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Positive and Negative Reinforcement: Should the Distinction Be Preserved?

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Michael (1975) reviewed efforts to classify reinforcing events in terms of whether stimuli are added (positive reinforcement) or removed (negative reinforcement). He concluded that distinctions in these terms are confusing and ambiguous. Of necessity, adding a stimulus requires its previous absence and removing a stimulus its previous presence. Moreover, there is no good basis, either behavioral or physiological, that indicates the involvement of distinctly different processes, and on these grounds he proposed that the distinction be abandoned. Despite the cogency of Michael's analysis, the distinction between positive and negative reinforcement is still being taught. In this paper, we reconsider the issue from the perspective of 30 years. However, we could not find new evidence in contemporary research and theory that allows reliable classification of an event as a positive rather than a negative reinforcer. We conclude by reiterating Michael's admonitions about the conceptual confusion created by such a distinction.

Key words: classification of reinforcers, positive reinforcement, negative reinforcement, stimulus onset, stimulus offset

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According to Thorndike's (1911) law of effect, responses that lead to favorable consequences increase in frequency (in current terminology, they are reinforced) and those that have neutral consequences or lead to unfavorable ones become less frequent. These relations have come to play an essential role in our understanding of operant behavior. Reinforcement not only defines what is or is not an operant response but also provides an account of the acquisition of adaptive responses and the extinction of maladaptive ones. Skinner (1976, 1981), and others before him, elevated the reinforcement principle to the level of Darwin's principle of natural selection. These two selective processes—evolution and reinforcement—permit organisms to cope with environmental stresses and organismic needs. Evolution selects adaptive forms within entire species. Reinforcement selects adaptive responses within each individual's lifetime.

The observation that a wide range of environmental events can strengthen responding has fueled efforts to classify reinforcers into a manageable number of categories. The prevailing approach for the past 50 or more years differentiates two types: positive and negative (Keller & Schoenfeld, 1950). In the case of positive reinforcers, strengthening effects are attributed to the stimuli whose presentation is contingent on responding (as when a hungry rat's lever press produces a food pellet). In the case of negative reinforcers, reinforcement is dependent on the removal of stimuli (as when the lever press terminates a painful electrical shock).

This distinction between presentation and removal is a central feature of most discussions of operant condition-

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ing. Presentation and removal also have come to define different areas of research. On the one hand is a set of phenomena and issues whose study most often involves positive reinforcement. Within the animal laboratory, investigations of schedules, choice, and stimulus control usually present food as the reinforcer. By comparison, investigations of the aversive control of behavior most often involve negative reinforcers. The subject is able to terminate intense stimuli (usually shocks), or, in the case of avoidance, escape from situations in which such events can occur.

Occasionally, writers have commented on similarities rather than differences between the two forms of reinforcement (e.g., Baron, 1991; Hineline, 1984), for example, the parallel effects of postponing the stimulus change. Also, a few researchers have sought paradigms that might bridge the gap, such as procedures in which responding produces a period of time-out from avoidance (Perone & Galizio, 1987; Verhave, 1962) or avoids a period of time-out from positive reinforcement (Baron & Kaufman, 1966; Stone, 1961). Nevertheless, treatments of operant conditioning continue to place behavior maintained by positive and negative reinforcers under separate headings (e.g., Catania, 1998; Iversen & Lattal, 1991; Mazur, 2002; Pierce & Cheney, 2004).

The purpose of this article is to review the current status of these two forms of reinforcement. In particular, we reconsider Michael's (1975) call to abandon the distinction. Although Michael's views have not been refuted to our knowledge, there are few signs that his recommendations are being heeded.

Traditional Bases for the Distinction

Traditional treatments sharpened the distinction between positive and negative reinforcement by introducing motivational variables (e.g., Hilgard & Marquis, 1940; Mowrer, 1960; Thorndike, 1911). In reward training (an earlier label for positive reinforcement), the response not only produces a stimulus but produces a stimulus that evokes pleasure or satisfaction. By comparison, escape-avoidance training (negative reinforcement) involves arrangements in which the response reduces pain, anxiety, or some other forms of discomfort or distress.

From the start, behavior-analytic discussions of the reinforcement process shied away from such interpretations of reinforcement on the grounds that they assign causal status to events that are ill defined and not easily observable (Skinner, 1938). The more desirable alternative is to couch the distinction strictly in terms of the stimulus change that follows the response (Keller & Schoenfeld, 1950). Thus, in his authoritative glossary of behavior-analytic terms, Catania (1998) provides the reader with this current definition: "A stimulus is a positive reinforcer if its presentation increases the likelihood of responses that produce it, or a negative reinforcer if its removal increases the likelihood of responses that terminate or postpone it" (p. 405). As we will see, a definition in these terms, although avoiding the pitfalls of motivational interpretations, has some problems of its own.

Michael's Objection

What might be regarded as a watershed in behavior-analytic discussions of positive and negative reinforcement was Michael's (1975) article, to which he gave the provocative title, "Positive and Negative Reinforcement, a Distinction That Is No Longer Necessary; or a Better Way to Talk about Bad Things." His discussion forcefully brought the ambiguity of the distinction to the attention of behavior analysts. The matter was not, however, completely new; definitional problems had previously been considered by both behavior-analytic and more motivationally oriented writers (e.g., Catania, 1973; D'Amato, 1969; Mowrer, 1960).

Michael (1975) identified two issues, the first of which pertained to a longstanding confusion about the difference between negative reinforcement and punishment. He observed that the term *negative reinforcement* had been used by a number of writers (including Skinner himself in *The Behavior of Organisms,* 1938) not only to refer to stimulus termination but also to punishment, that is, consequences that suppress responding. Happily, this ambiguity has been laid to rest in that current usage reserves the term punishment for suppressive operations. However, a link between reinforcement and punishment remains, in that it has become customary to use the presentation–removal difference developed originally for reinforcement to also distinguish between two types of punishment (e.g., Catania, 1998; Mazur, 2002). Thus, responding can be suppressed not only by delivery of a shock (positive punishment) but also by withdrawal of food (negative punishment).

Michael's (1975) second issue is the one that concerns us here. His point was that the reinforcing functions of an event, either its presentation or its removal, hinge on the context in which the event occurs. The response-contingent presentation of a stimulus requires, of necessity, that the response terminate a previous period when the stimulus was absent. By the same token, the response-contingent termination of a stimulus cannot be accomplished unless the response has been preceded by a period when the stimulus was present. The argument, then, is that positive and negative reinforcement are *changes* from one stimulus condition to another, not the simple presentation or removal of a stimulus. Without this essential clarification, the claim that a reinforcer is exclusively positive or negative always can be challenged by the assertion that the alternative form is the true basis for the reinforcing effect.

The conundrum for those who want to stick to the presentation–removal distinction is well illustrated by an experiment cited by Catania (1998). Weiss and Laties (1961) observed that rats kept in a cold chamber would press a lever that turned on a heat lamp. This outcome can be regarded as the product of positive reinforcement because the lamp's onset adds heat to the environment. But the behavior also reduces the extent to which the environment is cold and thus can be regarded as an instance of negative reinforcement. Similar questions can be raised about any reinforcement procedure. Although food is usually regarded as a positive reinforcer, its presentation also serves to reduce a state of deprivation (negative reinforcement). Similarly, the negatively reinforcing properties of escape from shock can be attributed to the onset of the stimuli correlated with safety (positive reinforcement). Moreover, the problem is by no means confined to unconditioned forms of reinforcement. Delivery of money contingent on some behavior has the consequence of ending a moneyless period, and escape from conditioned aversive stimuli produces situations in which the stimuli are absent.

Faced with these ambiguities, Michael (1975) concluded that there is no good basis for continuing to describe reinforcers as positive or negative. In his view, communication is not impeded if the focus is on the stimulus changes that strengthen behavior rather than on the onset or the offset of stimuli. If a distinction is to be made, it should be between processes of reinforcement and processes of punishment, that is, between environmental changes that strengthen and environmental changes that suppress.

Michael's Analysis

By most standards, Michael's (1975) analysis is quite cogent. Nevertheless, even a cursory survey of textbooks indicates that the positive–negative distinction continues to be taught to psychology students, and this might suggest that Michael's views have been discredited. Perhaps new research find-

ings or new theories have bolstered the distinction he believed should be abandoned. Or, perhaps, the original reasons for abandoning the distinction were faulty. Instead, Michael's classic article is not always cited in textbooks, even those that address operant conditioning in detail. When his views have been given some attention (e.g., Catania, 1998; Pear, 2001; Pierce & Cheney, 2004), the message is somewhat mixed. Although the validity of his argument may be acknowledged, the distinction that he argued against continues to be used as a way of classifying both different operant procedures and different research areas.

Given the persistence of this peculiar state of affairs, it seems worthwhile to reconsider Michael's discussion in the light of developments since his article was published. He considered and rejected three possible justifications for the distinction.

1. The strengthening effects of positive and negative reinforcers may differ in such regards as their temporal properties, their relation to other independent variables, or their role in the development of discriminations.

Michael (1975) could not find a good basis for such a conclusion. Although the environmental changes that function as reinforcers have unique properties, "these properties seem just as relevant to the distinctions among the various kinds of positive reinforcements as between positive and negative reinforcement" (p. 41). Consistent with this interpretation, our review of the literature on aversive control (Baron, 1991) led us to conclude (as had Hineline, 1984) that similarities between positive and negative reinforcement effects are more apparent than differences. Most notably, the well-known parameters of positive reinforcement (the magnitude, delay, and schedule of stimulus presentations) have similar influences on responses maintained by negative reinforcement.

A possible difference, one not mentioned by Michael (1975), pertains to the rapidity of the strengthening effects. This feature of reinforcement was discussed by Weiss and Laties (1961) in their study of heat reinforcement (or, if you like, cold termination). They commented that heat reinforcement appeared to produce more reliable effects than reinforcers that require eating or drinking, and they attributed the difference to the "long chain of processes that intervene between behavior and the ultimate effect" of eating and drinking. By comparison, the effect of heat "is practically instantaneous" (Weiss & Laties, 1961, p. 1344).

Perhaps the case can be made that stimulus change usually is more abrupt for negative than for positive reinforcement (cf. termination and food consumption). But even assuming that negative contingencies produce more reliable conditioning (we do not know of experiments that have demonstrated this), this does not mean that the difference is fundamental. A feature of stimulus change is that rates of onset and offset can vary, thus introducing differing degrees of delay before the event is fully present or fully absent. Although such time-dependent differences play an important role in operant conditioning, they are better viewed as a parameter of reinforcement (delay of reinforcement) than as a difference in the reinforcement process itself. For example, if Weiss and Laties's (1961) procedure had entailed a slow onset of the heat lamp, we would expect that conditioning would be retarded by comparison with food- and water-delivery procedures. Or consider the reinforcing functions of drugs: The reinforcing effect of a given dose of cocaine varies as a function of the mode of delivery (oral, intravenous, or intranasal) because of differences in speed of onset of drug effects.

2. There are differences in the physiological structures or processes that underlie positive and negative reinforcement.

Michael (1975) concluded that physiological information did not help to clarify the distinction. However, the

many advances in neuroscience since his article warrant a reconsideration of the literature. The literature on the physiological substrates of the reinforcement process is much too broad to survey in this paper. However, we will briefly consider research in the three areas that seem most relevant: pharmacological investigations, research on the neurobiology of reinforcement, and investigations of psychophysiological changes that may accompany reinforcement.

Research from the behavioral pharmacology laboratory has been guided by a search for drugs to counteract syndromes that are triggered by aversive events (tension, anxiety), and negative-reinforcement baselines have been used to model these syndromes. Early experiments within this framework suggested unique links between classes of drugs and type of reinforcement. For example, antipsychotic and anxiolytic drugs appeared to have different effects on shock-avoidance and food-reinforced baselines. However, a key experiment by Kelleher and Morse (1964) indicated otherwise. They administered drugs with opposing pharmacological properties (either amphetamine or chlorpromazine) to monkeys responding on identical schedules of positive and negative reinforcement (stimulus-shock termination vs. food presentation). Their major finding was that drug effects depended considerably more on the response rates controlled by the schedules than on whether the reinforcer was positive or negative. Although subsequent researchers continued to search for relations between drugs and baseline reinforcers, the evidence does not support a pharmacological basis for distinguishing between performances under schedules of positive and negative reinforcement (for reviews, see Barrett & Katz, 1981; Dworkin, Pitts, & Galizio, 1993).

Research on the neurobiology of reward and punishment also has sought physiological distinctions between positive and negative reinforcement. For example, the dopaminergic mesolimbic system of the brain (and in particular the nucleus accumbens) has been linked to the actions of rewarding stimulation (Kiyatkin, 1995; Vaccarino, Schiff, & Glickman, 1989; Wise & Bozarth, 1987), and an amygdala–hypothalamic–central gray system to processes of pain and fear (Davis, Campeau, Kim, & Falls, 1995; Panksepp, Sacks, Crepeau, & Abbot, 1991). However, these neurobiological distinctions do not correspond in straightforward ways to the distinction between positive and negative reinforcement. Research on dopaminergic mesolimbic involvement has largely involved procedures that would be classified as positive reinforcers. For example, the evidence for dopamine release in the nucleus accumbens comes from experiments in which animals responded for such events as food, opportunity for sexual interaction, or stimulant drugs (Kiyatkin, 1995). However, these results cannot be viewed as showing a unique link between dopamine and positive reinforcement. Parallel experiments with avoidance schedules have indicated similar patterns of dopamine release in the nucleus accumbens during shock avoidance (e.g., McCullough, Sokolowski, & Salamone, 1993). To complicate matters, other research has raised doubts about the functional role of dopamine in the nucleus accumbens. Insofar as mesolimbic dopamine is implicated in the neurobiology of reinforcement, the best evidence appears to suggest that it encompasses both forms of reinforcement—negative as well as positive (see Salamone, Correa, Mingote, & Weber, 2003; Salamone, Cousins, & Snyder, 1997, for reviews).

Finally, on a more behavioral level, evidence has not been forthcoming to support Mowrer's (1960) original contention that characteristic emotional processes are evoked by aversive and appetitive stimuli. Behavior analysts have not formed a consensus about the proper way to view the process of emotion (for a recent exchange of views, see Friman, Hayes, & Wilson,

1998; Lamal, 1998). In keeping with our discussion of the physiology of positive and negative reinforcement, we will concentrate on the psychophysiological responses that may accompany the action of reinforcers. Commonly used markers have included changes in heart rate, blood pressure, respiration, and skin conductance.

Despite considerable research over the past 50 years, the literature on the psychophysiology of reinforcement has been inconclusive. A major stumbling block has been the failure to identify specific response patterns that might differentiate between different classes of emotion, for example, the difference between such antithetical states as "fear" and "joy." In addition, the expectation that the psychophysiological changes would vary in orderly ways, that is, increase in magnitude in anticipation of the impending reinforcer and diminish following the reinforced operant response, has not been consistently borne out. Also problematic is the observation that stimuli may sometimes serve as effective reinforcers in the absence of observable affective responses.

The phenomenon of shock-maintained responding raises additional questions about the role of emotion in positive and negative reinforcement (Morse & Kelleher, 1977; for a recent review, see Pear, 2001). Painful electric shocks usually serve the role of aversive stimuli: as negative reinforcers through their offset or as punishers through their onset. However, under some circumstances the onset of response-contingent shocks has been found to have the opposite effect of maintaining responding (i.e., the shocks function as positive reinforcers). As noted by Pear and others, caution is in order in viewing this paradoxical outcome. The phenomenon appears to have limited cross-species generality (most of the research has been with squirrel monkeys); it appears most often in connection with fixed-interval schedules of response-produced shocks (results with ratio schedules are inconsistent); and it requires prior training with conventional schedules of reinforcement (a common procedure is to replace the shocks in a shock-avoidance schedule with a fixed-interval shock schedule). Moreover, the case can be made that, despite appearances to the contrary, the shocks actually function as punishers. According to this view, responding is maintained because fixed-interval shocks suppress long interresponse times (Galbicka & Platt, 1984). Also plausible is that the shocks possess a discriminative function: As a consequence of the animal's history of avoidance training, the fixed-interval shocks serve as cues for continued responding (Laurence, Hineline, & Bersh, 1994). Information about psychophysiological reactions under schedules of shock-maintained behavior might help to clarify matters, but to our knowledge such data have not been reported.

In brief, then, hopes that definitions of positive and negative reinforcement might be enhanced by references to neurobiological or psychophysiological processes have not been fulfilled. Perhaps this is not surprising insofar as stimulus functions depend in critical ways on historical and contextual variables as well as on physical features of stimuli (e.g., intensity, quality). Whether future technological advances (e.g., more sensitive recording equipment, identification of more appropriate response patterns) will allow fruitful research on this question remains to be seen. Some lines that are being pursued with both animal models and humans include variations in the startle response (Davis & Astrachan, 1978; Dawson, Schell, & Boehmelt, 1999), brain activity (Bjork et al., 2004; Small, Zatorre, Dagher, Evans, & Jones-Gotman, 2001), electromyographic activity of facial muscles (Lundqvist, 1995; Ritz, Dahme, & Claussen, 1999), and ultrasonic vocalizations in rats (Knutson, Burgdorf, & Panksepp, 2002).

3. By maintaining the distinction, we can more effectively warn applied be-

havior analysts about the undesirable aspects of negative reinforcement.

Michael (1975) rejected this argument on three grounds: First, he pointed out that if the distinction is difficult to make, then it also must be the case that such advice cannot easily be heeded. Second, he observed that it is an empirical question whether negative reinforcement procedures indeed are undesirable. Last, he questioned the wisdom of maintaining "a distinction at the level of basic science because of its possible social implications" (p. 42).

We see no basis for disagreeing with Michael's evaluation. No doubt, procedures that use negative reinforcement as a method of applied behavior analysis continue to be frowned at, and some have argued that use of such terms as *reinforcement* and *punishment* should be abandoned in the interests of gaining broader acceptance of behavior-analytic approaches (e.g., Brown & Hendy, 2001). Nevertheless, the question of whether an applied procedure is undesirable cannot be given a general answer without specifying the problem behaviors addressed by the procedures. When painful stimuli are used as a means of behavior modification, undesirable side effects may be outweighed by the severity of the disorder under treatment. In addition, it is not difficult to point to undesirable aspects of procedures that are often considered to involve positive reinforcement, as when deprivation is needed as an establishing operation or when the reinforcing potency of an activity distracts the individual from more worthwhile pursuits (Perone, 2003).

Since Michael's (1975) article, some applied behavior analysts have come to emphasize the positive-negative distinction in their analyses of problem behaviors. Iwata et al. (1994) studied self-injurious behavior from this standpoint, and their results suggested that individuals differed in the extent to which their behavior was maintained by one or the other forms of reinforcement. Thus, their study distinguished between instances when self-injurious behavior was maintained by escape from task demands (negative reinforcement) and instances when such behavior was maintained by the attention of others or by access to food or other materials (positive reinforcement). Although these findings may support a useful classification of the events that maintain problem behavior, they do not address the definitional ambiguity identified by Michael. Is it better to speak of the consequence as increased attention or as relief from loneliness? As escape from an aversive task or as access to an alternative activity? Either description appears to be appropriate.

The same dilemma has appeared in the drug abuse literature. Some writers have proposed that drug use by novices is maintained by positive contingencies, but that as use becomes more chronic, control transfers to negative ones (termination of withdrawal distress). On these grounds, negative rather than positive reinforcement is taken to be the more critical factor underlying drug dependence (Crowley, 1972; Farber, Khavari, & Douglass, 1980). Although this analysis may capture important features of addiction, it illustrates once again our definitional problem. No doubt, a host of changes can occur with habitual drug use, including diminished effects of the drug due to tolerance and the occurrence of various withdrawal symptoms that are terminated by drug delivery. However, at all stages in a history of drug use, administration of the drug creates a change from a drugless state to one in which the drug is active. As with reinforcers in general, the behavioral functions of either state cannot be evaluated without reference to the alternate state that is contingent on responding.

In summary, the three reasons considered (and rejected) by Michael (1975) for preserving the positive–negative distinction seem no more convincing now than they did to him some 30 years ago. However, Michael's article did not exhaust possible reasons.

In the following sections, we consider some additional possibilities.

The Role of Competing Responses

A distinction originally proposed by Catania (1973; see also Catania, 1998) and subsequently by Hineline (1984) and Pierce and Cheney (2004) pertains to the temporal relation between the operant response and the stimulus change. At the time of responding, the stimulus is absent in the case of positive reinforcement but present for negative reinforcement. This temporal difference can have a bearing on the extent to which stimulus-evoked responses can compete with the particular response chosen by the researcher for study.

Consider the behavioral interactions when lever pressing is positively reinforced with food. Delivery of the reinforcer brings the operant response to a halt: The rat leaves the lever, approaches the food cup, and eats the food. Because the contingencies are arranged so that the responses of lever pressing and eating occur at different times, competition between these response systems is minimized except, perhaps, at the point of transition from one to the other. By comparison, lever pressing that is negatively reinforced by removal of shock occurs in the presence of the shock. Moreover, the shock stimulus evokes a variety of characteristic responses (e.g., crouching, jumping, or running) that can interfere with the response chosen by the researcher (lever pressing is especially susceptible to such interference). However, once the operant response has been executed and the aversive stimuli terminated, the competition is more or less ended: The operant response has gained the reinforcer and the stimulus for shock-evoked responding has been removed.

Catania (1998) used the presence or absence of competing responses to decide whether lever pressing in the Weiss and Laties (1961) experiment was positively or negatively reinforced. The report indicated that the rats engaged in behaviors antithetical to lever pressing when first placed in the cold chamber: they huddled and shivered. Although these responses served the function of conserving heat, they also interfered with the heat-producing lever-press response. When a response did occur, heat from the lamp momentarily raised the animal's skin temperature and the interfering responses subsided. According to this analysis, the pattern of interfering behavior defines the reinforcer as negative. In other words, responding was reinforced by termination of cold rather than by onset of warmth.

This analysis can be extended to avoidance paradigms in which the aversive event is absent at the time of responding. Although the avoidance response is temporally separated from the primary aversive event (e.g., shock), the response occurs in the presence of stimuli correlated with shock. As with escape behavior, the development of efficient avoidance behavior may be hindered by the appearance of responses that are similar to those evoked by shock.

Although compelling in some respects, a distinction based on response competition falls short. Consider, again, food reinforcement. Although it is the case that the operant response occurs in the absence of responses evoked by the food stimulus itself, this does not preclude the possibility of competing responses generated by the establishing conditions for the reinforcer. A rat working for food also is food deprived, and deprivation (more precisely, the stimuli accompanying deprivation) may evoke behaviors that are incompatible with the lever-press response (e.g., grooming, inspecting the food cup), thus arguing for a process of negative rather than positive reinforcement. Moreover, we can point to everyday examples in which avoidance behavior appears to occur in the absence of disruptive or interfering responses (e.g., we may fill up the gas tank before we run out of gas, and set the alarm clock the night before). Ca-

tania (1998) acknowledged this ambiguity, and his last word was that "reinforcement always involves changes in the organism's situation and inevitably leads to differences in responding before and after the change" (p. 101).

Feelings of Reinforcement

A different approach to reinforcement focuses on what Skinner (1976) referred to as "the feelings of reinforcement." Skinner observed that "feelings have dominated the discussion of rewards and punishment for centuries" (p. 53), and he did not question that different forms of reinforcement may evoke distinctively different feelings. By "feelings," Skinner was referring to private events that are revealed by "asking the subject how he 'feels' about certain events" (1953, p. 82). Indeed, surveys have been developed with the objective of identifying the relative strength of different reinforcing events and activities. Cautela's (1972) reinforcement survey schedule asks respondents to rate events in terms of how much "joy or pleasurable feelings" each provides (the survey includes such diverse items as "eating ice cream," "playing basketball," and "dogs"). The resulting information has been used in programs of behavior therapy and research (e.g., Baron, DeWaard, & Galizio, 1981).

Skinner's treatment of the feelings of reinforcement followed his philosophical views about the role of private events in general. He did not take issue with descriptions that include references to feelings—that a person's responses are accompanied by the presentation or removal of events said to be liked or disliked. "But this does not mean that his feelings are causally effective; his answer reports a collateral effect" (1976, p. 53). In these writings and elsewhere (Skinner, 1986), he turned to other mechanisms for a causal account of the origins of reinforcement, in particular, evolutionary processes:

> Salt and sugar are critical requirements, and individuals who were especially likely to be reinforced by them have more effectively learned and remembered where and how to get them and therefore have been more likely to survive and transmit this susceptibility to the species. It has often been pointed out that competition for a mate tends to select the more skillful and powerful members of a species, but it also selects those more susceptible to sexual reinforcement. As a result, the human species, like other species, is powerfully reinforced by sugar, salt, and sexual contact. This is very different from saying that these things reinforce me *because* they taste or feel good. (Skinner, 1976, pp. 52–53)

Skinner's discussion of rewards and punishment provides a clue as to why the conception of two forms of reinforcement has persisted despite the lack of a clear operational basis for determining which is which. Perhaps the feelings of positive and negative reinforcement are different. Consider the labels given these states. Beginning with Thorndike (1911), positive reinforcers have been described in such terms as *satisfying, pleasing,* and *pleasurable.* Descriptive terms for the feeling of negative reinforcement are more difficult to find, and Thorndike used the term *satisfier* to refer to both positive and negative reinforcement. Mowrer (1960), however, coined the term *relief* to refer to states that accompany the withdrawal of aversive stimuli, and the same sense is conveyed by the dictionary definition: "Relief—an easing as of pain, discomfort, or anxiety" (*Webster's New World Dictionary,* 1994). These commonsense views of the difference between feelings of pleasure and feelings of relief are paralleled by textbook treatments of positive and negative reinforcement in separate sections—one in which the reinforcers involve presentation of such events as food, praise, or money, and one in which the reinforcers are termination of electric shock, loud sounds, or expressions of disapproval.

Paralleling Skinner's (1976) consideration of the place of feelings in the reinforcement process is his discussion of the feelings of accompanying states of motivation (feelings of "conditions of the body"). For both positive and negative reinforcement, these states are

correlated with the establishing operations for the reinforcers rather than by the reinforcer itself. In the case of food reinforcement, for example, the feeling state is evoked by the absence of food (thus, the sequence when responding is reinforced might be described as a transition from distress to pleasure). By comparison, when reinforcement involves termination of shock, the feeling state is evoked by the shock itself (the sequence is distress to relief).

Feelings of reinforcement and motivation may have a place in descriptions of reinforcement. However, they can hardly be relied on to distinguish positive from negative reinforcement (we emphasize that this was Skinner's point also). Not the least of the problems is that the burden of the definition is shifted from environmental events (i.e., the onset and offset of the stimuli) to the organism's responses to these events (the so-called feeling states). Equally apparent is that procedures for identifying these states are obscure. On the human level, we must depend on notoriously unreliable verbal reports, and on the nonhuman level, where most basic research has been conducted, such information simply is not available. And even if we are willing to accept verbal reports at face value, the distinctions are not all that clear cut. The thin line is exemplified by the story of the foolish individual who hits himself on the thumb with a hammer because it feels so good when the pain stops. Indeed, termination of states of pain or anxiety may evoke pleasure-like states (e.g., migraine sufferers report euphoric feelings when their headache is relieved), and termination of mild annoyers also may be felt as pleasurable (as when one scratches an itch) just as interruption of pleasurable states may be reported as aversive (Solomon, 1980; Solomon & Corbit, 1974).

Establishing Operations

Perhaps the conceptual problems created by references to feeling states can be solved by concentrating on the establishing operations and other contextual variables that give rise to feelings. Within such an analysis, the intensity of these variables plays a central role. In the case of food reinforcement, for example, the extent of deprivation intensifies feelings of reinforcement as well as reinforcer effectiveness. In the case of negative reinforcers such as shock, by comparison, the most important sources of reinforcer strength are to be found in the intensity and duration of the stimulus that is terminated.

For some writers, the severity of these operations contributes to whether the reinforcer is regarded as positive or negative. This view is apparent in Sidman's (1989) analysis of coercion, in other words, performances that occur in the face of what are termed *threats* and *duress*. According to Sidman,

> Both positive and negative reinforcers control our behavior, but I do not call positive reinforcement coercion. When we produce things or events that we usually consider useful, informative, or enjoyable for their own sake, we are under the control of positive contingencies. But when we get rid of, diminish, escape, or avoid annoying, harmful, or threatening events, negative reinforcers are in control; with that kind of control, I speak of coercion. (pp. 36–37)

Sidman went on to point to circumstances under which procedures conventionally regarded as positive reinforcement actually involve negative reinforcement because the procedures are coercive:

> Prisoners, first placed in solitary confinement, are then permitted social contacts as reinforcement for docility; first starved, so they can then get food in return for subservience. Freedom and food look like positive reinforcers, but when they are contingent on the cessation of artificially imposed deprivations, their effectiveness is a product of negative reinforcement; they become instruments of coercion. (p. 41)

By this account, the same operation, food delivery or social contact, can be viewed as stimulus presentation or as stimulus removal, depending on the severity of the establishing operation. Extreme deprivation (starvation, isolation) is analogous to an aversive event,

and termination of this state, that is, negative reinforcement, is the defining feature. But the focus changes when responding is under lesser levels of deprivation. Now performances are controlled by the addition of the positively reinforcing stimuli to the subject's environment (in the example, food or social contact).

Sidman's (1989) approach to the difference between positive and negative reinforcement is innovative. However, it appears to be limited because we do not have easy ways of scaling the level of different establishing operations. How can we identify the point at which the operations correlated with normal hunger shade over into starvation or the point at which an annoying shock becomes distinctly painful? Without answers to questions such as these, the problems of ambiguity we noted for the other definitions remain unresolved.

Conclusion

The position laid out by Michael (1975) was that we can preserve the distinction between pleasure and distress—between good and bad things, as he put it—without preserving the ambiguous and sometimes misleading distinction between positive and negative reinforcement. In his view the distinction between consequences that strengthen behavior (reinforcement) and those that weaken behavior (punishment) is quite sufficient to encompass the principles of behavior analysis (see also Morse & Kelleher, 1977). Our review has not provided us with compelling evidence to the contrary, and we are led to the same conclusion reached by Michael.

We noted at the start that a classification of reinforcers (and punishers) into positive and negative provides a way of classifying a range of diverse events into a smaller number of categories. Although we could not find satisfactory support for a classification in terms of different *processes,* perhaps a case can be made for maintaining the distinction on the level of *procedure,* that is, as a useful way of organizing operations that may have reinforcing or punishing effects. Michael's (1975) analysis, together with the amplifications we have offered in this article, indicate otherwise. The essential difficulty, as we have noted throughout, is that the operational specification of which reinforcers are positive and which are negative contains an essential ambiguity.

The dilemma is particularly apparent when one considers textbook treatments of positive and negative reinforcement, most of which make their point by providing "real-life" examples of reinforcers (no doubt to spark the interests of students). Textbooks play a vital role within any scientific endeavor: they represent an important way that the knowledge gained within a field is passed on to the next generation. We did not attempt a complete survey of textbooks currently in use. However, even a cursory survey of those that we found on our shelves and the shelves of our colleagues provides numerous illustrations of the ambiguity identified by Michael.

As a case in point, consider a student confronted with the following two behavior sequences intended to illustrate positive and negative reinforcement: (a) A child turns on the TV to watch a cartoon program; (b) I take an aspirin to relieve my headache. Which is which? Although the first example was intended to illustrate positive reinforcement and the second negative reinforcement, a closer look within the context of Michael's critique quickly reveals the arbitrariness of the distinction. Both instances of operant behavior (turning on the TV, opening the medicine bottle) involve the production of stimuli (the cartoon, the aspirin) as well as consequences that terminate prior events (boredom, a headache). In the former case, the example focuses on the immediate consequence of the response (onset of the cartoon), whereas in the second the focus is on more remote consequences (relief from the

headache). However, there is nothing in the distinction, as originally drawn by Keller and Schoenfeld (1950) and subsequently employed by others, that allows one to be certain which event is critical. We should note that we found instances in which authors acknowledged that either interpretation is possible, which, of course, is true. However, this concession undercuts the purpose of the labels in the first place: to provide a straightforward way of talking about two forms of reinforcement.

In summary, if we are to continue to talk about two kinds of reinforcement, we advise caution in the ways the terms are used. The continued role played by the terms *positive* and *negative* reinforcement in behavior-analytic discussions suggests that the distinction is serving a useful communicative function. The terms make it plain that when we are talking about reinforcers we are referring to environmental events rather than cognitive or physiological happenings. They provide a shorthand way of pointing to the reinforcers that have traditionally been used for the experimental study of different problem areas: positive reinforcement in the case of schedules, choice, and stimulus control (food is presented), and negative reinforcement for escape and avoidance (shock is terminated). Moreover, the distinction is so well embedded within discussions of operant behavior that one cannot navigate the literature without being familiar with it. These considerations may be good enough reason to continue to teach the distinction to our students. Nevertheless, it is apparent that the terms *positive* and *negative* come with considerable conceptual baggage. By remembering the ambiguities inherent within the distinction, we are less likely to use it to justify ethical or practical decisions. At the least, we should recognize that the question of functional differences between positive and negative reinforcement remains controversial.

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