origin and survival of practices at a cultural level. (4) Although Darwin’s principle of natural selection has eventually replaced the earlier, mechanical, attempts to explain the origin and evolution of species, a similar replacement of mechanical explanations at the ontogenetic and cultural levels are still intensely resisted. (5) A delay in recognizing the role of selection at these levels may seriously impede our efforts to solve current behavioral and societal problems.

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The present commentary will start with a description of certain similarities between Darwin's discovery of the role of natural selection and Skinner's discovery of the role of operant conditioning, suggesting a trajectory for the recognition of the role of operant conditioning in the scientific community as well as in the community at large. After that, I will restrict my commentary to the consideration of specific problems inherent in, or related to, Skinner's treatment of cultural selection, and suggest solutions. First, in their open peer commentaries on Skinner's (1981) both Marvin Harris and, even more articulately, Richard Dawkins, criticized him for not stating sufficiently clearly, what is selected, and what does the selection. Second, even colleagues who readily accept the role of selection in operant conditioning as well as in phylogenetic selection, have argued against the need for a third kind of selection, at the cultural level. Third, some processes in DNA replication may serve as interesting analogues for processes involved in the replication of cultural practices. Fourth, I will briefly note some shortcomings of selection by consequences. Finally, I will contrast Darwin's and Skinner's views on the importance of developing correcting measures for some of the shortcomings of selection by consequences.

Phylogeny—Ontogeny Parallels: A Trajectory for the General Acceptance of Operant Reinforcement?

Natural Versus Artificial Selection

In the first chapter of *The Origin of Species*, Darwin (1859/1958) made the distinction between artificial and natural selection. He referred to artificial selection as "selection by man." Darwin explained that the principle of selection was not a modern discovery. Breeding of domestic animals had been "carefully attended to in ancient times," and "the principle of selection [was] distinctly given in an ancient Chinese encyclopedia" (Darwin, 1859/1958, p. 50). Following the careful introduction to how "man's selection"

had shaped current domestic animal strains, Darwin made the distinction between two sub-categories of "selection by man:" Methodological selection was a deliberate selection of specific characteristics in order to permanently change the breed. He pointed out that selection does not need to have to be carried out with a long-term plan for changing the breed. "Unconscious selection" consisted of many people trying to breed from the best individual animals, but with no such deliberate goal of permanent changes. According to Darwin, such unconscious selection "will always tend . . . slowly to add to the characteristic features of the breed, whatever they may be. But the chance will be infinitely small of any record having been preserved of such slow, varying, and insensible changes." (Darwin, 1859/1958, pp. 54-55). Thus, he had laid the ground for his introduction of the principle of natural selection:

HOW will the struggle for existence, briefly discussed in the last chapter, act in regard to variation? Can the principle of selection, which we have seen is so potent in the hands of man, apply under nature? I think we shall see that it can act most efficiently. (p. 87)

Thus, Darwin's struggle was not to explain the principle of selection *per se*, but to explain how this principle could explain changes and complexity in nature, including the origin and evolution of species.

As pointed out by Catania (2001), the distinction between artificial and natural selection is just as relevant to operant reinforcement as it is to selection at the phylogenetic level. Therefore, the term phylogenetic is preferred here for Darwinian selection. Even something analogous to the distinction that Darwin made between methodological and unconscious artificial selection by man may apply to operant reinforcement. Artificial, or contrived, reinforcement can be used very deliberately, as when token deliveries are contingent on specific socially adequate responses in delinquents, when vouchers are contingent upon negative urine samples in drug abusers (e.g., Higgins, Heil, & Lussier,

2004), and when clickers are used to shape behavior in dogs and other animals (Pryor, 1999). This would correspond to methodological selection. When parents praise their children differentially for their best accomplishments, they may do so in appreciation of those accomplishments, and not as part of a deliberate long-term planning of their children's careers.

In any case, professionals and nonprofessionals alike can usually appreciate the impressive effects of operant reinforcement when applied in simple contexts. A pervasive role for operant reinforcement of verbal as well as nonverbal behavior in natural environments is not nearly as obvious.

Theory of Selection Developed Without Knowledge of Mediating Mechanisms

Darwin collected and built his treatise on natural selection on an impressive body of evidence. Notably, this evidence did not include any facts or even hypotheses regarding internal mechanisms of fertilization, variation, or heredity. Darwin himself wrote that, "the laws governing inheritance are for the most part unknown" (1859/1958, p. 36). A Swiss chemist, Friedrich Miescher, made the first discovery of deoxyribonucleic acid (DNA) substance in 1869, the year of the 5th edition of Darwin's "Origin." However, almost a hundred years would pass before Crick, Watson, and Wilkins received the Nobel Prize in Physiology or Medicine "for their discoveries concerning the molecular structure of nucleic acids and its significance for information transfer in living material" (Pray, 2008). Thus, as Skinner (1988, p. 239) pointed out, "genetics was a respectable science before anyone knew "what was really going on" in terms of internal mechanisms.

Skinner (1988, p. 111) suggested that, ". . . a science of behavior stands in about the position of genetic theory prior to the discovery of the role of DNA." Certainly as Skinner mentioned repeatedly, there are time gaps in a purely behavioral analysis, and

only brain science can fill them. However, as Skinner also noted,

The analysis of behavior need not wait until brain science has done its part. The behavioral facts will not be changed, and they suffice for both a science and a technology. Brain science may discover other kinds of variables affecting behavior, but it will turn to a behavioral analysis for the clearest account of their effects. (Skinner, 1989, pp. 24-25).

It has been pointed out that, not even within biology was there a general acceptance of the role of selection in phylogeny before a plausible genetic mechanism was described. Perhaps a similar general recognition of the importance of operant conditioning in ontogeny depends on the similar identification of the neural mechanisms by which it is mediated (Donahoe & Palmer, 1994).

What is Selected, and What is Doing the Selection?

In response to the open peer commentaries that called for a clearer description of exactly what is being selected and what constitute the selecting consequences, Skinner (1984a) proposed a distinction between the selection of cultures and the selection of cultural practices:

If the evolution of a culture could be said to correspond to the evolution of a species, then the evolution of cultural practices corresponds to the evolution of eyes and ears and hearts and legs and wings. (p. 506)

Regarding what is selected, Catania (2001) took the challenge from Dawkins and Harris directly, stating that when selection is proposed as an explanatory principle in evolution and other types of development, it is important to be able to specify exactly what it is that is being selected as well as what constitute the consequences that select. Catania argued that, in behavior analysis, at all levels our main concern is with behavior and with properties of behavior. At the level of phylogenetic selection, our focus is on how different behavioral properties may have a differential probability of being passed on from

parents to their offspring, following lineages across generations. At the ontogenetic level, our concern is with the changing strength of specific types of behavior or behavioral properties within the repertoire of each individual. Differential reinforcement, like natural selection, increases the rate of some types of behavior at the expense of others, in this case behavior or behavioral properties in the repertoire of an individual organism. It was Skinner's basic groundbreaking contribution that he identified the operant as a behavioral unit which brought "voluntary" behavior within the realm of science (Iversen, 1992; Vargas, 2004). At the third level, the cultural level, our focus is on behavior as it passes across individuals independently of ancestral lineage or kinship.

Regarding what does the selection, Skinner, as Darwin before him, pointed to the environment. Dawkins (1995) suggested that the selective action could be likened to that of a sieve: "Each generation is a filter, a sieve; good genes tend to fall through the sieve into the next generation; bad genes tend to end up in bodies that die young or without reproducing" (p. 3). Darwin found "no need . . . to invoke any internal force beyond the tendency to ordinary variability" (p. 224), but accounted for the gradual evolution by gradual changes in what Skinner would later refer to as the contingencies of survival. At the ontogenetic level, we talk about "contingencies of reinforcement."

Skinner's distinction between the selection of cultures and the selection of cultural practices point to two different sets of selecting consequences: Whole cultures, or groups of people characterized by certain practices, may survive more effectively than others into future generations because of those practices, whether or not it happens in direct competition with other groups. Cultural practices, on the other hand, may simply spread across individuals within the short periods of time, within the same generation. Skinner's paper was mainly concerned with cultural practices.

Then what is the appropriate term for selection at the cultural level? Catania (2001)

suggested that, "in cultural selection, behavior is selected and maintained by a social environment" (p. 156). However, behavior that is transmitted from one person to another may presumably be reinforced by nonsocial as well as by social consequences. Again, the crucial point seems to be that behavior passes through a "sieve" which in this case consists of whatever obstacles exist for behavior to pass from one person to another. Hence, an appropriate term might be "contingencies of social transmission."

Cultural Selection as a Level on its Own?

Some slightly different formulations in different writings by Skinner seem to have created a lot of confusion regarding the importance or necessity at all to consider a third level of selection, called cultural selection. For example in the article Skinner wrote just before he died he wrote that "the behavior of the organism as a whole is the product of three types of variation and selection" (Skinner, 1990, p. 1206). He then went on and listed (1) natural selection, (2) operant conditioning, and (3) cultural selection. Such formulations have left the impression that Skinner considered this third-level, cultural, selection as a separate source of human behavior in addition to the contingencies of survival in the history of the species and the contingencies of reinforcement in the history of individual organisms. The same idea of a third level selection that adds to the phylogenetic and ontogenetic levels of selection as causes of human behavior was suggested in Skinner's (1981) original paper on selection by consequences:

Behavior described as the defense of territory may be due to (1) 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. (p. 503)

However, it is difficult to imagine how a third, cultural-level selection could affect the behavior of individuals except through contingencies of reinforcement and, possibly, contingencies of survival. As Donahoe (1984) suggested: “The appeal to a new ‘kind’ of selection involving an ‘effect on the group, not the reinforcing consequences for individual members’ seems unnecessary” (p. 488).

Interestingly, when Skinner’s selection paper was reprinted in *Behavioral and Brain Sciences* (Skinner, 1984b), the abstract from the original Science version was replaced by a new one:

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. (p. 477)

Here, cultural selection is not being portrayed as a third set of causes of behavior in addition to phylogenetic and ontogenetic selection. Instead, it boils down to a level that simply adds to our understanding of the evolution of contingencies working on those other levels, particularly our advanced social environments, which constitute important contingencies of reinforcement. Unnecessary confusion has resulted from Skinner’s descriptions of the cultural level as an additional source of contingencies that affect the behavior of individual organisms. This confusion could likely have been avoided by sticking consistently to this latter formulation, where cultural selection simply adds to the explanation of the evolution of a social environment that contributes remarkably to the origin and maintenance of the behavior of individuals.

DNA Replication and Social Transmission: Facilitators and Obstacles

As mentioned earlier, the general acceptance of “selection by consequences” as

an explanatory principle may await the identification of appropriate mediating, or retention, mechanisms. Genes serve that role in phylogeny, and neural mechanisms, presumably, in the ontogeny of behavior. An additional physiological mechanism for cultural selection hardly exists. However, I have often thought of DNA replication as a useful analogue to the replication or transmission of cultural practices. As discovered by Watson and Crick (1953), the DNA molecule consists of two strands winded up around each other in the shape of a double helix. Standard cell replication occurs in a pattern called *semiconservative replication*. During this process, the beginnings of two copies of the original DNA molecule each contains one of the original strands after an enzyme called DNA *helicase* has worked to *split the helix into two halves*, like the opening of a zipper. The split open portion of the helix is referred to as the *replication fork*. Then, specific enzymes called DNA *polymerase* catalyze the formation of DNA from *precursor substances* in the presence of the preexisting DNA, which is acting as a template. Longer strains of fragments, *Okazaki fragments*, are usually constructed, with spaces between them (Jin, Ayyagari, Resnick, Gordenin, & Burgers, 2003). Next, these fragments are connected, or ligated, through “ligase,” the filling in of the missing building blocks along the preexisting strain. A lack of perfection in the DNA replication is important because it is equivalent to *variability*. However, it is also important that the rate of errors is normally kept quite low. Thus, newly synthesized DNA is exposed to *proofreading* procedures, and corrected for replication errors.

All of the concepts that refer to basic processes in the DNA replication process seem to have their parallels in the transmission of behavior across persons. The behavior of each person can be analyzed in terms of sequences of repeatable behavioral units (B), their antecedents (A), and their consequences (C). A: B → C means that, in

the presence of A, B occurs and is followed by C, which next affects the probability of whether B happens again in the presence of A, and so on. Such three-term contingencies can constitute the building blocks of long and complex chains of behavior, analogous to a strand in DNA. Something analogous to the double helix structure occurs when behavioral chains of two persons are interconnected. The two strands of a double helix are interlocked by hydrogen bonds, whereas series of human behavior chains are interlocked with other persons' behavioral chains through interlocking behavioral contingencies. Interlocking behavioral contingencies (e.g., Glenn, 2004) occur whenever an event in the contingencies of reinforcement for one person's behavior simultaneously serves another function in the contingencies for another person's behavior. Such interlocking contingencies may be most conspicuous in verbal interactions, where each person's verbal behavior typically serves both as a consequence of the other person's previous response and as an antecedent, an occasion, for the other person's next response. Many characteristic features of such interactions are continuously being shaped when our behavior enters into interlocking contingencies with other persons' behavior. Two persons playing tennis, doing the dishes together, or collaborating to complete a piece of research, would be other straightforward examples of interlocking behavioral contingencies. In many such examples, the most effective way to have the behavior transmitted to new persons would be by allowing them to interact with those who are already skilled at the behavior involved. Some very rudimentary interlocking contingency is established when others are allowed to watch, but more effective interlocking contingencies will usually prevail if the novice can actually get to interact with someone who already has some of the skills. If two partners work very well together, they may be of relatively little help to others as long as they continue to reject new interactors. Thus, the social "replication

fork" is ready for action whenever two skilled interactors split and start interacting with novices. Something similar to *semiconservative replication* seems to characterize cultural replication, or transmission, of behavior. In order for such transmission to happen, the behavior of one person has to come into some sort of contact with the behavior of another organism or with special products of the behavior of another organism. In short, at least some minimal elements of contingencies of reinforcement for the behavior of one organism has to "touch base" with elements of the contingencies of reinforcement for the behavior of another. When learning a new behavioral sequence from others, different composite skills are usually preexistent in the repertoire of the learner. Such preexisting skills may start to form gradually longer sequences, like Okazaki fragments, where modeling and verbal instruction from the more skilled person function like DNA polymerase. In any case, the additional perfection of complex performances, obtaining the smoothness of performance that characterizes the behavior of experts, can only be accomplished through the proofreading that includes feedback, or reinforcing consequences, in the social and/or nonsocial environment. This feedback from the environment will constitute process similar to DNA "ligase," the filling in of the missing building blocks along the preexisting behavioral chain, and the proofreading with its correction for replication errors. Like DNA replication, the social transmission of skills is sometimes far from perfect. Again, the errors are very important, because they constitute the materials upon which selection can work and result in the evolution of cultural practices.

Shortcomings of Selection by Consequences

Selection by consequences prepares only for a future that resembles the past. Thus, phylogenetic selection prepares members of any species for future contingencies of

survival that are similar to those prevailing during their historic contingencies of survival. This fact poses serious problems when those contingencies change abruptly. However, “. . . to some extent [the shortcoming] was corrected by the evolution of a process through which a different kind of consequence could select additional behavior during the lifetime of the individual. The process is called operant conditioning and the selecting consequence a reinforcer” (Skinner, 1989, pp. 114-115).

Further, as Skinner also pointed out, a similar shortcoming is evident in operant reinforcement. Contingencies of reinforcement, too, prepare us only for a similar future, and the duration of a normal human lifetime puts severe limits on the time available to learn all the facts from scratch, from a non-social environment. Hence, in the absence of a culturally evolved environment, even with operant conditioning processes fully evolved, we would all have to start from scratch to learn how to collect fruits, hunt, put up a fire, make tools, defend ourselves, take care of the young, and so on. Although operant conditioning seems to be the most important principle in our acquisition of a useful behavioral repertoire, an evolved culture magnifies what we can learn that way.

Selection by Consequences and the Need for Corrective Measures

Towards the end of *The Origin of Species*, Darwin (1859/1958) suggested that the principle of natural selection would always work out to the best: “And as natural selection works solely by and for the good of each being, all corporeal and mental endowments will tend to progress toward perfection” (Darwin, 1859/1958, p. 450). However, species have gone extinct, and as Darwin himself also noted:

Though Nature grants long periods of time for the work of natural selection, she does not grant an indefinite period; for as all organic beings are striving to seize on each place in

the economy of nature, if any one species does not become modified and improved in a corresponding degree with its competitors, it will be exterminated. (Darwin, 1859/1958, p. 104)

In fact, biologists of today are concerned about an increasing rate of extinction of species, particularly as a function of climate change (e.g., Thomas et al., 2004), and modern zoos typically participate in a Species Survival Plan (SSP) Program. Such programs have been established in order to help maintain healthy and self-sustaining populations of endangered species such that they become genetically diverse as well as demographically stable. Hence, correction measures are considered necessary when natural selection goes wrong. Further, as Skinner pointed out:

Things go wrong under all three contingencies of selection, and they may need to be put right by explicit design. Breeding practices have long represented a kind of intervention in the evolution of the species, and geneticists are now talking about changing genetic codes. The behavior of the individual is easily changed by designing new contingencies of reinforcement. New cultural practices are explicitly designed in such fields as education, psychotherapy, penology, and economic incentives. (Skinner, 1974, pp. 205-206)

Such advanced cultural practices include sciences that have helped and continue to help us solve serious problems. In fact, natural sciences have been so effective that their success now may have become the most serious threats to the future of our cultures and our species. Wars are fought more deadly than ever, resources are depleted faster than ever, bacteria grow resistant to antibiotics faster than ever, and our climate is probably altered by human behavior faster than ever. Whether behavioral sciences can help us come up with additional corrective measure is an important question:

Whether they will evolve in time is the ultimate question. Those who are unhappy about scientific solutions sometimes assure

us that we shall solve our problems in other ways when they are bad enough, when the immediate consequences are no longer reinforcing and the remoter ones have been sampled. But it is in the nature of overpopulation, the exhaustion and pollution of the environment, and a nuclear war "bad enough" is a point of no return. (Skinner, 1989, p. 120)

In this perspective, the understanding of human behavior, including human cultures, is extremely important. Perhaps it is time for behavioral scientists to join forces in furthering our understanding of selection by consequences.

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