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What Every Student of Behavior Analysis Ought to Learn: A System for Classifying the Multiple Effects of Behavioral Variables

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An accurate repertoire of tacts and intraverbals about behavior is essential for scientific and technical communication. All behavioral effects of the environment can be classified in an eight-cell arrangement created by three dichotomies: respondent versus operant, evocative versus function altering, and unlearned versus learned. By refining some old definitions and inventing a few new terms and symbols, it becomes possible to locate any functional relation in the eight cells of this set of categories. Much instruction about behavior analysis can then focus on helping students master a two-part repertoire consisting of (a) providing the term (or symbol) when given a description of a relevant situation and (b) describing the environmental and behavioral evidence for the relation when given the term (or symbol). This system of analysis is described and illustrated with sample questions and answers that teach about the system.

Key words: behavioral terminology

An environmental change, such as a stimulus onset or offset, usually has more than one effect on behavior. Behavior analysts have technical terms for the different functional relations involved, and being able to identify a functional relation with an appropriate term is an important part of our scientific repertoire. Accurate tacts and intraverbals permit us to communicate effectively, but beyond interacting with others this repertoire plays an important role in our ability to understand how the environment affects behavior, and in our ability to change the environment for practical purposes. The development of a consistent and unambiguous repertoire regarding these terms and functional relations should be a major goal for a course in behavior analysis, both because it is a substantial portion of the field and because it is a critical tool for learning about other aspects of the subject matter.

For the last several years in a junior-level course on the concepts and principles of behavior analysis, I have increasingly focused on teaching the technical terminology concerned with a small number of basic functional relations, especially when they constitute multiple effects of the same environmental variable. Although there are only a little over two dozen such relations, an effective repertoire has been difficult to establish and maintain. This difficulty is no doubt due in part to my less-than-optimal instructional technology, but I think it is also due to inconsistencies and ambiguities in the technical terminology of behavior analysis itself. In particular, several of the key terms have more than one set of controlling variables. This inadequacy can sometimes be remedied by more restrictive definitions, but sometimes only the invention of new terms will suffice.

What follows is a formalization and refinement of existing verbal practices regarding behavior and its causes. The result is a set of concepts that are mutually exclusive and sufficiently ex-

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BEHAVIORAL FUNCTIONS

		Respondent	Operant
Evocative	Unlearned	UE	UEO
	Learned	CE	CEO S^D
Function-Altering	Unlearned	UC/CE UC/CC EXT UC/S^r UC/S^p EXT	S^R S^P EXT
	Learned	CC/CE CC/CC EXT CC/S^r CC/S^p EXT	S^r S^p EXT

Figure 1. Three-category classification of behavioral effects.

haustive to cover most behavioral events and functional relations. You may disagree with my usage of some terms, but unless a verbal repertoire is explicit, its faults cannot be easily identified. My analysis is molecular in orientation; it does not contest the existence and importance of molar relations, but rather assumes that the molar effects are the cumulative result of molecular processes.[1] I also make no use of physiological information beyond an occasional reference to the different receptors and effectors.

THE CLASSIFICATION SYSTEM

Figure 1 shows the three-category classification of behavioral functional relations; I will explain the meaning of the abbreviations as we proceed. Figure 2 shows the same arrangement but with more explanation of the various effects. (It will be helpful in reading what follows to have available photocopied versions of Figures 1 and 2.)

Let me begin by examining a fairly well-understood experimental arrangement and introducing the terms and symbols for the relevant functional relations. Consider the development and maintenance of a discriminated operant performance by a food-deprived dog. The chamber has a treadle on the left side of the front wall that the animal can press with its foot, a food cup at the bottom of the right side of the front wall into which a pellet of food can be dropped by a food dispenser (which makes a brief loud sound), a sound source referred to as a buzzer, and a dim overhead light for general chamber illumination. The floor is a grid that can deliver a painful shock. I will not be describing actual research, but the apparatus and procedure are not much different from those found in standard rat and pigeon operant conditioning chambers.

The procedure begins with magazine training, operation of the feeder (food dispenser) on a random-time basis until the dog comes readily to the food cup when it hears the feeder operate but rarely approaches the cup when the feeder has not sounded. The sound of the feeder has become a *discriminative stimulus* (S^D) for approaching the food cup as a result of the relation of the sound to the presence of food in the cup. Food-cup approach behavior has also been added to the class of responses that are increased in frequency[2] by food deprivation. In other words, the food-cup approach response has been brought under the joint control of food deprivation as an *estab-*

[1] For a general treatment of molar versus molecular approaches, see Mazur (1994, pp. 141–143, 345–351).

[2] I use *frequency* to refer to number of responses per unit time, or number of response occurrences relative to the number of opportunities for a response. In this way I can avoid such terms as *probability, likelihood,* and *strength* when referring to behavior. The controlling variables for these terms are problematic, and because of this, their use encourages a language of intervening variables, or an implied reference to something other than an observable aspect of behavior.

BEHAVIORAL FUNCTIONS OF AN ENVIRONMENTAL EVENT

		Respondent	Operant
Evocative	Unlearned	UE unconditioned elicitor	UEO uncond. estab. operation[1]
	Learned	CE conditioned elicitor	CEO cond. estab. operation[2] S^D discriminative stimulus
Function-Altering	Unlearned	UC/CE uncond. conditioner of a conditioned elicitor UC/CC uncond. conditioner of a conditioned conditioner EXT (extinction)[3]	S^R unconditioned reinforcer S^P unconditioned punisher EXT (extinction)[3]
		UC/S^r unconditioned reinforcer conditioner UC/S^P unconditioned punisher conditioner EXT (extinction)[3]	
	Learned	CC/CE cond. conditioner of a cond. elicitor (higher order conditioning) CC/CC cond. conditioner of a cond. conditioner EXT (extinction)[3]	S^r conditioned reinforcer S^P conditioned punisher EXT (extinction)[3]
		CC/S^r conditioned reinforcer conditioner CC/S^P conditioned punisher conditioner EXT (extinction)[3]	

Figure 2. Behavioral functions of an environmental event. [1]Alters—increases or decreases—the current frequency of responses that have been reinforced by whatever events are altered in reinforcing effectiveness by the same UEO, or together with an S^D alters the current frequency of responses that have been reinforced by the same event. [2]Alters—increases or decreases—the current frequency of responses that have been reinforce by whatever events are altered in reinforcing effectiveness by the same CEO. A detailed explanation of the three kinds of CEO with examples of each appears in Michael (1993). In that paper, they are named (surrogate, reflexive, and transitive), symbolized (CEO-S, CEO-R, and CEO-T), and the rationale provided for the terminology. [3]There are several important function-altering relations that are not symbolized. Some are referred to with the term *extinction* but some have no technical term. Respondent extinction consists in presenting the CE without its being followed by the UC. The elicitative effect of the CE also weakens when the UC occurrence is unrelated to the CE occurrence, although this is not ordinarily called extinction. Similarly, when a response that has been developed with reinforcement occurs without the reinforcement, the frequency of the response in the EO and S^D decreases. Operant stimulus control is weakened without decreasing EO control by reinforcing the response irrespective of the stimulus condition; similarly with punishment, although statement of the effect is somewhat more complex. Conditioned reinforcers and punishers lose their effectiveness as such when their relation to unconditioned reinforcers and punishers is discontinued, or when it becomes nondifferential.

lishing operation (EO)[3] and the feeder sound as an S^D. These new functional relations are due to the effect of food presentation as unconditioned reinforcement, for which the symbol S^R is commonly used.

At this point three operant functional relations, symbolized as EO, S^D, and S^R, have been identified. When the food-deprivation EO is in effect (but not otherwise), food presentation functions as reinforcement (S^R) for any type

[3] I introduce several new symbols in this paper. Pronouncing the letters of these symbols rather than the words the letters stand for is quicker. Many of us already do this with the respondent US and CS, and with the operant S^D. This practice is especially convenient for those symbols that stand for rather lengthy expressions, such as UE, CE, UEO, and so on.

of response that immediately preceded that food presentation (approach to the food cup in the present case) in that it brings this type of response under the joint control of that EO (food deprivation) and an S^D (the sound of the feeder). In the future, when the EO and S^D conditions are again in effect, the approach response will occur at a higher frequency than it did before the reinforcement. Reinforcement, then, alters the function of the relevant EO and the S^D with respect to their control of the approach response. It is convenient and important, therefore, to classify the S^R as having a function-altering effect, an effect that may not be apparent at the time the S^R occurs, but will be seen when the conditions are again as they were prior to the occurrence of the relevant response. In this sense, the effect of reinforcement is delayed from the time of the occurrence of the reinforcement.

The S^D, on the other hand, results in an increase in the current (as opposed to future) frequency of the approach response (given that a relevant EO is at some nonzero value), an effect for which the term *evoke* seems to be appropriate. It is thus convenient to refer to the S^D as having an evocative effect on the relevant behavior. Evocative effects can be seen immediately after the occurrence of the relevant environmental change, as contrasted with the delayed effects of the function-altering relation. It may seem strange to use *evoke* for the effect on the approach response of a slowly developing EO like food deprivation; nevertheless, it is useful to classify the EO, like the S^D, as having an evocative effect on the response of interest. Food deprivation increases the current frequency of all behavior that has been reinforced with food. Like the S^D (and in contrast with the S^R), an EO does not permanently alter any functional relations between environmental variables and behavior. In summary, an evocative effect is transient but immediate; a function-altering effect is relatively permanent but delayed. The distinction between evocative and function-altering effects is one of the three fundamental dichotomies of the classification system as shown in Figures 1 and 2.

Although our hypothetical experiment would not be convenient for the study of respondent (Pavlovian) conditioning, the taste of food is an unconditioned stimulus for salivation, and because the feeder sound has been closely related to this taste, the sound should come to function as a conditioned stimulus for similar behavior. (The distinction between respondent and operant relations is another fundamental dichotomy of the classification system.) The respondent terms *unconditioned stimulus* (US) and *conditioned stimulus* (CS) are ambiguous, however, with respect to whether they refer to evocative or function-altering effects. The US clearly has both effects: It elicits salivation at the time the food stimulates the taste receptors, a transient but immediate (evocative) effect, and it conditions the dog with respect to any other stimuli that precede the food taste, in this case the feeder sound, a somewhat permanent but delayed (function-altering) effect. Similarly, the CS, as a result of its relation to the US, elicits salivation and conditions the dog with respect to any other stimuli that precede the CS occurrence (higher order conditioning).

It would be better if each technical term referred only to one effect or relation, and for this reason I find it necessary and helpful to invent some new terms.[4] Because the taste of food elicits salivation and does so without prior conditioning, I refer to that taste as an unlearned or *unconditioned elicitor* (UE). And because the taste's elicitation of salivation is immediate but temporary, it is an evocative effect. On the other hand, because the sound of the

[4] Perhaps omnibus terms that refer to multiple effects can be useful, in which case use of such terms as unconditioned stimulus (US) and conditioned stimulus (CS) can continue. This point will come up again in connection with the term *aversive stimulus.*

feeder elicits salivation only after pairing with the taste, I refer to the sound as a learned or *conditioned elicitor* (CE). The role of the taste in conditioning the dog's salivation response to the feeder sound can be indicated symbolically by UC/CE. (The UC, or unconditioned conditioner, part of this symbol can be interpreted as referring to the pairing operation, and the CE part refers to the relationship that results from this pairing.) UC/CE refers to a function-altering effect because the food taste alters the eliciting function of the feeder sound, an effect that will only be seen when that sound is presented the next time.[5] In other words, this conditioning is function altering because it alters the function of the feeder sound somewhat permanently, with the apparent effect of this alteration being delayed until the next presentation of the feeder sound. Similarly, the CS can be seen to function both as a CE and, in higher order conditioning, to transfer its effect to another neutral stimulus, a relation that can be symbolized as CC/CE. (I do not have a short name for these more complex function-altering relations. When it is necessary to refer to them other than with the symbol, "unconditioned conditioner of a conditioned elicitor" and "conditioned conditioner of a conditioned elicitor" can be used, although in speaking I tend to pronounce the letters and ignore the slash or diagonal line.)

At this point three quite different behavioral effects of food presentation have been identified. As reinforcement (S^R), food presentation brings food-cup approach behavior under the control of the food deprivation EO and the feeder sound S^D, an operant function-altering effect. As a gustatory unconditioned elicitor (UE), the taste of food elicits salivation at the time the food is tasted, a respondent evocative effect. As a gustatory UC/CE (unconditioned conditioner of a conditioned elicitor), the taste of food alters the function of the feeder sound, a respondent function-altering effect. There are also three behavioral effects of the feeder sound. As an auditory S^D, it evokes the food-cup approach response. As an auditory CE, it elicits salivation. As an auditory CC/CE (conditioned conditioner of a conditioned elicitor), it conditions the dog's salivation response to any stimulus that immediately preceded the feeder sound. The first two are evocative effects, and the third is function altering.

In addition to the classification of effects as evocative or function altering and as respondent or operant, the preceding analysis has implied a classification as to provenance—whether the relation is unlearned or learned. The function of food presentation as reinforcement (S^R), given food deprivation, and the UE and UC/CE relations are usually considered to be unlearned relations attributed to the evolutionary history of the species. On the other hand, the S^D, CE, and CC/CE are clearly learned relations; the first two are evocative and the third is function altering. The distinction between unlearned and learned relations is the third fundamental dichotomy of the classification system.

With respect to the EO, the classification of provenance is a little more complex. EOs such as food and water deprivation, uncomfortably high or low temperatures, painful stimulation, and others, have two main effects on behavior: (a) an increase in the effectiveness of other stimulus changes as forms of reinforcement (food deprivation makes food presentation more effective as reinforcement, becoming too cold makes an increase in temperature

[5] Pairing an effective stimulus with a neutral one seems to be a relevant operation with respect to many kinds of effective stimuli. Here a stimulus that elicits a response in a respondent relation is paired with a neutral stimulus that then becomes capable of eliciting a similar response. The same procedure is referred to later with respect to developing a conditioned reinforcer and a conditioned punisher by pairing a neutral stimulus with a stimulus that already functions as a reinforcer or a punisher. Perhaps all functions can be transferred to some extent in this way, even the S^D.

effective as reinforcement), and (b) an increase in the current or momentary frequency of all behavior that has obtained the relevant type of reinforcement. The first effect can be called *reinforcer establishing*; the second is the evocative effect of the EO mentioned earlier. Classification of an EO as to provenance is based on the reinforcer-establishing effect, not the evocative effect. Food deprivation can be considered an unlearned or *unconditioned establishing operation* (UEO) because the increase in reinforcing effectiveness of food as a result of such deprivation is an unlearned effect. However, the particular type of behavior that is increased in frequency, the behavior evoked by food deprivation, is the result of the individual organism's learning history. So let us add the UEO consisting of food deprivation to the other unlearned relations, giving us two unlearned function-altering effects (S^R and UC/CE),[6] and two unlearned evocative effects (UEO and UE). (The learned or conditioned establishing operation, CEO, is also shown in Figures 1 and 2, but an adequate description would go beyond the scope of the present paper. The three different kinds of CEO are described in detail in Michael, 1993.)

Food ingestion is also an unconditioned establishing operation (UEO) working in the opposite direction from food deprivation, and should be added to the set of behavioral functional relations. The other operant evocative relation, the S^D, is similarly bidirectional in that there are S^Ds that decrease the frequency of behavior that has been punished in their presence. This means that operant evocative effects either increase or decrease response frequency. We could refer to such effects as evocative or suppressive, but it seems simpler to expand the meaning of *evoke.* In this paper, then, *evoke* is equivalent to "alter (increase or decrease) the current frequency of some type of response." (Respondent inhibitory relations are also well known—the effects of conditioned inhibitors—which means that *elicit* will be equivalent to *elicit* or *inhibit.*)

For the next phase of the dog's training, the buzzer is turned on and a treadle-press response is shaped by delivering food contingent on successive approximations to that response. The buzzer is then turned off and several treadle responses occur without operating the feeder. The buzzer is turned on again, and several treadle responses are reinforced, and so on. Eventually the dog will readily press the treadle when the buzzer comes on but will press it infrequently when the buzzer is off. The onset or occurrence of the feeder sound plays a dual role in this process. It is an S^D that controls approach to the food cup, and because of its relation to the food, it will also function as *conditioned reinforcement* (S^r) in increasing the future frequency of the treadle response. In referring to this double function, it is sometimes said that the S^D is also an S^r, but I think it is much better to say that the feeder sound functions as an S^D and also as an S^r. In this manner, each technical term refers to only one functional relation, and each functional relation is referred to by only one technical term. With the S^r we now have four operant relations, two learned (S^D and S^r) and two unlearned (UEO and S^R); and, cross classified, two function altering (S^R and S^r) and two evocative (UEO and S^D).

Now we must add the development

[6] It is possible at this point to confuse one of the dichotomies with the other. EOs have two effects, reinforcer establishing and evocative. All of the behavioral variables being described can also be classified with respect to another dichotomy, whether their effect is function altering or evocative. These two sets of categories should be considered orthogonal to one another; they are different kinds of distinctions. With respect to the second dichotomy, EOs are evocative, not function altering, and none of the other behavioral variables (S^D, UE, UC/CE, S^R, etc.) have reinforcer-establishing effects in the sense that this term applies to EOs. Your hypothalamus will surely turn to mush if you confuse reinforcer-establishing effects with function-altering effects. (This will be my only use of current neuroscience in this paper.)

of the conditioned reinforcing effectiveness of the feeder sound as a new function-altering effect of the food presentation. Having used UC/CE and CC/CE to represent respondent function-altering effects, we can use UC/S^r as the symbol for this new effect. Like the UC/CE and CC/CE, the UC/S^r consists in the pairing of two stimuli. In the respondent case a neutral stimulus becomes a CE; in the operant case a neutral stimulus becomes an S^r. When the pairing of a conditioned reinforcer with a neutral stimulus results in that neutral stimulus becoming a conditioned reinforcer, the symbol CC/S^r will be used. The UC/S^r and the CC/S^r can be thought of as hybrid relations, in that they involve the respondent procedure of pairing two stimuli, but the result of the pairing is a new operant relation. For this reason these relations or effects are shown in Figures 1 and 2 between the respondent and operant categories. (As with the UC/CE and CC/CE, I do not have short names for these relations. Perhaps "unconditioned reinforcer conditioner" and "conditioned reinforcer conditioner" would be convenient, when it becomes necessary to name rather than symbolize the relation.) Note that when one function-altering effect occurs with respect to another function-altering effect, the ultimate behavioral change is not only delayed in the ordinary sense, but is doubly delayed from the environmental change that produced the effect.[7] The defining behavioral change is not seen immediately, nor even when the S^r occurs, but only when the situation is again as it was before the S^r occurred. (In spite of somewhat similar terms and procedures, the development of a conditioned reinforcer by pairing a neutral stimulus with another reinforcer should not be equated with respondent conditioning. In respondent conditioning a neutral stimulus acquires the capacity to elicit behavior somewhat similar to that elicited by the stimulus it was paired with. In the development of the S^r, the eliciting effect of the stimulus is neither necessary nor sufficient to qualify it as a conditioned reinforcer, but only its effect in altering the future frequency of the response that preceded it.)

Figures 1 and 2 show extinction (EXT) as a function-altering relation in the bottom half of the figures. When the CE is presented without the UC/CE or the CC/CE, its elicitative capacity is weakened and its function with respect to the salivation response is altered. When the previously reinforced response occurs without reinforcement (S^R or S^r), the evocative control over that type of response by the EO and S^D is weakened. For the hybrid relations also, when the S^r occurs without the UC/S^r or the CC/S^r its reinforcing effectiveness is weakened. Just like the relations that develop the CE and the S^r, all of these weakening relations are clearly function altering.

PRACTICE IN USING THE CLASSIFICATION SYSTEM

At this point I will switch to a question-and-answer format, which will illustrate the repertoire that I believe the students should have, and will also serve as further explanation of the classification system. There are two aspects to this repertoire: being able to identify the function (with its symbol) when given a description of the relevant behavioral change, and being able to describe the behavioral change that constitutes evidence for the function when given the symbol. The second aspect is the more difficult, so we will

[7] Doubly delayed respondent relations also occur. This means that when a neutral stimulus (a tone) is paired with a stimulus that already elicits some type of response (food), the effective elicitor not only endows the neutral stimulus with the capacity to elicit a similar response, the ordinary delayed effect of any functional-altering relation (the food causes the tone to elicit salivation the next time the tone occurs), but also empowers the neutral stimulus to condition that response to a new neutral stimulus as a form of higher order conditioning, a doubly delayed effect. This relation is symbolized in Figure 1 as UC/CC, and CC/CC in an analogue to higher order conditioning.

start with the first. The items proceed in a logical and increasingly complex manner, but a more random sequence of items would be used to assess students' mastery of the repertoire.

Provide the symbol for each effect described below, using for each description one (and only one) of the symbols shown in Figure 1. Cover the answer (in brackets right below the question) as you read each item.

1. Food in the mouth evokes (elicits) salivation, thus functioning as ____.
[UE. This is the evocative effect of what is ordinarily called an unconditioned stimulus or US.]

2. Food in the mouth also alters the function of the feeder sound so that the sound will evoke (elicit) salivation the next time the sound occurs. This shows that the food in the mouth functioned as ____.
[UC/CE. This is the function-altering effect of what is ordinarily called an unconditioned stimulus or US. Note that although the effect of the feeder sound had to be mentioned in the item, the question is directly concerned with an effect of the food, not with an effect of the feeder sound.]

3. That the sound now evokes (elicits) salivation on its own shows its function as ____.
[CE. This is the evocative effect of what is ordinarily called a conditioned stimulus or CS. Note that the question asks about an effect of the feeder sound, not the event responsible for its having this effect.]

4. If by chance the overhead light happened to flicker right before the feeder sounded, we might expect to see a weak salivation response the next time the light flickered. This would illustrate that the feeder sound had functioned as ____.
[CC/CE. This is an instance of higher order conditioning, where the feeder sound has a function-altering effect. Note that the item is directly concerned with an effect of the feeder sound, not the light flicker, although the item had to mention the light flicker.]

5. Salivation to the light flicker would also illustrate the function of the light flicker as ____.
[CE. The light flicker has this effect because of the function-altering effect of the feeder sound as CC/CE, but the item is directly concerned with the effect of the light flicker.]

6. The pupillary constriction reflex—a decrease in pupillary diameter as a result of an increase in level of illumination—is an example of a reflex that cannot be conditioned. That is, repeatedly pairing a neutral stimulus, for example, a tone, with an increase in illumination, will not ultimately result in the tone's eliciting the pupillary constriction response by itself. The light functions as ____ for the response.
[UE]

7. But there is no evidence that the increase in illumination can function as ____.
[UC/CE]

8. Because of its relation to the food the feeder sound evokes (increases the current frequency of) the behavior of approaching the food cup. In this respect the feeder sound is functioning as ____ for the approach behavior.
[S^D. (However, S^Δ training—extinction in the absence of the S^D—is implied.) An S^D is a stimulus condition that has been correlated with the availability of a type of reinforcement. Such a correlation consists in response-contingent reinforcement in the presence of the S^D and no reinforcement in its absence.]

9. The role of food presentation in bringing the approach response under the joint control of the feeder sound and food deprivation illustrates the role of the food presentation as ____.
[S^R]

10. That food deprivation now evokes (increases the current frequency of) the approach behavior shows the function of food deprivation as ____.
[UEO]

11. To shape the treadle-press response, the pellet feeder is operated contingent upon successive approximations to that response. Although the food is critical in the procedure, it is actually the feeder sound that functions to increase the future frequency of the treadle press, to bring it under the control of the food deprivation EO and the buzzer S^D. In this capacity the feeder sound is functioning as ____.
[S^r. This is a function-altering effect of the feeder sound. The same stimulus event also has a respondent evocative effect as CE and an operant evocative effect as S^D.]

12. The effectiveness of the feeder sound as S^r depends upon the food having functioned as ____.
[UC/S^r. If you said S^R you were assigning more than one function to this symbol. As is indicated above, the food has many behavioral effects, but the only one I wish to label with the symbol S^R, the only one I wish to call its *reinforcement* effect, is the increase in future frequency of the type of behavior that immediately preceded the delivery of the food. Or said another way, its reinforcement effect consists in bringing the behavior that immediately preceded it under the control of the relevant EO and S^D. The UC/S^r is a hybrid function-altering effect of the food, not unlike its respondent function-altering effect as UC/CE, in that both depend simply on temporal

contiguity or the pairing of two stimuli. However the UC/CE effect is only once delayed, whereas the UC/S^r is twice delayed.

13. In addition to its function as S^D in evoking the treadle press, the buzzer sound would increase the future frequency of any response that happened to precede it, and would thus function as ____.
[S^r. This would be an instance of accidental reinforcement, because the buzzer onset is not dependent on the organism's behavior. However, some behavior would be occurring when the buzzer came on, and that behavior would be increased in future frequency.]

14. That the buzzer sound could increase the future frequency of any response that preceded it is due to the feeder sound having functioned as ____.
[CC/S^r. If you said S^r you were assigning more than one function to that symbol. The feeder sound has several functions, but I would like the symbol, S^r, to refer to only one of those functions.]

15. Food reinforcement is also food ingestion. In most experiments the amount of food ingested as a result of reinforcement is kept small so that the effectiveness of food as reinforcement does not decline rapidly. However, it does decline some, and the current frequency of behavior that has been reinforced with food also declines. In this respect food ingestion is functioning as ____.
[UEO. Just as food deprivation *increases* the current frequency of all behavior that has been reinforced with food, food ingestion *decreases* the current frequency of all such behavior.]

Providing the symbol when given the behavior, as with Questions 1 through 15, is essentially a many-choice multiple-choice repertoire. We will now sample the other aspect of the repertoire, which consists in providing a description of the relevant behavioral and environmental variables when given the symbol. This is clearly more difficult for the student.

16. What change in behavior with respect to what stimulus is evidence that the food functioned as UC/CE?
[Salivating to the feeder sound.]

17. What change in behavior with respect to what stimulus is evidence that the feeder sound is a CE?
[Salivating to the feeder sound, an evocative effect. It is the same change in behavior that is evidence for the food's function-altering effect as UC/CE.]

18. What change in behavior with respect to what stimulus is evidence that the buzzer sound is an S^r?
[This is difficult because the change is the result of accidental reinforcement. The answer is that whatever type of behavior was occurring immediately prior to the buzzer onset will show an increase in frequency the next time the buzzer is off, assuming the same EO conditions.]

19. What change in behavior with respect to what stimulus is evidence that the feeder sound is an S^D?
[The dog approaches the food cup immediately after the feeder sound occurs.]

20. What change in behavior with respect to what stimulus is evidence that the feeder sound is a CC/CE?
[Salivation to whatever stimulus immediately preceded the feeder sound. During the first phase of the training procedure, the feeder was operated on a random-time basis, so no stimulus systematically preceded the sound. When training with respect to the buzzer and treadle press began, the buzzer evoked the treadle press, which systematically produced the feeder sound. Tactile and kinesthetic stimuli resulting from pressing the treadle would be likely to evoke salivation, as would the buzzer.]

21. What change in behavior with respect to what stimulus is evidence that food ingestion is a UEO?
[There would be a decrease in the current frequency of all behavior that had been reinforced by food and by the feeder sound. Most obvious would be a decrease in the current frequency of treadle pressing (when the buzzer is on). This is simply an opposite to the effect of food deprivation, which increases the current frequency of all behavior that has been reinforced by food and by the feeder sound.

22. What change in behavior with respect to what stimulus is evidence that the feeder sound is a CC/S^r?
[This is difficult because the critical effect is twice removed from the causal variable. The feeder sound as CC/S^r caused the buzzer onset to function as S^r, but the relevant change in behavior will not be seen until after the buzzer sound next occurs and the situation is again as it was before that occurrence of the buzzer sound. The change in behavior would be an increase in whatever behavior immediately preceded that occurrence of the buzzer sound.]

Let us now change the experimental procedure so that functional relations involving punishment[8] can be illustrat-

[8] Many behavior analysts use the terms *aversive stimulus* and *aversive control* in dealing

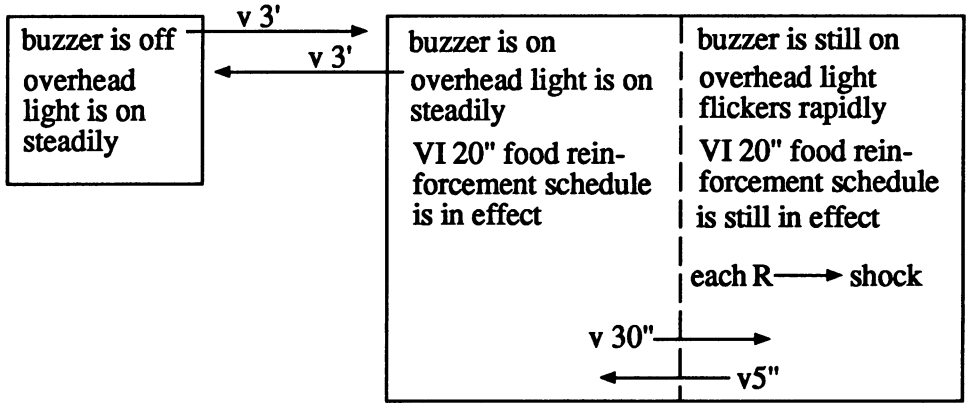

Figure 3. A discriminated operant procedure plus punishment.

ed. The new procedure is shown in Figure 3. When the buzzer is off (box at left), treadle-press responses have no effect. The buzzer-off condition is an S^{Δ} with respect to reinforcement of the treadle-press response. The buzzer comes on after a variable period with an average duration of 3 min. While it is on, a variable-interval 20-s schedule of food reinforcement is in effect for treadle pressing (box at right). When the buzzer comes on, a variable timer with an average duration of 3 min starts timing, and when it times out, the buzzer is turned off and the first condition is again in effect. These two variable 3-min timers simply cause the situation to switch back and forth between the buzzer-off and the buzzer-on conditions. When the buzzer comes on, another timer with a variable duration of 30 s also starts timing. When it times out, the overhead light, which has been on steadily until now, starts flickering rapidly. While the buzzer is on and the light is flickering, the VI 20-s food schedule is still in effect, but each response is immediately followed by an electric shock delivered through a floor grid. The light-flicker condition lasts for a variable period with an average of 5 s. The shock functions to decrease the future frequency of whatever response immediately preceded it, and we can use the symbol S^{P} (unconditioned punishment) for this unlearned function-altering effect. As with reinforcement, we can use S^{P} (conditioned punishment) for a similar learned function-altering effect, UC/S^{P} for the effect of the shock in making any stimulus that immediately precedes the shock function as learned punishment (in this case the flickering of the overhead light), and CC/S^{P} for the effect the flickering light would have in making any stimulus that preceded it also function as learned punishment. The shock also has respondent effects related to the activation syndrome. (Weakening operations like those discussed in connection with extinction are also relevant to the punishment variables.)

with various aspects of this type of procedure. The trouble with this omnibus term is that it has at least three different controlling variables. A stimulus may be called aversive because its offset functions as reinforcement, because its onset functions as punishment, or because it evokes the behavior that has in the past terminated it. That it evokes respondent behaviors related to the activation syndrome may also lead to its designation as aversive. This multiple meaning may well be why it is seen as convenient, but it works against unambiguous identification of functional relations, and it is not a part of my own repertoire when I wish to speak precisely.

23. When the buzzer is off, the dog's treadle-press response occurs only rarely, because the buzzer-off condition is an S^{Δ} for treadle pressing. When the buzzer comes on, treadle pressing occurs at high frequency. When the overhead light starts flickering, the next treadle press is followed by shock, with the effect that the future

frequency of the treadle-press response under these stimulus conditions will be lower than it was before the shock. This illustrates the effect of the shock as ____.
[S^P. As with reinforcement, punishment is a function-altering rather than an evocative effect.]

24. The shock also evokes (elicits) the activation syndrome (heart rate increase, adrenalin secretion, etc.), and in this respect is functioning as ____.
[UE. It might be tempting to say that the punishment (S^P) evokes the activation syndrome, but this would be assigning two functions to one function name and symbol, not a good terminological practice.]

25. The shock is also responsible for the light flicker evoking the activation syndrome when it next occurs, showing the effect of the shock as ____.
[UC/CE]

26. That the light flicker now evokes the activation syndrome shows its function as ____.
[CE]

27. The light flicker will decrease the future frequency of any response that preceded it, showing its effect as ____.
[S^P]

28. That the light flicker functions as punishment indicates that the shock must have functioned as ____.
[UC/S^P]

29. When the light flicker begins, the treadle pressing stops; the light flicker causes a decrease in the current frequency of (suppresses) the treadle-pressing behavior, showing its function as ____.
[S^D]

Here is a sampling of the repertoire shown in Figure 1 using examples from everyday human situations.

A man invites a woman to dinner at his apartment. She arrives while he is still setting the table in the dining room, and he asks her to wait in the living room for a few minutes. She sits down on a sofa. After a while he calls "Dinner is served."

30. What change in the woman's behavior is evidence that the call "Dinner is served" functioned as an S^D?
[She gets up and goes to the table.]

31. What change in the woman's behavior is evidence that the call "Dinner is served" functioned as a CE?
[She salivates.]

32. What change in the woman's behavior is evidence that the call "Dinner is served" functioned as an S^r?
[Whatever type of behavior occurred immediately before the call to dinner would be more likely to occur the next time she is in the same situation. This is a case of accidental reinforcement. Assume that just before dinner was called the woman picked up a magazine that was on the sofa. She would put it down when dinner was called and go to the table, but we might see a slight increase in the frequency of picking up a magazine the next time she comes to dinner and has to wait in the living room.]

A young child is watching his father at the keyboard of his computer. The father stops to look at a book and the child begins to reach toward the keyboard. The father says "No!" in a loud and stern tone of voice.

33. That the child stopped moving his hand toward the keyboard when he heard his father's "No!" showed that the warning had functioned as ____.
[S^P. In the presence of such a stimulus condition in the past, continued movement or continued responding of some sort had been subjected to more serious consequences.]

34. What change in the child's behavior is evidence that the "No!" functioned as S^P?
[The child will show a lower frequency of reaching for his father's keyboard in the future, when the situation is again as it was just before he reached this time. These two, S^D and S^P, are often confused. The first is evocative and the second function altering.]

CONCLUSION

Although I have not illustrated all of the functional relations in Figures 1 and 2 nor considered their role in all of the more important behavioral situations, the general approach should be clear.[9] There are, of course, concepts and principles that are not uniquely related to any particular cell of Figure 1, but rather apply to functional relations in all or most of the cells (e.g., the principle of stimulus generalization). But the functional relations represented by the symbols in the figures constitute a large portion of our field. This ap-

[9] I have available some more practice questions covering avoidance and the three kinds of conditioned establishing operation (CEO). If you would like a copy of these items you can write or E-mail me.

proach seems to be especially convenient as a basis for analyzing everyday human behavior in terms of its behavioral components. There is some tendency in such analyses to seize on the first concept that seems to fit, and neglect other possible variables. With a fluent repertoire involving the symbols of Figure 1 and illustrated in the preceding questions and answers, the chances of overlooking an important variable are reduced.

One might ask why it is of any value to be able to recognize and correctly name these various effects. I would answer that I have found, for myself, at least, that I cannot understand some things unless I can talk about them clearly. I cannot think clearly about nonverbal events unless I have a consistent verbal repertoire regarding those events. Perhaps I should be more intuitive or contingency shaped and less rule governed, but my intuition tells me otherwise.

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