OPERANTS¹

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The definition of an operant as a response class each of whose members possesses the property upon which reinforcement is contingent is not broad enough to cover the units that are supposed in Skinner's accounts of extinction, superstition, and transfer of learning. A broader definition is suggested. Finally, properties defining operants are discussed.

I

When one sets out to construct a science of behavior, one is confronted immediately by two problems. The first problem is that of saying how much of what goes on in the world counts as behavior. Do all changes in states of organisms count as behavior, or only some of them? And if only some of them, then which ones? For example, is the growth of a tumor inside an organism to count as behavior of that organism? And if an organism is moved by some external mechanical force, is that movement of the organism to count as behavior? If cases such as these are to be excluded, then on what grounds are they to be excluded?

The second problem is selecting units of behavior. How is one to divide behavior into units so that one can give an account of it?

In *The Behavior of Organisms*, Skinner attempts to say what behavior is. His account is not wholly satisfactory, however. Evidently he wants to say that some movements of organisms are not behavior. But it is not clear from his account which movements fail to qualify.

Behavior is only part of the total activity of an organism, and some formal delimitation is called for.

... Behavior is what an organism is *doing*—organism to be doing.

... behavior is that part of the functioning of an organism which is engaged in acting upon or having commerce with the outside world [Skinner, 1938, p. 6].

Because Skinner explicitly rejects ordinary mentalistic descriptions of behavior, it is difficult to see what he is trying to convey by saying that behavior is what an organism is *doing*. When he says that behavior is that part of the

functioning of an organism which is engaged in acting upon or having commerce with the outside world, he seems to be suggesting that behavior is an organism's activity which has some direct effect upon the environment.

This interpretation is probably wrong, however, because Skinner in *Science and Human Behavior* (1953, p. 271) and elsewhere (1963a, p. 954) talks about the behavior of seeing. Seeing, of course, does not have a direct effect upon the environment. Besides, when Skinner sums up his discussion of the nature of behavior, he does not talk about the environmental effects of an organism's activity:

By behavior, then, I mean simply the movement of an organism or of its parts in a frame of reference provided by the organism itself or by various external objects or fields of force [Skinner, 1938, p. 6].

Nothing in Skinner's characterization of behavior prevents one from reckoning all movements of organisms or parts of organisms as behavior. His account of behavior seems, therefore, to be unsatisfactory because it does not rule out cases that intuitively should be ruled out.

Fortunately, one need not be able to say precisely what counts as behavior before one begins to construct a science of behavior. One can single out certain instances of behavior and begin to study them, even though one is unable to say exhaustively what is and what is not behavior.

If one is aiming at a science of behavior, it is not enough to be able to recognize certain

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events as behavior. One must go on to establish, at least tentatively, a system of classification for instances of behavior. That is, one must define units of behavior so that one will be able to say of any two instances of behavior whether they are of the same or different kinds. If a person touches an object with his right hand and then touches it with his left hand, has he done the same thing twice or has he done two different things? More precisely, is the first instance of touching to be counted as being of the same kind as the second instance of touching? Should both be counted as instances of *touching the object*, or should one be counted as an instance of *touching the object with one's right hand* and the other counted as an instance of *touching the object with one's left hand*? Or should both be counted as instances of *moving an arm*? Or should one be counted as an instance of *moving one's right arm* and the other counted as an instance of *moving one's left arm*? There are multiple nonequivalent ways of classifying instances of behavior. How is one to decide which system of classification to adopt? Or does it matter?

Skinner says that it does.

The analysis of behavior is not an act of arbitrary subdividing, and we cannot define the concepts of stimulus and response quite as simply as "parts of behavior and environment" without taking account of the natural lines of fracture along which behavior and environment actually break [Skinner, 1935, p. 40].

He argues that one should pick units of behavior that allow one to find orderly changes in behavior:

A specification [of behavior] is successful if the entity which it describes gives smooth curves for the dynamic laws [Skinner, 1938, p. 37].

According to Skinner, there are two broad categories of behavioral laws corresponding to two basic kinds of behavior.

... in the unconditioned organism two kinds of behavior may be distinguished. There is, first, the kind of response that is made to specific stimulation, where the correlation between response and stimulus is a reflex in the traditional sense. I shall refer to such a reflex as a *respondent* and use the term also as an adjective in referring to the behavior as a whole. But there is also a kind of response which occurs spontaneously in the absence of any stimulation with which it may be specifically correlated. We need not have a complete absence of stimulation in order to demonstrate this. It does

not mean that we cannot find a stimulus that will elicit such behavior but that none is operative at the time the behavior is observed. It is the nature of this kind of behavior that it should occur without an eliciting stimulus, although discriminative stimuli are practically inevitable after conditioning. It is not necessary to assume specific identifiable units prior to conditioning, but through conditioning they may be set up. I shall call such a unit an *operant* and the behavior in general, operant behavior [Skinner, 1937, p. 274].

Because Skinner's main concern is with operant behavior, we shall examine his account of how one selects units of behavior only as it applies to operant behavior.

A prime example of operant behavior is the behavior of a rat pressing a lever. According to Skinner, all instances of pressing a lever are, in certain circumstances, to be classified together because, when one does so, one discovers certain dynamic laws of behavior.

Suppose that we are studying the behavior of such an organism as a rat in pressing a lever. The number of distinguishable acts on the part of the rat that will give the required movement of the lever is indefinite and very large. Except for certain rare cases they constitute a class, which is sufficiently well-defined by the phrase "pressing the lever." Now it may be shown that under various circumstances the rate of responding is significant—that is to say, it maintains itself or changes in lawful ways. But the responses which contribute to this total number-per unit-time are not identical. They are selected at random from the whole class—that is, by circumstances which are independent of the conditions determining the rate. Not only, therefore, are the members of the class all equally elicitable by the stimulation arising from the lever, they are *quantitatively mutually replaceable*. The uniformity of the change in rate excludes any supposition that we are dealing with a group of separate reflexes and forces the conclusion that "pressing the lever" behaves experimentally as a unitary thing [Skinner, 1935, pp. 44-45].

In the example of the lever, we obtain smooth curves by restricting up to a certain point only; if we further limit the response by excluding all examples except those of one given kind (pressing with a certain muscle-group, for example), we destroy our curves by eliminating many instances contributing to them. The set of properties that gives us "pressing the lever" is uniquely determined; specifying either fewer or more will destroy the consistency of result that we have obtained [Skinner, 1935, p. 54].

A *part* of behavior, isolable in terms of some classificatory scheme, is not known to be a *unit* of behavior until certain dynamic properties have been demonstrated . . . [Skinner, 1938, p. 433].

Skinner is saying that one cannot be sure about what the units of behavior are until one

has discovered certain dynamic laws of behavior. The units of behavior are, then, just those things with which the laws deal. We have yet to see, however, just what sorts of behavioral laws, according to Skinner, establish the units of analysis.

The most fundamental law in Skinner's theory of operant behavior is his version of the law of effect. Skinner's version of the law of effect, just like other versions, should be viewed as an attempt to capture the basic insight that certain consequences of certain behavior help to determine certain subsequent behavior. In order to capture this insight in a precise statement of lawful relations, however, one must say which consequences of what behavior help to determine what behavior in which ways. When one has done this, one will have given a precise statement of the law of effect. But more importantly, for our present purposes, one will have characterized behavior implicitly in a way which, at the least, is appropriate for expressing the law of effect.

In 1963, Skinner stated the law of effect as follows:

The approximately simultaneous occurrence of a response and certain environmental events (usually generated by it) changes the responding organism, increasing the probability that responses of the same sort will occur again [Skinner, 1963*b*, p. 503].

Though this statement is indefinite in that it does not exactly specify either behavior or consequences of behavior, it is nevertheless important. It is important because it says that the behavior that is determined in part by the consequences is *of the same sort* as the behavior that has the consequences. The earlier response and the responses whose probability of emission is increased are responses of the same sort.² These sorts or kinds of responses are called 'operants'. And the environmental events that follow responses and increase the probability that responses of the same kinds will occur again are called 'reinforcements'. Reinforcements are presentations of reinforcing stimuli. We do not know, however, how operants and reinforcing stimuli are defined.

Skinner says that an operant is a class whose members are responses each of which possesses "the property upon which reinforcement is contingent [Skinner, 1953, p. 66]."

... in the case of conditioned operant behavior the defining property of a class is exactly that given by the conditions of the reinforcement. If the reinforcement depended, for example, upon making the response with a certain group of muscles, the class would change to one defined by that property [Skinner, 1938, p. 38].

A response which has already occurred cannot, of course, be predicted or controlled. We can only predict that *similar* responses will occur in the future. The unit of a predictive science is, therefore, not a response but a class of responses. The word "operant" will be used to describe this class. The term emphasizes the fact that behavior *operates* upon the environment to generate consequences. The consequences define the properties with respect to which responses are called similar [Skinner, 1953, pp. 64-65].

An operant is a class, of which a response is an instance or member.

... reinforcement [of a response] is contingent upon properties [of a response] which define membership in an operant [Skinner, 1969, p. 131].

As we have just seen, Skinner's definition of operants makes use of the notion of reinforcement. Thus, if we are to understand the definition of operants, we must know what reinforcement is. We already know that reinforcement is the presentation of a reinforcing stimulus, but we do not yet know what a reinforcing stimulus is.

Skinner gives the following account of reinforcing stimuli: "A reinforcing stimulus is defined as such by its power to produce the resulting change [Skinner, 1938, p. 62]." For Skinner, then, a reinforcing stimulus is something the presentation of which after a response changes the probability of occurrence of responses of the same kind, *i.e.*, responses belonging to the same operant.

But now we seem to be in some sort of trouble. Operants were defined in terms of reinforcement, which was defined in terms of reinforcing stimuli. And now reinforcing stimuli are defined in terms of operants. We seem to have come full circle.

Skinner was certainly aware of this problem. He anticipated the charge of circularity and replied to it directly.

A reinforcing stimulus is defined as such by its power to produce the resulting change. There is no circularity about this; some stimuli are found to produce the change, others not, and they are classi-

²We shall not discuss Skinner's notion of probability in this paper. Suffice it to say that Skinner believes that the probability of occurrence of responses belonging to particular classes can be derived in some way—he does not say how—from the frequency of occurrence of responses belonging to those classes.

fied as reinforcing and non-reinforcing accordingly [Skinner, 1938, p. 62].

What Skinner failed to note, however, was that the resulting change is a change in the probability of occurrence of responses belonging to the same operant as the response which was reinforced. Skinner has no way of talking about the change resulting from reinforcement without talking about operants.

Meehl, in defending Skinner's definition of reinforcing stimuli, makes the same mistake.

It must be pointed out that there are two meanings of the word "circular" in common use. We have on the one hand circularity in *definition*, in which an unfamiliar term is defined by using other terms which are (directly or ultimately) defined by the term in question. There is no question of circularity in this sense in a definition of the Skinner-Spence type. Let us accept as a crude preliminary formulation the following: "A reinforcing stimulus is one which increases the subsequent strength of responses which immediately precede it." The words *stimulus*, *strength*, *increase* and *response* are all definable without any reference to the fact or theory of reinforcement. The definitions of these terms, particularly the term "response," present terrible difficulties; but I do not know of anyone who maintains that they involve the notion of reinforcement [Meehl, 1950, pp. 54-55].

Meehl says that a reinforcing stimulus is a stimulus that increases the subsequent strength of responses that immediately precede it. But what sense can be made of the notion of strengthening responses that have already occurred? Presumably, what Meehl means is that presentation of a (positive) reinforcing stimulus increases the strength of a certain class of responses that contains the reinforced response as a member. In Skinner's system, that class of responses is an operant.

An operant is a class, of which a response is an instance or member. The usage is seldom respected. Strictly speaking, it is always instances which are counted in determining frequency, and from that frequency the probability of a *response* inferred. The probability is frequently taken, however, as the measure of the strength of an *operant*. Strength of response has no meaning except as a property of an instance, such as its force or speed [Skinner, 1969, p. 131].

Meehl's account, thus corrected, comes out as follows: a reinforcing stimulus is a stimulus which when presented after a response changes

the subsequent strength of the operant to which the reinforced response belongs. From this formulation, it is clear that reinforcing stimuli are defined in terms of operants. And, as we have already seen, operants are defined in terms of reinforcing stimuli.

At this point, one might be inclined to look for some way either of defining operants independently of reinforcing stimuli or of defining reinforcing stimuli independently of operants. But one need not do this. One might instead simply say that operants and reinforcing stimuli must be identified in pairs. Suppose, for example, that whenever the occurrence of a response that depresses a lever is followed by the presentation of a food pellet, the probability of occurrence of responses that depress levers is increased. If this were so, then, armed with the definition of operants and the definition of reinforcing stimuli, one could simultaneously identify the class of lever-pressing responses as an operant and food pellets as reinforcing stimuli. Because operants are defined in terms of reinforcing stimuli and reinforcing stimuli are defined in terms of operants, one cannot identify an operant without identifying a reinforcing stimulus at the same time, and *vice versa*. But, though one cannot independently identify either operants or reinforcing stimuli, one can identify operants and reinforcing stimuli dependently, *i.e.*, in pairs.

Operants and reinforcing stimuli are defined relatively, in pairs. Still, one can make the notions less relative: a class of responses is an operant if it is an operant in any pair. And a stimulus is a reinforcing stimulus if it is a reinforcing stimulus in any pair.

Having given an account of operants and reinforcing stimuli, we might go on to state the law of effect as follows: if the occurrence of a response belonging to any operant is followed by the presentation of any reinforcing stimulus, then the probability of occurrence of responses belonging to that operant is changed. This law goes beyond what is stated in either the definition of operants or the definition of reinforcing stimuli, for it guarantees that the probability of occurrence of responses belonging to *any* operant can be altered by the presentation of *any* reinforcing stimulus. This account of the law of effect is very close to Meehl's account of what he calls 'the Weak Law of Effect', which says that all reinforcers, *i.e.*, reinforcing stimuli, can be used to

strengthen all learnable responses (Meehl, 1950, pp. 60-62).³

Should one reject this law of effect because of exceptions, one would have to state a great many laws of effect that say precisely which operants can be strengthened by which reinforcing stimuli.

It is not clear to the present writer whether Skinner's statements of the law of effect were intended as expressions of one law or as exhibitions of the general form of multiple laws of effect. His statements of the law of effect can be read either way. What is important for present purposes, however, is that Skinner has found some dynamic laws that govern operants (*i.e.*, response classes each of whose members possesses the property upon which reinforcements is contingent) and which, therefore, by his standards, establish operants as units of analysis.

II

To this point we have been concerned mainly with setting forth Skinner's account of operants. We have permitted interpretation and criticism to enter our exposition only to the extent that they seemed to make that account more clear and coherent. It is now time to look more critically at what Skinner has said about operants.

Skinner says that an operant is a class of responses each of which possesses a certain property upon which reinforcement is contingent. Thus, it seems that according to Skinner the existence of an operant at any moment depends upon the existence at that moment of a contingency which makes reinforcement conditional upon the occurrence of a response possessing the property which defines that operant. No contingency of reinforcement, no operant.

But surely this requirement is too stringent. One could not even properly classify responses emitted under an extinction procedure, because the operant to which they should belong would have ceased to exist.

Skinner's own account of extinction supposes that there are operants not defined by a

property upon which reinforcement is contingent;

When reinforcement is no longer forthcoming, a response becomes less and less frequent in what is called "operant extinction" [Skinner, 1953, p. 69].

What Skinner means is that when reinforcement is no longer forthcoming, responses belonging to a particular operant become less and less frequent. But that operant cannot be defined by a property upon which reinforcement is contingent, because in an extinction procedure there is no reinforcement.

The definition of operants must be extended so that an operant is a class of responses each of which possesses a certain property upon which reinforcement *could be made* contingent. But now something curious has happened. Because reinforcement can be made contingent upon any property of a response, *i.e.*, any property manifested prior to reinforcement, every class of responses possessing the same property becomes an operant. All the complexity of Skinner's definition of operants has now disappeared: an operant is a class of responses each of which possesses the same property.

There is a simple but very important consequence of this conception of operants: because every response has indefinitely many different properties, every response belongs simultaneously to indefinitely many different operants.

These conclusions seem to be in conflict with some of what Skinner says about operants. But, in fact, they follow from his accounts of superstition and transfer of learning. On the one hand, Skinner seems to require that an operant be a class whose members possess the property upon which reinforcement is contingent. But on the other hand, when he discusses superstition and transfer, he counts as operants classes of responses whose members do not possess the properties upon which reinforcement is contingent.

Skinner begins his earliest discussion of superstition with a statement about the nature of contingencies of reinforcement.

To say that a reinforcement is contingent upon a response may mean nothing more than that it follows the response. It may follow because of some mechanical connection or because of the mediation of another organism; but conditioning takes place presumably because of the temporal relation only, expressed in terms of the order and proximity of response and reinforcement [Skinner, 1948, p. 168].

³What Meehl calls 'the Strong Law of Effect' may be paraphrased as follows: every increment in operant strength due to learning is the result of a presentation of a reinforcing stimulus which is such that it can be used to strengthen any operant (Meehl, 1950, p. 64).

What Skinner says here is a little confused. The point he is concerned to make is that because conditioning takes place because of temporal relation only, reinforcement can be effective even when it is not produced by the response it follows. But he is mistaken in his claim that saying a reinforcement is contingent upon a response may mean nothing more than that it follows the response. Reinforcement is never made contingent upon a response. It is always made contingent upon some property of a response. And reinforcement is contingent upon a property of a response if it follows that response *just because* that response possesses that property. Of course, reinforcement may follow a response without being contingent upon any of its properties. Indeed, it is a situation of just this sort that Skinner proceeds to discuss.

Skinner says that operant conditioning takes place even when the response that is followed by reinforcement does not produce the reinforcement.

Whenever we present a state of affairs which is known to be reinforcing at a given drive, we must suppose that conditioning takes place, even though we have paid no attention to the behavior of the organism in making the presentation.

... If a clock is ... arranged to present the food hopper at regular intervals *with no reference whatsoever to the bird's behavior*, operant conditioning usually takes place.

... The conditioning process is usually obvious. The bird happens to be executing some response as the hopper appears; as a result it tends to repeat this response [Skinner, 1948, p. 168].

The bird behaves as if there were a causal relation between its behavior and the presentation of food, although such a relation is lacking [Skinner, 1948, p. 171].

Skinner says that when a bird's response is followed by reinforcement, the bird "tends to repeat this response". Evidently, he means that when a bird's response is followed by reinforcement, the bird tends to make more responses belonging to the same operant. Indeed Skinner characterizes the results of his experiments by saying that "operant conditioning" takes place.

It is important to emphasize here that the operants that are being strengthened are not defined by properties upon which reinforcement is contingent. The responses belonging to these operants do not produce reinforcement. Each of these operants is simply a class of responses that possess the same property.

Skinner's account of transfer of learning also supposes that operants may be defined by properties other than those upon which reinforcement is contingent. At one point, when introducing a discussion of transfer, Skinner writes: "In reinforcing one operant we often produce a noticeable increase in the strength of another [Skinner, 1953, p. 94]." He then proceeds to argue that there is nothing problematical about transfer if one selects proper units for the analysis of behavior.

What is the "transfer" which appears to strengthen behavior without reinforcing it directly? This is a good example of a pseudo problem. We divide behavior into hard and fast units and are then surprised to find that the organism disregards the boundaries we have set. It is difficult to conceive of two responses which do not have something in common. Sometimes the same muscular system is used. The effect of a reinforcement may reflect this fact rather than our arbitrary practice of calling the responses separate units.

... The traditional explanation of transfer asserts that the second response is strengthened only insofar as the responses "possess identical elements." This is an effort to maintain the notion of a unit of response. A more useful way of putting it is to say that the *elements* are strengthened wherever they occur. This leads us to identify the element rather than the response as the unit of behavior. It is a sort of behavioral atom, which may never appear by itself upon any single occasion but is the essential ingredient or component of all observed instances. The reinforcement of a response increases the probability of all responses containing the same elements [Skinner, 1953, p. 94].

Skinner's terminology here is confusing. He seems not to be clear about whether elements are operants or whether elements are properties of responses that define operants. Evidently taking elements to be operants, he says that elements are strengthened and that the element rather than the response is the unit of behavior. And evidently taking elements to be properties, he says that reinforcement of a response increases the probability of all responses containing the same elements. When one reads 'operants' for 'elements' in appropriate places and 'properties' for 'elements' in other places, Skinner's point becomes clearer: the reinforcement of a response increases the probability of all responses possessing the same properties as those possessed by the reinforced response.

Skinner's point is still not clear enough, however. Does he mean that reinforcement of a response increases the probability of all re-

sponses possessing *all* of the same properties possessed by the reinforced response? Probably not, because then he would not be talking about transfer. So he must mean that reinforcement of a response increases the probability of all responses possessing *some* of the same properties possessed by the reinforced response. But now another question arises: does reinforcement of a response increase the probability of all responses possessing *any* property possessed by the reinforced response?

One might be tempted to answer that reinforcement increases the probability of just those responses possessing the property upon which reinforcement is contingent. But those responses belong to the same operant as the reinforced response. Thus, one would not be talking about transfer. Remember that when introducing his discussion of transfer Skinner says, "In reinforcing one operant we often produce a noticeable increase in the strength of another." These other operants that are strengthened obviously cannot be defined by the unique property upon which reinforcement is contingent. They are, therefore, operants defined by properties other than that upon which reinforcement is contingent.

In summary, Skinner's view seems to be that reinforcement of a response often strengthens multiple operants to which the response belongs, even though not all of those operants are defined by the property upon which reinforcement is contingent. Whether reinforcement strengthens *all* operants to which the reinforced response belongs is another question that will not detain us here.

From Skinner's discussions of extinction, superstitution, and transfer, one can conclude that Skinner is counting as operants classes whose member responses do not produce reinforcement. Thus, it is not in general the case that operants are defined by properties upon which reinforcement is contingent.⁴

Contingencies of reinforcement do not on any occasion single out and selectively strengthen just those operants whose members actually produce reinforcement. Reinforcement strengthens many operants to which the reinforced response belongs. Nevertheless, over a period of time in which the contingencies of reinforcement remain unchanged, those operants whose members actually are effective in producing reinforcement are bound to be strengthened most often, because they will be

strengthened when any operant is.

Consider the following example: a rat presses a lever with its right front foot exerting a pressure of 32 g on the lever. That response belongs to numerous operants, including among others (1) moving a leg, (2) moving the right front leg, (3) pressing a lever with the right front foot, (4) pressing a lever exerting a pressure of at least 30 g, and, (5) pressing a lever exerting a pressure of at least 20 g. Suppose now that the rat is presented with a reinforcer just because it has pressed the lever exerting a pressure of at least 20 g. (For the sake of simplicity, we will imagine that responses are reinforced on a continuous schedule.) Operant (5) is strengthened. But so are operants (1), (2), (3), (4) and certain others.

If, on another occasion, but under the same experimental conditions, the rat presses the lever with its nose exerting a pressure of 22 g, it will again be presented with a reinforcer. Operant (5) and certain others will be strengthened, but not operants (1), (2), (3), or (4). Moreover, as long as the experimental conditions remain unchanged, every reinforcement will strengthen operant (5), because reinforcement will not occur unless a response belonging to operant (5) has occurred. No such guarantees can be given for other operants, however, because reinforcement does not require the occurrence of responses belonging to them.⁵

In this experimental situation, the strength of operant (5) will be increased most often, and operant (5) may therefore come to command the exclusive attention of the experimenter. Typically, reinforced responses would be recorded only as members of operant (5). Probably this narrowing of attention is encouraged

⁴It is perhaps important to note that operants defined by properties upon which reinforcement is contingent are affected by the introduction of intermittent schedules of reinforcement. On a fixed-ratio 10 schedule of reinforcement, for example, only the tenth response after the last reinforcement possesses the property upon which reinforcement is contingent. (To be sure, that property is a complex property, only one part of which is the property of being the tenth response after the last reinforcement.) Thus, if all of the responses in each successive 10 belong to the same operant, that operant cannot be defined by the property upon which reinforcement is contingent.

⁵Actually, operant (6), pressing a lever exerting a pressure of at least 10 g, will be strengthened whenever operant (5) is. But whereas members of operant (5) cannot occur without bringing reinforcement, members of operant (6) can.

by the fact that only responses belonging to operant (5) actually produce reinforcement. But it is important to recognize that other operants are undergoing changes in strength also. All responses that belong to operant (5) also belong to other operants. Every time a response in operant (5) is reinforced, the same response in certain other operants is reinforced. Operant (5) is properly thought to be of prime importance, but it is not the only operant whose history should be recorded. Unless one keeps account of other operants, one will miss the phenomena of superstition and, as a result, lose much of one's ability to predict transfer of learning.

Skinner's definition of an operant as a class of responses that possess the property upon which reinforcement is contingent is not broad enough to cover the units he talks about in discussing extinction, superstition, and transfer. His accounts of extinction, superstition, and transfer suppose that an operant is a class of responses that possess the same property. But if operants are not always defined by properties upon which reinforcement is contingent, then how should we interpret Skinner's explicit definition of operants? Perhaps we should take his definition not as a definition at all but as a characterization of the operants which, in contingencies operating over a period of time, are most often changed in strength. Skinner has given a sufficient condition for being an operant. But that condition is not a necessary condition. Operants need not be classes whose member responses possess properties upon which reinforcement is contingent.

Because every response belongs to many operants at once and because reinforcing a response strengthens many of the operants to which that response belongs, it is incorrect to say that reinforcement of a response increases the strength of *the* operant to which it belongs. One must say instead that reinforcement of a response strengthens certain of the operants to which the response belongs. And one must say which operants are strengthened, though, of course, not exhaustively.

If, with certain exceptions, every property or combination of properties of a response defines an operant, then operants can be defined before one has found any dynamic laws of behavior. Given that operants are Skinner's units of behavior, how should one interpret Skin-

ner's claim that units of behavior should emerge from dynamic laws of behavior? It seems that his statement is not best interpreted as being about the definition of units of behavior. Instead, it seems to say how one can tell in any instance whether one has picked the right operants to sum up one's observations. The right operants are simply those for which dynamic laws can be found.

III.

Responses are movements. Operants are classes of responses. Thus, operants are classes of movements.

Response properties of different kinds are used to define operants. What property an operant is defined by is simply a question of what response property the definition of that operant talks about.

Some definitions of operants talk about effects of responses. That is, some definitions of operants admit responses to operants or do not depending upon the effects of those responses. What such definitions yield are operants defined by effects. Some definitions of operants talk instead about forms of responses. That is, some definitions of operants admit responses or do not depending upon the forms of those responses. What such definitions yield are operants defined by forms. Some operants are defined jointly by effects and forms of responses. Whether an operant is defined by effects, by forms, or by both is simply a question of the nature of the definition that specifies the composition of that operant.

In order to tell whether a response has a particular form, one must have some device, human or otherwise, that can detect the response's form. Because such a device somehow registers effects of responses of a particular form, could one not convert a definition of an operant by the forms of its member responses into a definition of an operant by the effects of its member responses?

There is no simple answer to this question. One can replace a definition in terms of form by a definition in terms of effect. But no two such definitions will ever be strictly equivalent. This is so because responses of the same form can be detected by different devices.

If one gives up the claim of equivalence, one can replace definitions in terms of form by definitions in terms of effect. All one must do

is to specify what effect must be produced in what device.

Building a device to detect the forms of responses is not easy, however. In the face of this difficulty, one is likely to settle for an experimenter who waits and watches and records the occurrence of responses of particular forms.

This program seems simple enough, and yet it is deceptive in its seeming simplicity. We said earlier that one must specify what effect must be produced in what device. But we have not really done that yet. In particular, we have not completely specified the experimenter. What constitutes an experimenter? Not just anybody will do. He must know what to look for. That is, he must know the definition of the class of responses whose occurrence he is to record. And that definition is a definition in terms of form. If we had a complete knowledge of human machinery, we could specify the human device without appealing to knowledge of a definition. But we do not. So talking about effects in human observers does not allow one to dispense with definitions of operants in terms of form.

We have seen that the response property that defines an operant may be an effect of a response or the form of a response. These are not, however, the only properties of responses. A response's occurring in the presence of a particular stimulus may be counted as a property of that response and may be used to define an operant.

Properties of occurring in the presence of particular stimuli are never used alone to define operants. They are always used in conjunction with other properties. Thus, for example, one might define an operant by the complex property of depressing a lever when a light is on.

Operants that are defined in part by discriminative stimuli are called 'discriminated operants'. Skinner introduced the term in 1937 in the same paper in which he first talked about operants (Skinner, 1937, p. 275). But the notion that responses occurring in the presence of different stimuli could be considered responses of different kinds had already been advanced by Skinner:

... to speak of a response to a lever is a rather severe though necessary simplification. We are actually concerned with an indefinite number of responses, corresponding to the number of possible ways in which the stimulating energies may affect the organism [Skinner, 1932, p. 282].

Skinner has come to place greater and greater emphasis upon discriminated operants, just as he has come to emphasize three-term contingencies of reinforcement more and more. In fact, the growing importance of discriminated operants in Skinner's system has become reflected in Skinner's terminology. He no longer says simply that an operant is a class of responses that possess a property upon which reinforcement is contingent. Now he says that an operant is a class of responses that possess a property which satisfies a three-term contingency of reinforcement. According to Skinner,

... a three-term contingency of reinforcement ... may be stated in this way: in the presence of a given stimulus, a given response is characteristically followed by a given reinforcement [Skinner, 1957, p. 31].

What he means is that in the presence of a stimulus of a given kind, a response of a given kind is characteristically followed by a reinforcement of a given kind.

Skinner often says that operants are defined by contingencies of reinforcement. For example, in *Contingencies of Reinforcement*, he writes: "a set of contingencies defines an operant [Skinner, 1969, p. 131]." "And in *Operant Behavior*", he speaks twice of "the contingencies of reinforcement which define operant behavior [Skinner, 1963b, p. 514 and p. 515]." It is important to recognize, however, that Skinner is speaking elliptically. What he means, as he himself explains, is that operants are defined by properties that satisfy contingencies. Thus, it is only in a derivative sense that contingencies define operants.

The properties of an operant response are specified by the contingency of reinforcement in the sense that only responses having certain properties achieve reinforcement [Skinner, 1957, p. 209].

It is always a response upon which a given reinforcement is contingent, but it is contingent upon properties which define membership in an operant. Thus a set of contingencies defines an operant.

Contingencies cannot always be detected upon a given occasion. Although a response is reinforced, we cannot be sure what property satisfied the contingencies and hence defines the operant [Skinner, 1969, p. 131].

The defining properties of both species and operants are practical; they are the characteristics (of individual organisms or responses) which are important in their respective contingencies [Skinner, 1969, p. 132].

Operants, then, are defined by contingencies of reinforcement in the sense that they are defined by properties that uniquely satisfy contingencies of reinforcement.

Operants can be defined by response properties of several different kinds: properties of having certain effects, properties of having certain forms, and properties of occurring in the presence of certain stimuli. In fact, operants can be defined by any property upon which reinforcement can be made contingent. Moreover, operants must be defined only by properties upon which reinforcement can be made contingent.

Skinner's mands are defined in part by properties of being characteristically reinforced by characteristic reinforcers.

It will be convenient to have a name for the type of verbal operant in which a response of given form is characteristically followed by a given consequence in a verbal community.

... A "mand," then, may be defined as a verbal operant in which the response is reinforced by a characteristic consequence and is therefore under the functional control of relevant conditions of deprivation or aversive stimulation [Skinner, 1957, pp. 35-36].

A mand is characterized by the unique relationship between the form of the response and the reinforcement characteristically received in a given verbal community [Skinner, 1957, p. 36].

But Skinner's mands are ill-defined because each is defined in part by a property upon which reinforcement cannot be made contingent.

Imagine yourself as society's agent: you are to reinforce mand responses when they occur. Of course, before you can reinforce mand responses, you must identify them. In order to learn how to identify mand responses, you look up the definition of a mand, and you find that a mand is a class of responses followed by reinforcements of a characteristic sort. But now you are puzzled, because you cannot tell whether a response is a mand response until it has been reinforced, and you cannot reinforce that response until you know that it is a mand response. The trouble is, of course, that a response's being reinforced is not a property of that response upon which reinforcement can be made contingent.

Perhaps Skinner's slip came in confusing ordinary effects with reinforcing effects. As Skinner was well aware, operants can be defined by the effects of responses. But what he may

have forgotten in defining mands was that those effects of responses must be effects upon which reinforcement can be made contingent.

The fact that mands are defined in part by properties upon which reinforcement can be made contingent in no way affects the present argument. The present argument assumes only that mands are defined in part in terms of the reinforcement of their members. And the conclusion that mands are ill-defined rests on that premise alone.⁶

If an operant is to be defined by a given property, then all of the members of that operant must have that property. This is a basic fact about the definition of classes. But it can be overlooked. Skinner's operants which are defined in part by properties of being reinforced in certain ways are ill-defined on this score too. Recognizing, as he does, that not all mand responses are reinforced, Skinner says that the mand is a type of verbal operant "in which a response of a given form is characteristically followed by a given consequence" [Skinner, 1957, p. 35]. But even if mand responses were characteristically reinforced, which is doubtful, that would not be good enough. If an operant is to be defined by a given property, then all of the members of that operant must have that property. It is not sufficient that some or even most of the members have that property.

It can be argued that Skinner's definition of mands does not do justice to his intent, which is to classify responses by the functional relations into which they enter. Because no response occurs as a function of its own reinforcement, Skinner may have meant to define mands so that a mand is a response class composed of verbal responses that are functionally related to the reinforcement of earlier verbal responses belonging to the same mand. This definition will not do, however, because it is circular.

⁶It might seem to some that mands are defined in part in terms of conditions of deprivation or aversive stimulation. Mention of such conditions is made in the first quotation given above. A careful reading of that passage shows, however, that the talk of such conditions is not a part of the definition itself. In the second quotation, there is no mention of these conditions. Of course, as we have just argued, even if mands were defined in part in terms of conditions of deprivation or aversive stimulation, mands would still be ill-defined, unless talk of reinforcement were omitted.

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