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# A Descriptive Taxonomy of Environmental Operations and Its Implications For Behavior Analysis

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Environmental operations may be classified according to whether they have evocative or function-altering effects. Evocative events, such as the presentation of unconditioned and conditioned stimuli, establishing operations, and discriminative stimuli, serve to increase, decrease, or maintain the momentary frequency of behavior. Function-altering operations, such as operant and respondent conditioning, the correlation of stimuli, and the presentation of certain verbal stimuli, serve to increase, decrease, or maintain the evocative and function-altering (e.g., reinforcing or punishing) functions of other events. This paper expands upon the functional taxonomy of environmental events described by Michael (1993a). The resulting classification scheme should permit behavior analysts to more easily respond to similarities and differences between functional environmental events. This paper discusses implications of the suggested taxonomy for how behavior analysts talk about motivational variables, discriminative stimuli, the operant unit of analysis, and the distinction between operant and respondent conditioning.

*Key words:* evocative functions, function-altering operations, respondent conditioning, operant conditioning, units of analysis, determinism

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Classification in the natural sciences is a common practice. Classification schemes can be constructed according to either the form or the function of the subject matter. In chemistry, substances and materials can be classified according to physical properties, which do not depend on the effects of other materials or substances (form), or chemical properties, which do depend on the effects of other substances (function) (Godman, 1982). Moreover, classification schemes may vary within a science, depending on the level at which the classification is constructed and upon the agreement of scientists within the discipline. For example, in addition to the classical two-kingdom approach to life forms, some zoologists have suggested multiple-kingdom and single-kingdom approaches (Dillon, 1970). All classification schemes have their respective advantages and disadvantages. Obviously, the more numerous the subdivisions of the classification system, the more difficult is the demonstration of similarities between those subdivisions. Classification systems are, thus, verbal devices that help scientists respond to similarities or differences between the objects of classification.

Behavior analysis has its own taxonomic systems. Some are simple, such as Skinner's (1935, 1937) subdivision of the types of conditioning into operant and respondent. Others are more elaborate, such as Skinner's (1957) classification of verbal operants into mands, tacts, intraverbals, echoics, textual behavior, transcription, and autoclitics. Skinner's verbal taxonomy is a functional system in which verbal behavior is classified according to its controlling variables rather than its form. In a similar vein, Michael (1993a) has provided the foundation for a formalized taxonomy of stimulus function. In this system, stimuli are classified according to (a) their behavioral type, that is, whether they are respondent or operant; (b) their provenance, that is, whether they are phylogenetic or onto-

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genetic; and (c) their function, that is, whether they are evocative or function altering.

There are two goals of the present paper. The first goal is to extend Michael's (1993a) taxonomy of stimulus functions to include a wider array of function-altering operations than the basic (operant and respondent) conditioning processes. These include procedures that produce conditional discrimination and conditioned reinforcers and punishers, as well as verbal function-altering operations and operations that result in observational learning. The second goal of the paper is to discuss the implications of conceptualizing operant and respondent behavior according to the suggested functional taxonomy. Although the emphasis of the present paper is on operant behavior, it will argue that the distinction between evocative and function-altering operations is a useful way to classify all functional environmental events.

## BASIC UNITS OF ANALYSIS AND FUNCTIONAL TAXONOMY

The subject matter of behavior analysis comprises the functional relations between behavioral and environmental variables. Progress in discovering such functional relations depends on the discovery of basic units of analysis, primarily because a "well-defined unit clarifies the way phenomena are conceptualized and thereby guides research and theory" (Zeiler, 1986, p. 1). Research, then, involves the manipulation of variables that determine "how generic classes are constructed and the factors responsible for particular forms of coordinated behavior" (Zeiler, 1986, p. 5). Once functional units of behavior analysis have been discovered, the factors responsible for behavior—namely, environmental events—may be classified accordingly. The present paper suggests that the operations that result in the construction of all "generic classes" can be described as function altering.[1] These operations produce their effects by altering (i.e., increasing, decreasing, or maintaining) the evocative and function-altering (e.g., reinforcing and punishing) functions of antecedent and consequent stimuli, respectively. Hence, all operations that produce the long-term changes in behavior–environment relations that lead us to talk about learning can be called function altering.

## FUNCTIONS OF ENVIRONMENTAL EVENTS

Behavior analysts distinguish between the immediate versus the more enduring effects of environmental events on behavior (e.g., Catania, 1984; Michael, 1983, 1986; Reynolds, 1975; Skinner, 1938, 1953; Thompson & Lubinski, 1986). For example, in *The Behavior of Organisms* (1938), Skinner described several laws governing both immediate but transitory changes in reflex strength and the longer lasting changes produced by conditioning and extinction. Reynolds (1975) described the distinction as follows:

> There are two kinds of environmental determinants of behavior: the contemporary and the historical. The behavior of an organism at any one moment is determined by the currently acting, contemporary environment but also by the organism's previous experience with these, or similar environmental conditions. (p. 3)

Michael (1983, 1986) has classified these environmental operations according to whether they alter the momentary frequency of behavior or whether they produce a more lasting effect "which can best be observed when the conditions that

[1] The term *function altering* also includes *function establishing*, which denotes the conditioning of formerly neutral events (e.g., CSs, EOs, $S^D$s, $S^{r+}$s), *function maintaining*, which denotes the effects on environmental events whose evocative or function-altering functions have previously been established, and *function diminishing*, which includes the suppressive effects of extinction and punishment on evocative events. The term *conditioning* may seem to adequately encompass the effects referred to in the present paper as "function altering" and, consequently, some might wonder why a different term is being introduced. The term *conditioning*, however, connotes changes in behavior rather than changes in the functions of environmental events, and, furthermore, it does not as easily denote the effects of extinction or punishment.

preceded the event are again present" (1983, p. 21). Michael used the term *evoke* to denote to the former and the term *repertoire altering* to denote the latter. Schlinger and Blakely (1987) have suggested that the term *function altering* might be more accurate than *repertoire altering* because the emphasis is on long-term changes in the relations between environmental events and behavior rather than on the behavior of the organism itself. Michael (1993a) has recently adopted the term *function altering* in place of *repertoire altering.*

*Evocative Functions of Stimuli*

The taxonomy presented herein assumes a distinction between environmental events that evoke (i.e., produce momentary changes in) behavior and other environmental events that alter these evocative functions.[2] The term *evoke* is used to describe the fact that both operant and respondent antecedent events produce momentary changes in their respective behaviors. With respect to respondent relations, *evoke* is equivalent to *elicit,* and with respect to operant discriminative relations, it is equivalent to *set the occasion,* or simply, *occasion.* Of course, there are other operant antecedent events (e.g., establishing operations) that also may be said to evoke behavior (Michael, 1982, 1993b). However, it does not seem appropriate to describe their evocative effect with the terms *elicit* or *set the occasion* because of the long history of using these terms for respondent and operant stimulus control, respectively. The term *evoke* describes the common effect in all cases, namely the momentary change in the frequency of the relevant behavior. Some have suggested that the term *evoke* be used to denote behavior that "is induced by the temporal arrangement of current stimulus events" (Thompson & Lubinski, 1986, p. 221), or, in other words, schedule-induced (or adjunctive) behavior. The dictionary states that *evoke* and *elicit* can be used synonymously (see also Zuriff, 1985, p. 106). These points all lead to the conclusion that operant and respondent (and schedule-induced, or adjunctive) behavior may be, at least temporally speaking, properly described as evoked by contemporaneous events.

Operations that evoke behavior include, but are not restricted to, the presentation of unconditional and conditional stimuli (USs and CSs), discriminative stimuli ($S^D$s), sign stimuli, releasers, and the carrying out of establishing operations (EOs). There are several reasons why it is useful for behavior analysts to use the term *evoke* to describe operant events (i.e., EOs and $S^D$s). Although behavior analysts have traditionally referred to respondent behavior as elicited by antecedent stimuli, there has been no counterpart when speaking of the momentary strengthening effects of antecedent stimuli on operant behavior. Behavior analysts have historically used the phrase *stimulus control* to refer to the discriminative relation, but that does not adequately encompass relations between EOs and behavior. The phrase *set the occasion for* also does not suffice (see below). In several places (e.g., 1938, 1957), Skinner used *evoke* to describe the effects of antecedent events on operant behavior. Although *evoke* accurately describes these effects on both operant and respondent behavior, it is unrealistic to expect behavior analysts to cease using *elicit* for respondent relations. Using *elicit* to refer to respondent relations denotes a particular type of conditioning that is different from operant conditioning. However, we do not think that the operant–respondent distinction is violated by using *evoke* to describe the effect of antecedent events on both operantly and respondently conditioned behavior. The use of specific terms such as US, CS, EO, and $S^D$ should suffice to denote whether the evocative effect is an operant or a respondent one. One of the purposes of this paper is to point out that the relation between operant behavior and its antecedent controlling variables is similar to the one between respondent behavior and its antecedent controlling variables. The

[2] Any stimulus change can have multiple effects simultaneously; for example, it might be possible for a stimulus change to simultaneously have both evocative and function-altering effects.

term *evoke* accurately characterizes that relation; therefore, *evoke* will be used for both operant and respondent antecedent effects, not as a technical term, but rather as a descriptive one. The critical question, and the one that is most important in differentiating operant from respondent conditioning, is *how* the evocative effects in both types of behavior are engendered and subsequently altered and/or maintained. Before answering this question, let us briefly clarify some issues related to describing behavior as evoked.

First, an evocative effect is one that is immediate by definition (i.e., it produces a momentary change in behavior), but the temporal limits of immediacy are not easily defined. In laboratory research, the effects on behavior of EOs, $S^D$s, and CSs are observed within a few seconds. However, it would be difficult to categorically limit evocative effects to $x$ seconds; the issue is ultimately an empirical one.

Second, although evocative effects appear to be momentary, many $S^D$s and EOs are present over extended periods of time; therefore, their effects on behavior are also probably ongoing. The duration of such evocative effects appears to mirror that of the evoking stimulus. For example, all things being equal, food-seeking behavior is evoked by food deprivation for as long as the organism is deprived. In the present scheme, then, *evoke* implies covariation between the evocative operation and the duration of the evocative effects. The effects of long-lasting evocative operations may be quantified over time on a continuous scale (such as rate of response, percentage of trials with responses, etc.) that may vary with the relevant dimension (e.g., intensity) of the operation. The effects of brief operations are easily described in terms of latency, magnitude, and so forth.

A third consideration is that the evocative functions of many events are codetermined by the context in which they occur. For example, the red patch on the underside of the male stickleback is a stimulus that evokes attack if another male stickleback enters into its territory and a stimulus that evokes fleeing if it enters the other stickleback's territory. Similarly, in a conditional discrimination, the evocative functions of one stimulus depend on the presence of other stimuli. Moreover, as previously stated, the general context in which operant (or respondent) conditioning occurs surely acquires some evocative control that can be assessed by varying one or more stimuli in that context.

Finally, in a related vein, most evocative effects are fluid and dynamic; their strength can vary from moment to moment depending on current circumstances and accumulating histories. Even the evocative effects of unconditional stimuli and releasers can vary with procedures involved in habituation and sensitization. In operant conditioning, even in apparently simple contexts, many $S^D$s are probably associated with a given operant. Thus, fluid behavior depends on the interaction of the organism with such a changing context.

### *Function-Altering Operations*

Many stimuli have acquired their evocative functions in the evolutionary histories of the respective species. Such stimuli include sign stimuli, releasers, unconditional stimuli, and unconditional establishing operations. Such effects are straightforward and are treated more extensively elsewhere (see Fantino & Logan, 1979, and Slater, 1985, for a concise introduction to ethology). The present paper is more concerned with the ways in which the environmental histories of individuals establish, modify, and maintain the behavioral functions of stimuli. The specific operations are therefore referred to as *function altering*. The present classification of environmental events as function altering is simply a descriptive classification; that is, it is a description of empirical observations. The descriptions are, therefore, under the stimulus control of those environmental events.

*Respondent function-altering operations.* The function-altering operation called *respondent conditioning* generally involves the operation of correlating two or more stimuli. In this operation, one stimulus, usually a US but sometimes an

already-established CS, is presented in such a way that its correlation with a neutral stimulus (NS) is positive. The result of this procedure is that the NS acquires evocative functions that in many cases are evidenced when its presentation increases the frequency or magnitude (or decreases the latency) of the conditioned response (CR).[3] Once this happens, we call the NS a CS. The function-altering operation called *respondent extinction* involves reducing the correlation between the US and CS, for example by presenting one stimulus (e.g., the CS) without the other (e.g., the US). Thus, respondent extinction is not simply a change in a CR, but is a diminished tendency for a CS to evoke a CR. It is the evocative function of the CS that is described as extinguished. Some have suggested that temporal contiguity between the US and CS is neither necessary nor sufficient for the respondent evocative functions of stimuli to be altered (see Rescorla, 1988, for a recent summary). Rescorla has emphasized the importance of the correlation between a US and a CS. For example, consider two procedures, A and B, in which the US and the CS are contiguously paired the same number of times in each procedure. If, in addition, Procedure B contains several occurrences of the US not paired with the CS, then the net result will be that the evocative function of that CS will be less than that of the CS in Procedure A. According to this view, the function-altering operation we speak of as respondent conditioning may be best described in terms of the probability of the US given a CS: The higher the probability of the US given the CS, the greater the function-altering effect on the CS. Likewise, the evocative function of the CS can be lessened not only by presenting the CS without the US, but by increasingly presenting the US alone. Both procedures decrease the positive correlation between the two and, hence, the evocative function of the CS.

In addition to respondent conditioning and extinction, there are other operations that alter the respondent evocative functions of stimuli. Consider the phenomenon of blocking (Kamin, 1969). If a stimulus is already established as a CS (i.e., CS 1) and is then part of a compound stimulus with another NS (i.e., CS 2), where the compound is correlated with a US, the result is that only CS 1 will evoke the CR. It is said that the prior conditioning of CS 1 "blocked" conditioning of CS 2. However, the evidence of the blocking is that only the previously established CS (CS 1) will evoke the CR. Other related phenomena (e.g., overshadowing, latent inhibition) are also examples of how prior experience with stimuli can alter the evocative effects of those or other stimuli. In all of these examples, the correlation of stimuli—a function-altering operation—alters the evocative functions of other stimuli.

*Operant function-altering operations.* When reinforcing consequences are made contingent on behavior, the effect of the contingency is not simply to increase the frequency of the behavior, as is so often stated, but actually to bring the behavior under the evocative control of certain contemporary events (e.g., EOs, $S^D$s). Said another way, reinforcement alters the evocative function of those events. For example, providing food contingent on lever pressing brings lever pressing under the evocative control of the EO, food deprivation. This relation is demonstrated simply by varying the deprivation level and observing the momentary changes in the frequency of the behavior. When the contingency is expanded to include a correlated stimulus, as in discrimination training, the effect is to bring the behavior under the joint evocative control of the EO and the $S^D$. This effect is demonstrated by manipulating both the EO and the $S^D$ (Michael, 1982; Skinner, 1953). In both instances, what is observed is the momentary increase in the frequency of responses making up the functional class. Moreover, maximum control by the EO and $S^D$ depends on the context in which the function-altering operation (e.g., reinforcement) occurs. This control can be

[3] The present analysis includes CSs that produce effects that may mimic those of the US as well as effects that may be opposite to those of the US.

demonstrated by holding the EO and $S^D$ constant and varying other aspects of the context. In the standard operant conditioning arrangement, for example, the size of the chamber, the ambient illumination, or the location of the food tray might be changed. In such instances, one would observe generalization (or stimulus change) decrement, in which the evocative functions of the EO or $S^D$ are lessened, as measured by increases in response latency or decreases in response magnitude or rate.

Just as reinforcement strengthens the evocative control of EOs and $S^D$s over the operant class, extinction and punishment diminish the capacity of these events to evoke the operant class. Moreover, just as with respondent procedures, the phenomena of blocking and overshadowing also influence the evocative functions of EOs and $S^D$s (e.g., Johnson & Cumming, 1968; Reynolds, 1961).

*Conditional discrimination training, matching to sample, and stimulus equivalence.* The relatively simple situation involving an EO, an $S^D$ (including contextual cues), and an operant class can be made slightly more complex by providing consequences in the presence of an $S^D$ only if another stimulus is present. The effect of this function-altering operation is to bring the behavior under the joint evocative control of the EO, the $S^D$, and the conditional stimulus. A conditional stimulus is so called because the evocative function of one stimulus (the nominal $S^D$) is conditional on the presence of another stimulus. The resulting discriminative relation is called a conditional discrimination. Matching to sample is just one example of a procedure that involves a conditional discrimination. As has been shown in a variety of experiments in which matching-to-sample procedures were employed with human subjects, stimulus functions can be "transferred" from one stimulus to another (Hayes & Hayes, 1992). When the transfer of stimulus function results from training in matching to sample, the term *stimulus equivalence* is often used (see Sidman & Tailby, 1982). However, the transfer of stimulus functions is not unique to matching-to-sample preparations; all function-altering operations result in the transfer of stimulus function.

*Conditioned reinforcers and punishers.* Function-altering operations, by definition, alter the behavioral functions of other environmental events. In addition to altering the evocative functions of CSs, EOs, and $S^D$s, the reinforcing and punishing capacity of stimuli can also be altered. As in the case of respondent conditioning, the operation of correlating stimuli, one of which already functions as a reinforcer, usually alters the reinforcing function of the other stimulus. Such events are called *conditioned reinforcers.* Likewise, if the correlation between the unconditioned and conditioned reinforcer is weakened (e.g., by allowing either one to occur without the other), we can expect that the reinforcing function of the conditioned reinforcer will be lessened. Several existing theories attempt to explain the processes of establishing and altering conditioned reinforcing and punishing properties of stimuli (e.g., Baum, 1974; Case & Fantino, 1981). However, irrespective of how behavior analysts ultimately explain the phenomena, at a descriptive level what happens is the conditioned reinforcing or punishing functions of stimuli are altered.

### *Verbal Function-Altering Effects*

Behavior analysts have become more and more interested in the effects of verbal stimuli on behavior. Many behavior analysts use the term *rule* to refer to the general effects of antecedent verbal stimuli on behavior (e.g., Braam & Malott, 1990; Catania, 1992; Cerutti, 1989; Chase & Danforth, 1991). Behavior analysts frequently interpret the presentation of "rules" as $S^D$s (e.g., Baldwin & Baldwin, 1981; Galizio, 1979; Skinner, 1969) or as EOs (Braam & Malott, 1990). Although there are certainly numerous instances of the presentation of verbal operant stimuli whose function is either discriminative or motivational, there are also instances in which the presentation of such stimuli has function-altering effects. Frequently these verbal events take the form of what Skinner (1969) referred

to as "contingency-specifying stimuli" (CSSs) (Schlinger & Blakely, 1987). That is, some statements specify the functional relations among antecedent stimuli, responses, and consequences, although a formal CSS is not necessary for verbal events to be function altering (Schlinger, 1993b).

Skinner described such function-altering verbal events in a well-known section of *Verbal Behavior* (1957) titled, "Conditioning the Behavior of the Listener" (pp. 357–362). In that section, Skinner described how verbal stimuli could produce conditioning-like effects analogous to respondent conditioning and discrimination training. Recently, others have suggested that behavior analysts take a closer look at such verbal events, especially in the context of their interest in rule-governed behavior (Schlinger, 1990; Schlinger & Blakely, 1987). Blakely and Schlinger (1987) suggested specifically that if behavior analysts were going to continue to use the term *rule,* they should perhaps reserve it for these function-altering verbal events. For the present purpose, these verbal events are important because they are analogues to the more basic function-altering processes of respondent and operant conditioning (Alessi, 1992).

*Observational learning.* So far we have described how behavioral relations can be altered through operant and respondent conditioning as well as through verbal function-altering events. However, behavioral relations can also be altered through observation of others' behavior. Presumably, any relation (e.g., motivational, discriminative, respondent) that can be altered through direct conditioning can be altered via observation. We are not talking here about simple imitation or even generalized imitation, both of which consist of discriminative relations wherein the imitative stimulus functions either as an $S^D$ or like an $S^D$ to evoke the imitative response. If the phenomena we speak of as observational learning have any unique quality, it is that they reflect a function-altering process with effects similar to those of verbal function-altering operations (see also Baldwin & Baldwin, 1981). At a purely descriptive level, behavioral functions of environmental events can be altered as a result of seeing those functions in effect for another individual. For example, Berger (1962) showed that a buzzer could come to evoke increases in galvanic skin response in a subject as a function of that subject observing a confederate receiving shocks and withdrawing a hand. There are many other examples of studies showing the alteration of behavior–environment relations by observation. The fundamental issue regarding observational learning is the provenance of such effects (Deguchi, 1984).

### *Other Function-Altering Operations*

*Imprinting.* We have said that all environmental operations resulting in long-term behavior change may be classified as function altering. Thus far, we have only provided examples of fairly traditional learning phenomena. However, ethological learning phenomena may also be classified as function altering. Sign stimuli and releasers may be classified as evocative operations, even though their evocative function has been established by the contingencies of survival of the particular species in which their effects are observed. Some stimuli (e.g., those called imprinting stimuli) acquire their evocative functions as a result of specific function-altering experiences early in an organism's life.

Many behavioral scientists used to think that the following behavior observed in young precocial birds was inherited. After all, most young members of the species follow their mothers soon after hatching. Moreover, in one of the most celebrated demonstrations in ethology, Lorenz showed that young newly hatched precocial birds would even follow a human if it was the first large moving object they saw during a sensitive period after hatching. In the standard experimental preparation of imprinting, a moving object is presented to a newly hatched duckling. Soon thereafter, the moving object evokes following, snuggling, and vocal behavior by the duck-

ling. The removal of the object will evoke "distress" calls and "searching" behavior, and, if the object is presented at a later time, it will continue to evoke approach and following. Furthermore, the presentation of a novel object will evoke avoidance behaviors.

Gewirtz (1961) and Hoffman and Ratner (1973) have proposed reinforcement models of imprinting that are based on a precocial bird's innate disposition to be affected by exposure to certain kinds of stimulation soon after hatching. For the purposes of the present discussion, however, the important thing about imprinting is that, whereas we can describe the learning as specific to certain species of precocial birds, what appears to be "learned" is not the particular behavior, but rather the functions of a particular stimulus. Although it would be difficult to separate the phylogenetic and ontogenetic contributions of early exposure to a moving object, it does appear that at some point the imprinting stimulus acquires operant (and probably also respondent) functions. Thus, any behavior that results in proximity to or movement of the imprinting stimulus will show an increase in frequency, and behavior that results in removal of the imprinting stimulus will show a decrease in frequency. Several experiments have reliably demonstrated such operant functions of imprinting stimuli (e.g., Bateson & Reese, 1968, 1969; Hoffman, Searle, Toffey, & Kozma, 1966; Hoffman, Stratton, & Newby, 1969; Peterson, 1960). For example, Peterson (1960) showed that exposing young ducklings to a moving yellow light soon after hatching established that stimulus as a reinforcer. This function was evidenced by demonstrating that the imprinted stimulus could be used to operantly condition an arbitrary response, such as pecking a Plexiglas disc. The conclusion from this and other experiments is that even learning that is apparently constrained by species-specific characteristics can be classified as evocative and function altering.

We have seen that many types of environmental operations may be classified as function altering. At a descriptive level of analysis, what this means is that these otherwise apparently different operations can be described as altering the behavioral functions of other environmental events.

## IMPLICATIONS FOR CLASSIFYING OPERANT BEHAVIOR AS EVOKED

Classifying operant behavior as evoked by antecedent controlling variables has important implications for many of the ways in which operant behavior has traditionally been conceptualized. Typically, operant behavior has been described as emitted, primarily to contrast it with respondent (or reflexive) behavior, which has been described as elicited. The original reason for this terminological difference was to underscore the distinction between operant and respondent conditioning. This usage is no longer relevant, because most behavior analysts readily accept the distinction. However, the practice of describing operant behavior as emitted still continues, as do some of the problems associated with it.

One of the earliest, if not the first, uses of the term *emitted* to describe operant behavior occurred in Skinner's book *The Behavior of Organisms* (1938), which followed on the heels of his earlier (1935, 1937) papers in which he introduced the historically important distinction between operant and respondent conditioning. According to Skinner (1938),

> [A]n event may occur without any observed antecedent event and still be dealt with adequately in a descriptive science. I do not mean that there are no originating forces in spontaneous behavior but simply that they are not located in the environment. We are not in a position to see them, and we have no need to. This kind of behavior might be said to be *emitted* by the organism, and there are appropriate techniques for dealing with it in that form. (p. 20)

By 1953, when he published *Science and Human Behavior,* Skinner distinguished operant from respondent behavior not by describing the former as emitted and the latter as elicited, but by describing operant behavior as behavior

that "*operates* upon the environment to generate consequences" (p. 65). By then, Skinner had also moved closer to a general evocative conception of operant behavior with regard to motivational operations and discriminative stimuli (see below). These changes notwithstanding, other behavior analysts continued the tradition of characterizing operant behavior as emitted (e.g., Catania, 1984; Ferster & Perrott, 1968; Reynolds, 1975). Nowadays, most authors distinguish operant behavior according to its control by consequences, even though they may still use the term *emitted* (e.g., Fantino & Logan, 1979; Mazur, 1990; Schwartz, 1989).

The choice of the term *emitted* has led to several ways of talking about operant behavior that may lead to problems. In *The Behavior of Organisms* (1938), Skinner warned that unless operant behavior was distinguished from respondent behavior, the investigation of operant behavior would be severely delayed. Describing operant behavior as emitted was one way to underscore the distinction. However, this terminological decision may have had some unintended effects. Most notably, when *emitted* is used to describe operant behavior, proximal causes ($S^D$s and EOs) may be overlooked, or even worse, they may be assigned to forces within the organism. To emit means "to send out, give forth," or "discharge," and it is typically used to describe phenomena (e.g., radiation, visual stimulation from light-emitting diodes) that are determined by endogenous processes. Hence, the term *emitted* might encourage descriptions of behavior that are organism based rather than environment based (see Hineline, 1986). Emit is a verb with the organism as subject of the sentence. Thus, instead of saying that, "The rat emitted a lever press," the framework in the present paper suggests saying that an EO (e.g., food deprivation) or an EO and $S^D$ (e.g., food deprivation plus a tone) evoked a lever press.

*The EO is taken for granted.* One of the most important problems with not recognizing the evocative nature of operant behavior concerns the status of motivational variables. It is customary in behavior-analytic lore to describe operant conditioning as a process whereby consequent events (called reinforcers) strengthen behavior that (immediately) precedes them (e.g., Fantino & Logan, 1979; Martin & Pear, 1983; Reynolds, 1975). However, in the present scheme, this locution neither fully nor accurately describes what happens. Rather, as already stated, reinforcement (as a function-altering operation) alters the evocative function of the prevailing EO and, thus, the behavioral relation between the EO and behavior. In *Science and Human Behavior* (1953), in a section titled, "The Control of Operant Behavior," Skinner described the evocative control of operant behavior by motivational operations as follows:

> [T]he frequency of response which results from reinforcement depends upon the degree of deprivation *at the time the response is observed.* Even though we have conditioned a pigeon to stretch its neck, it does not do this if it is not hungry. We have, therefore, a new sort of control over its behavior: in order to get the pigeon to stretch its neck, we simply make it hungry. (p. 68, italics added)

Behavior analysts may have taken the EO for granted because manipulation of an EO (e.g., food deprivation) in order to condition behavior, and then again at a later time to demonstrate the conditioning effects, is merely a technological detail (Reynolds, 1975). However, in their analyses, behavior analysts have rarely described the evocative relation between the EO and the operant, which is established by the reinforcement contingency (but see Michael, 1982, 1993b). The purpose of the present discussion is simply to clarify the evocative functions of motivational operations and to acknowledge their rightful place in behavior-analytic theory.

*Conceptualizing the $S^D$.* Another important problem with describing operant behavior as emitted concerns the $S^D$. As stated previously, operant evocative events include EOs and $S^D$s. Most textbook descriptions implicitly recognize the evocative effect of the $S^D$ by stating that

the result of discrimination training is to increase the probability of the operant in the presence of the $S^D$ (e.g., Catania, 1984; Reynolds, 1975; Skinner, 1938). However, behavior analysts, by and large, do not explicitly conceptualize the $S^D$ as evoking responses (but see Michael, 1980, 1983); behavior analysts still say that the $S^D$ "sets the occasion" for the response (to be reinforced). By not explicitly recognizing the evocative relation between the $S^D$ and the operant it controls, some of the deterministic assumptions underlying behavior analysis may be weakened and the door may be opened to organism-based descriptions of behavior. Moreover, cognitive descriptions of operant behavior may sneak into the vernacular (Michael, 1980). In addition, neglecting the evocative effect of the $S^D$ may result in relations between antecedent stimuli and responses being interpreted as discriminative when they may not be (Schlinger, 1990). For example, in human affairs, behavior analysts often describe as $S^D$s events that precede behavior by hours, days, weeks, or even months (Schlinger, Blakely, Fillhard, & Poling, 1991). Again, this trend may be traced to Skinner's (1938) distinction between respondent and operant behavior. According to Skinner (1938), as a result of differential training, the organism

> comes to respond whenever a stimulus is present which has been present upon the occasion of a previous reinforcement and not to respond otherwise. The prior stimulus does not elicit the response; it merely sets the *occasion* upon which the response will be reinforced. (p. 178)

Thereafter, behavior analysts adopted the phrase "sets the occasion" to describe the effect of the $S^D$. Although the original intentions were to maintain a clear distinction between respondent and operant stimulus control, such a characterization may have prevented behavior analysts from fully appreciating the $S^D$'s evocative effects. Zuriff (1985) recognized the problem when he wrote that,

> The distinction between eliciting stimulus and discriminative stimulus requires further clarification. Both are antecedent causes, even in Skinner's sense of causation as functional relation. The difference, therefore, must be found in the type of functional relation. If the term "elicit" is restricted to functional relationships of the type exemplified by the Pavlovian conditioned and unconditioned responses, then the discriminative stimulus cannot be said to elicit. On the other hand if "elicit" is used in the more general sense of causally related, the $S^D$ may be said to elicit a response. (p. 106)

The rationale for describing the $S^D$ as setting the occasion for a response was, again, to distinguish operant from respondent stimulus control, and to emphasize the role of behavioral consequences (e.g., reinforcement) in the operant case. In the original phrase, it was said that the $S^D$ "sets the occasion upon which a response *will be* reinforced" (Skinner, 1938, p. 178, italics added). Notwithstanding the teleological connotations, this way of describing the $S^D$ has led to similar descriptions of the $S^D$ that move even further from the nature of the relation. For example, some speakers often talk of "an $S^D$ for reinforcement." As Michael (1980, 1983) has pointed out, this way of characterizing operant stimulus control neglects what the stimulus actually controls, namely, a class of responses. As suggested previously, this locution opens the way for organism-based accounts of operant behavior and, ironically, cognitive accounts. Indeed, Michael (1980, p. 48) suggests that omitting the response in the account "may ... be the result of contact with cognitive orientations" of behavior. However, it may have been the other way around. It is possible that behavior analysts have not made explicit references to the responses evoked by the $S^D$ because Skinner (1938) did not do so, and this omission may have opened the door for cognitive-like descriptions to work their way into behavioral language. For example, one can read about the $S^D$ "signaling reinforcement" or "predicting reinforcement" (e.g., Mackintosh, 1977).

In *The Behavior of Organisms* (1938), Skinner contrasted respondent and operant stimulus control, as illustrated in the following quote:

> The discriminative stimulus has a very different status from that of the eliciting stimulus. It is less likely to be regarded as a spur or goad and is perhaps best described as "setting the occasion" for a re-

sponse. Whether or not the response is to occur does not depend upon the discriminative stimulus, once it is present, but upon other factors. . . . Strictly speaking we should refer to a discriminated operant as "occurring in the presence of" rather than "elicited as a response to" $S^D$. The analogy with true reflex is almost too strong to be resisted in casual speech, however, and little difficulty should arise from the extension of these terms, provided a general intermediate meaning is assigned to them with respect to the mere temporal and topographical correlation of stimulus and response. . . . In distinguishing between an eliciting stimulus and a discriminative stimulus I am simply contending that a stimulus may have more than one kind of relation to a response. . . . The same temporal order of S and R obtains in both cases but the same quantitative properties are not to be expected. (p. 241)

Thus, Skinner seems to have wrestled with the similarities between the $S^D$ and the eliciting stimulus. On the one hand, the $S^D$ is not to be considered as a "spur" or "goad," but on the other hand, it does have the same temporal properties as the eliciting stimulus, which are part of what leads one to say that it spurs or goads its response. The conflict, if there was one, for Skinner, seems to have been between acknowledging the evocative effect of the $S^D$ while at the same time attempting to maintain the distinction between operant and respondent stimulus control.

When Skinner addressed this issue again in *Science and Human Behavior* (1953), he clearly had moved closer to a stronger evocative role for the $S^D$:

The discriminative stimulus . . . shares its control with other variables, so that the inevitability of its effect cannot be easily demonstrated. But when all relevant variables have been taken into account, it is not difficult to guarantee the result—to force the discriminated operant as inexorably as the eliciting stimulus forces its response. (p. 112)

So, for example, if the rat is positioned such that its paws are only a few centimeters from the lever, and food deprivation is maximum, then if a tone (which has been used in differential training) sounds, the effect will be indistinguishable from that of a reflex. That is, a response will occur immediately (see also Terrace, 1966, p. 273 for a similar description). The point to be made here is that the temporal relation involved in both operant and respondent stimulus control is roughly the same, even though the histories (i.e., function-altering operations) that establish the respective types of stimulus control and the quantitative properties are different.

## IMPLICATIONS FOR THE OPERANT UNIT OF ANALYSIS

The present framework for classifying the effects of environmental events also has implications for how behavior analysts conceptualize the basic operant unit of analysis. The traditional view of the operant unit of analysis is the two-term contingency, which stands "as a milestone in the development of behavioral analysis" (Sidman, 1986, p. 217). This two-term relation, between an operant and reinforcement (i.e., $R \rightarrow S^R$), has historically been juxtaposed with the respondent two-term relation (i.e., CS → CR) and used, in part, to distinguish operant from respondent behavior (see below). However, the present view of reinforcement as altering, at minimum, the evocative functions of an EO implies that the basic operant contingency cannot consist of only two events, but rather, must contain at least three events: the EO that determines the value of the consequence, the behavior, and the function-altering operations (e.g., reinforcement or punishment) that determine the evocative strength of the EO (Schlinger, 1993a). Hence, the basic operant unit of analysis is a three-term contingency; inclusion of the $S^D$, then, expands the three-term contingency into a four-term relation:

$$\left.\begin{matrix}\text{EO}\\ \text{SD}\end{matrix}\right\} : R \rightarrow S^R.$$

## IMPLICATIONS FOR THE DISTINCTION BETWEEN OPERANT AND RESPONDENT CONDITIONING

We have argued that the traditional conception of operant behavior and operant stimulus control was born out of Skinner's early attempts to clarify the distinction between operant and respondent

conditioning. Hineline (1986) suggested that behavior analysts have historically cited three bases for distinguishing operant from respondent behavior. They are (a) "the absence of an immediate environmental precursor that could be said to elicit the behavior in question"; (b) "the sensitivity of the behavior to its consequences"; and (c) "the possibility that distinct response systems are involved in the two types of behavior" (p. 55). The first of these was introduced by Skinner in *The Behavior of Organisms* (1938) and has been cited by behavior analysts ever since. Concerning the role of an immediate environmental precursor of behavior, we have argued that if the terms *elicit* and *evoke* are defined solely in terms of their temporal controlling relation to subsequent behavior, then it is difficult to distinguish operant and respondent behavior on the basis of antecedent control alone.

There is another issue related to the distinction between operant and respondent behavior that is relevant to the present argument. Behavior analysts have traditionally described respondent behavior as being controlled by antecedent events and operant behavior as being controlled by consequent events. Skinner (1938) initially presented the distinction this way:

> The kind of behavior that is correlated with specific eliciting stimuli may be called respondent behavior. . . . The term is intended to carry the sense of a relation to a prior event. Such behavior as is not under this kind of control I shall call operant. . . . The term refers to a posterior event. (p. 20)

However, this basis may not be proper for the operant–respondent distinction either. Distinguishing respondent from operant behavior by asserting that the former is controlled by antecedent events and that the latter is controlled by consequent events is to confuse the two types of control. It is a distinction based on evocative control on the one hand (for respondent behavior) and on function-altering control on the other hand (for operant behavior). According to the conception in the present paper, operant *and* respondent behavior are controlled (i.e., determined) by *both* evocative *and* function-altering events. Respondent behavior is evoked by CSs because of a certain function-altering history (i.e., stimulus–stimulus correlation), called respondent conditioning, that has established the evocative functions of those CSs. Similarly, operant behavior is evoked by EOs (and $S^Ds$) because of a function-altering history, called operant conditioning, that has endowed those events with evocative functions. Hence, the appropriate distinction between operant and respondent relations is between the two types of function-altering histories responsible for the evocative relations that characterize both.

## IMPLICATIONS FOR DETERMINISM IN BEHAVIOR ANALYSIS

Some might view the present argument as reverting to a simple stimulus–response (S–R) model for all behavior, which would have the unfortunate by-product of validating many of the worst misrepresentations of behavior analysis (Malone, 1987). In fact, Skinner (1938) foresaw the possibility that behavior theorists might "attempt to force" all behavior "into the simple stimulus–response formula," and warned against such practices several times in *The Behavior of Organisms.* Although one could argue that describing operant behavior as evoked is tantamount to extreme mechanism or, perhaps worse for a modern behavior analyst, to a simple S–R behaviorism in which every response must have a prior evocative stimulus, one could counterargue that insisting on the absence of evocative controlling variables is contrary to both the deterministic assumptions and the empirical facts of behavior analysis.

The issue of determinism raised by the present arguments is also related to the concept of mechanism. Of the many possible ways the term *mechanical* is used in behavior analysis, there are two that should help to elucidate the implications of the present argument for the deterministic view in behavior analysis. The first is that "all behavior consists of individual movements elicited by punctate

stimuli," and the second is that "behavior is an invariable, lawful, and therefore 'automatic' consequence of antecedent environmental causes" (Zuriff, 1985, pp. 186–187). The first usage of *mechanical* is reminiscent of what has been referred to as the S–R reflex thesis, whereas the second is a more apt depiction of modern behavior analysis (Zuriff, 1985). The first meaning has also been termed *mechanistic determinism* (Marr, 1982); it is generally agreed that, at least in the strictest sense, mechanistic determinism (i.e., the S–R reflex thesis) has been abandoned by modern behaviorists (Marr, 1982; Zuriff, 1985). It is also this meaning of *mechanical* that some might say is implied by the present argument that operant behavior should be classified as evoked. Although the present treatment of operant behavior may represent a molecular viewpoint, it neither asserts nor implies the extreme molecularism inherent in the concept of the S–R reflex thesis. On the other hand, not all arguments against the S–R reflex thesis are convincing. For example, Zuriff (1985) writes that

> All that remains of the original S–R reflex thesis is the assertion that behavior consists of responses, each caused by antecedent stimuli. Even this weakened version of the thesis is contradicted by the concept of the operant, which is emitted rather than elicited. (p. 99)

But simply reiterating the logical contention that the operant is emitted and not elicited does not by itself seriously contradict any version of the S–R thesis. The task for behavior analysis is to recognize the evocative control of operant and respondent behavior and to understand how such control in both cases is engendered, maintained, and weakened.

The present characterization of operant behavior does not necessarily imply a mechanistic determinism that leaves no room for order at other levels. For example, although operant behavior is under the evocative control of EOs, such events are not necessarily or even typically punctate events, each evoking a simple discrete movement. Rather, EOs are frequently ongoing. They control streams of behavior that may or may not be further analyzed into components. Nowhere in behavior analysis is it ordained that behavioral units can be orderly at only one level. The ultimate strength of behavior analysis is the freedom to find order at any level (Branch, 1977). Thus, conceptualizing operant behavior as evoked should in no way prevent behavior analysts from considering such molar concepts as resonance (Hineline, 1986), integration (Hackenberg, 1987; Thompson & Lubinski, 1986), or kinetic structure (Thompson & Lubinski, 1986), if those concepts turn out to be helpful in conceptualizing behavior–environment relations.

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