Handbook of Applied Behavior Analysis

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CHAPTER 3

Basic Operant Contingencies

Main Effects and Side Effects

A. Charles Catania

Handbooks are often consulted as resources for information about specific topics, so this chapter is organized as a set of somewhat independent sections. It opens with a discussion of operant contingencies, then considers some aspects of the basic contingencies known as reinforcement and punishment and their positive and negative variants, and closes with some implications of these contingencies and brief surveys of a few related issues. For more detailed treatments see Skinner (1938, 1953, 1999), Iversen and Lattal (cf. 1991a, 1991b), Catania (2006), various volumes of the *Journal of the Experimental Analysis of Behavior* and *The Behavior Analyst*, and two special issues of the *European Journal of Behavior Analysis*, one devoted to contingencies (Arntzen, Brekstad, & Holth, 2006) and the other devoted to noncontingent reinforcement (Arntzen, Brekstad, & Holth, 2004).

Response–Consequence Contingencies

Contingencies relating responses to their consequences are properties of environments. They are probability relations among events. When a response changes the probability of some event, we say that the change is contingent on the response; when the change is from a relatively low probability to a probability of 1.0, we usually say that the response has produced the event. An organism is said to *come into contact with a contingency* when its behavior produces some consequences of the contingency. Unless otherwise stated, for convenience the term *contingency* here implies a response–consequence contingency rather than contingencies more broadly conceived (e.g., stimulus–stimulus contingencies).

When responses produce stimuli, the contingent relation is defined by two conditional probabilities: probability of the stimulus (1) given a response and (2) given no response. Without both probabilities specified, the contingent relations cannot be distinguished from incidental temporal *contiguities* of responses and stimuli that are occurring independently over time.

Response–reinforcer relations involve two terms (the *response* and the *reinforcer*), but when correlated with *discriminative* stimuli (stimuli that set the occasion on which responses have consequences), they produce a *three-term contingency*, which involves antecedents, behavior, and consequences. For

example, a child's touch of a card might be reinforced with an edible if the card is green, but not if it is any other color. In this case, green, as the discriminative stimulus, is the first term; the touch, as the response, is the second term; and the edible, as the reinforcer, is the third term. Antecedents may include establishing conditions as well as discriminative stimuli. For example, the edible might not serve as a reinforcer if the child has very recently eaten.

Conditional discriminations add a fourth term, a fifth, and so on, for other contingency relations of various orders of complexity. For example, if a child is presented with green or red balls or blocks, then the appropriate color name might be reinforced given the question "What color?", whereas the appropriate shape name might be reinforced given the question "What shape?" In this example, the questions are the fourth terms that set the occasion for whether the operative three-term contingency is the one involving color, color name, and reinforcer or that involving shape, shape name, and reinforcer.

When a response for which a contingency operates produces a stimulus, the stimulus is sometimes called a *contingent* stimulus. The term *consequence* may refer to such a stimulus, but stimuli are not the only kinds of consequences. The term encompasses stimulus presentations or removals, changes in contingencies, or any other environmental alterations that follow a response. For example, food produced by a response is both a stimulus and a consequence, but food presented independently of behavior is a stimulus only; shock prevented by a response is a stimulus, but the consequence of the response is the absence of shock, which is not a stimulus; replacing a defective light switch does not turn on the light, but it changes the consequences of operating the switch. The term *consequence* is particularly useful when the status of a stimulus as a possible reinforcer or punisher is unknown. Contingencies can also be arranged based on context, as when responses are reinforced based on their variability (e.g., Neuringer, 2004) or as when, in learned helplessness, organisms exposed to environments in which their responses lack consequences become insensitive to new contingencies (e.g., Maier, Albin, & Testa, 1973).

Contingencies, Establishing Events, and Multiple Causation

An *establishing* or *motivational event* is any environmental circumstance that changes the effectiveness of a stimulus as a reinforcer or punisher. Here are some examples: deprivation; satiation; procedures that establish formerly neutral stimuli as conditional reinforcers or as conditional aversive stimuli; and stimulus presentations that change the reinforcing or punishing status of other stimuli, as when an already available screwdriver becomes a reinforcer in the presence of a screw that needs tightening (Michael, 1982).

A *conditional* or *conditioned reinforcer* is a stimulus that functions as a reinforcer because of its contingent relation to another reinforcer. If a conditional reinforcer is based on several different primary reinforcers, then it will be more effective than one based on a relation only to a single primary reinforcer. Such a reinforcer is called a *generalized reinforcer.* For example, the sound of a clicker may serve as a generalized reinforcer of the behavior of a pet if it has been often followed by food, opportunities for play, and other significant consequences.

With regard to establishing events, whether one is in the light or in the dark, a flashlight usually lights when one turns it on, but turning it on usually matters only when it is dark. Thus, a change from indoor lighting to the darkness of a power outage is an establishing event with regard to whether one is likely to turn on the flashlight. It is not a discriminative stimulus because one could have turned the flashlight on even had there been no power outage.

The consequences change, however, if one's flashlight battery has died. The flashlight no longer works. Thus, the dying of the battery is not an establishing event but instead determines whether trying to turn on the flashlight will be reinforced by light. Now finding a fresh battery is important. Once one finds a battery to replace the dead battery, one's flashlight becomes functional again. In other words, the battery going dead had two effects: It had not only a consequential effect because it changed what happened when one tried to turn on the flashlight, but it also had an establishing effect because it made finding a fresh battery important.

Any particular instance of behavior has multiple causes, though some may be more important than others. In behavior analysis we examine the multiple causes of behavior one at a time and assess their relative contributions. Multiple causation operates in the flashlight example because establishing events ordinarily go together with consequential effects, but it is important to be clear about which behavior is related to each. In these examples, turning on the flashlight was behavior with consequences, but the lighting conditions established whether it was important to turn the flashlight on; similarly, when the battery went dead, replacing the battery was behavior with consequences, but the failure of the flashlight to work established whether it was important to change the battery (cf. Michael, 1989).

Distinguishing between Causal Antecedents and Causal Contingencies

Some stimuli have their effects as antecedents of behavior, and other stimuli as its consequences, and sometimes stimuli can serve both roles simultaneously. In chaining, for example, the stimulus produced by a response early in a sequence both reinforces that response and sets the occasion for the next one, as when the opening of a door both reinforces the turn of the doorknob and allows the behavior of stepping through to the next room. Stimuli that reinforce or punish some responses can also elicit or occasion others, so choices among such consequences in reinforcement applications must take into account both the main reinforcing or punishing effects and their eliciting or occasioning side effects.

It may be necessary to determine whether behavior is maintained by its consequences or is produced more directly by stimuli. Imprinting provides a case in point. A newly hatched duckling ordinarily follows the first moving thing it sees; this imprinted stimulus is usually its mother. The duckling's following is sometimes said to be elicited by the imprinted stimulus, but to speak of elicitation is misleading. A natural consequence of walking is changing the duckling's distance from its mother. If closeness is important and requires behavior other than walking, that other behavior should replace the walking.

When a dark compartment containing a moving imprinted stimulus was on one side of a one-way window and a response was available on the other side that lit up the dark side so the duckling could see it, behavior incompatible with following, such as pecking a stationary disk on the wall or standing still on a platform, was readily shaped (Peterson, 1960). In imprinting, therefore, presentations of the to-be-imprinted stimulus are establishing events, not eliciting stimuli. Imprinted stimuli, which acquire their significance by being presented under appropriate circumstances, begin as stimuli toward which the duckling is relatively indifferent but end as ones that function as reinforcers. Imprinted stimuli do not elicit following; rather they become important enough that they can reinforce a variety of responses, including following, pecking, and standing still. The point should have been obvious to early researchers on imprinting. In natural environments, swimming replaces walking when the duckling follows its mother into a body of water. If walking had been mere elicited behavior, it should not have done so.

Analogous relations can have profound implications in clinical settings. For example, interpreting a hospitalized child's problem behavior as elicited behavior when it has its source in reinforcement contingencies might prevent appropriate treatment options from being considered. But misdiagnosis can go either way. For example, if such behavior has its source in eliciting stimuli, perhaps for neurological reasons, interpreting it as shaped by reinforcement contingencies could similarly lead to ineffective treatment. And it can get even more difficult. In multiple causation, eliciting stimuli and reinforcement contingencies may operate at the same time, so identifying the role of one should not rule out assessments of the other.

Reinforcement

A reinforcer is a type of stimulus but reinforcement is neither stimulus nor response. The term *reinforcement* names a relation between behavior and environment. The relation includes at least three components: (1) Responses must have consequences; (2) their probability must increase (i.e., they must become more probable than when not having those consequences); (3) the increase must occur *because* they have those consequences and not for some other reason. For example, if we knew only that responding increased, we could not say that the response must have been reinforced; maybe it was elicited. It would not even be enough to know that the response was now producing some stimulus it had not been producing before. We would still have to know whether responding increased *because* the stimulus was its consequence.

Assume that an abusive parent gets annoyed whenever an infant cries and tries to suppress the crying by hitting the child. The infant cries and then gets hit, which produces even more crying. Here the consequence of crying is getting hit, and getting hit produces more crying, but we cannot argue that the hitting reinforced the crying. Two criteria for reinforcement are satisfied but not the third. Stimuli may have other effects along with or instead of their effects as consequences of responding. Crying did not increase here because getting hit was a consequence; getting hit brought on crying even if the infant was not crying at the outset. Probably the infant will eventually learn to suppress the crying. At that point we will know that the crying was punished rather than reinforced.

Specificity of Reinforcers

By definition, reinforcement always increases responding relative to what it would have been like without reinforcement. Also by definition, that increase must be specific to the response that produces the consequence. For example, if a rat's lever presses produce shock and only the rat's jumping increases, it would be inappropriate to speak of either pressing or jumping as reinforced.

As an operation, reinforcement is presenting a reinforcer when a response occurs; it is carried out on responses, so we speak of reinforcing responses rather than of reinforcing organisms. We say that a pigeon's key peck was reinforced with food, but not that food reinforced the pigeon or that the pigeon was reinforced for pecking. The main reason for this restriction is that it is too easy to be ambiguous by omitting the response or the reinforcer, or both, when we speak of reinforcing organisms. The restriction forces us to be explicit about what is reinforced by what. For example, if we have been told only that a child has been reinforced, we do not know much about actual contingencies. Although this grammatical restriction forces us to be explicit about which response has been reinforced, it does not prevent us from mentioning the organism whose behavior had consequences.

Function and Topography of Reinforced Responses

Reinforcement creates response classes defined by their functions and not by their forms or topographies. Common contingencies select the members of operant classes, and they do so even if the relations among members are arbitrary. A lever press is a lever press whether the rat presses with right paw, left paw, chin, or rump.

The distinction between function and topography is particularly crucial when it enters into diagnostic categories. The self-injurious behavior of two children may be similar in topography, but if one child's behavior is reinforced socially by attention and the other's is reinforced by avoidance of compliance with simple requests, effective treatment programs designed for the two children will have to be radically different (Iwata, Pace, Kalsher, Cowdery, & Cataldo, 1990). The first child must be taught more effective ways of engaging the attention of others and must be brought into situations where attention is more readily available. Requests must be selected for the second child that are appropriate to the child's competence, and the child's compliance with those requests must be reinforced (perhaps in the past such behavior has instead been punished). What behavior does is more important than what it looks like.

Assessing Reinforcers

Events that are effective as reinforcers are often described in terms of positive feelings or strong preferences. Such descriptions are subject to the inconsistent practices of verbal communities, so we must be wary of using them to predict whether particular events will serve as reinforcers. It is tempting to equate reinforcers with events colloquially called rewards. But reinforcers do not work because they make the organism "feel good," or because the organism "likes"

them. Our everyday language does not capture what is important about reinforcers. For example, staff predictions of the reinforcers that might be effective in managing the behavior of people with profound handicaps were inconsistent with reinforcers identified by systematically assessing each individual's nonverbal preferences among those events (Fisher et al., 1992; Green et al., 1988).

We sometimes make good guesses about what will be effective reinforcers because reinforcers often involve events of obvious biological significance. But reinforcers are not limited to such events. For example, sensory stimuli, such as flashing lights, can powerfully reinforce the behavior of children along the autism spectrum (Ferrari & Harris, 1981). Restraint also seems an unlikely reinforcer, but in an analysis of self-injurious behavior, restraints that prevented children with severe developmental disabilities from poking or biting themselves were effective in reinforcing arbitrary responses, such as putting marbles in a box (Favell, McGimsey, & Jones, 1978).

In the final analysis, the primary criterion for reinforcement remains whether the consequences of behavior have raised the likelihood of that behavior. Reinforcers are defined by their behavioral effects even though they may sometimes be correlated with other properties, such as reported feelings or preferences.

Delay of Reinforcement

The effects of a reinforcer depend on other responses that preceded it besides the one, usually most recent, that produced it. Thus, when one response is followed by a different reinforced response, the reinforcer may strengthen both. Clinicians and teachers need to take this effect into account because it is important to recognize that reinforcing a single correct response after a long string of errors may strengthen errors along with the correct response.

Assume that a task involves a child's correct responses and errors over trials. Reinforcing every correct response and repeating any trial with an error until the child gets it right guarantees that any sequence of errors will eventually be followed by a reinforced correct response. Correct responses will probably dominate eventually because the reinforcer most closely follows them. But errors may diminish only slowly and perhaps even continue indefinitely at a modest level, though they never actually produce the reinforcer, because they are reliably followed after a delay by a reinforced correct response. Thus, always reinforcing a single correct response after a sequence of errors will probably maintain errors.

Teachers and clinicians must be alert for situations in which they may be strengthening incorrect responses along with correct ones that they reinforce. A reinforcer that follows a sequence of correct responses will probably do a lot more good than a reinforcer that follows a single correct response after several errors. Thus, teachers must judge whether correct responses are so infrequent that they should be reinforced even though they are preceded by errors, or so frequent that the reinforcer can wait until the student has made several correct responses in a row. One other way to reduce the strengthening of errors is to extend the time to the next trial after every error.

Many practical applications of reinforcement include other behavior that precedes the behavior we target for reinforcement. When such behavior shares in the effect of the reinforcer, we may mistakenly conclude that the reinforcer is not doing its job very well. But if the reinforced behavior includes response classes that we did not intend to reinforce, it may simply be doing very well a job other than the one we wanted it to do. When one response is followed by a different reinforced response, the reinforcer may strengthen both, so we should keep behavior that we do not want to reinforce from getting consistently close to reinforcers produced by other responses.

Relativity of Reinforcement

Reinforcement is relative in the sense that it depends on relations between the reinforced response and the reinforcer. A less probable response may be reinforced by an opportunity to engage in a more probable response. The inverse relation does not hold. For example, food is not always a reinforcer. When a parent allows a child to go out and play with friends only after the child has eaten, the opportunity to play may reinforce the eating.

The reversibility of the reinforcement relation has been amply demonstrated (Premack, 1962). For example, levels of food and water deprivation can be selected so that drinking is reinforced by an opportunity to eat at one time, and eating is reinforced by an opportunity to drink at another. In providing an a priori means for predicting whether an opportunity to engage in one response will reinforce some other response, the relativity of reinforcement also avoids the problems of circular definition inherent in some earlier definitions of reinforcement.

The significance of reinforcers is based on the opportunities for behavior that they allow. For example, when time spent in isolation was used in an attempt to punish the tantrums of a 6-year-old girl with autism, her tantrums increased substantially instead of decreasing. This child often engaged in self-stimulation, such as waving her fingers over her eyes to create visual flicker, but that behavior was frequently interrupted by the staff. Time in the isolation room reinforced rather than punished her tantrums because the isolation room allowed her to engage in self-stimulation without interruption (Solnick, Rincover, & Peterson, 1977).

The relativity of reinforcement reminds us that we should not expect the effectiveness of reinforcers to be constant across different reinforced responses, different individuals, or even different time samples of the behavior of a single individual. When a reinforcer is effective on some behavior in some context, we must not assume that it will be effective on other behavior or even on the same behavior in other contexts.

Reinforcement and Extinction

The effects of reinforcers are not permanent. Reinforcers have temporary effects; when reinforcement stops, responding returns to its earlier, lower levels. The decrease in responding during extinction does not require a separate treatment; rather, it is simply one property of reinforcement.

If the effects of reinforcement are temporary, then once we have created new behavior with reinforcers we cannot count on its maintenance after our intervention ends. Consider children learning to read. Only long after they have learned to name letters of the alphabet and to read whole words are they perhaps ready to read stories, so that reading can become "its own reward." Until that happens, teachers have no choice but to arrange artificial contingencies, using extrinsic consequences such as praise to shape the components of reading. Responsible teaching adds extrinsic reinforcers only when there are no effective intrinsic consequences. If we want to maintain behavior after we terminate artificial consequences, we should do so only if natural consequences are in place that will take over that maintenance.

Side Effects of Reinforcement and Extinction

Discontinuing reinforcement in extinction has two components: (1) It terminates a contingency between responses and reinforcers, and (2) reinforcers are no longer delivered. Because of the former, the previously reinforced responding decreases. Because of the latter, unwelcome side effects of extinction may appear. For example, aggressive responding is sometimes a major side effect of extinction (e.g., Lerman, Iwata, & Wallace, 1999). If food is suddenly taken away from a food-deprived rat that has been eating, the rat may become more active and perhaps urinate or defecate. If the food was produced by lever presses, the rat may bite the lever. If other organisms are in the chamber, the rat may attack them (Azrin, Hutchinson, & Hake, 1966). These effects and others, though observed in extinction, are not produced by the termination of the reinforcement contingency because they also occur upon the termination of response-independent food deliveries, where there had been no reinforcement contingency. In either case, a rat that had been eating stops getting food. The termination of a reinforcement contingency in extinction necessarily entails the termination of reinforcer deliveries, and the effects of the latter are necessarily superimposed on the decrease in previously reinforced responding.

Even if reinforcers have produced problem behavior, taking them away may still produce undesired side effects. That is why extinction is not the method of choice for getting rid of behavior that has been created by reinforcement. Suppose a developmentally delayed boy engages in severe self-injurious behavior such as head banging or eye poking, and we discover that his behavior is in

large part maintained by staff attention as a reinforcer. Because of the harm he might do to himself if the self-injurious behavior is ignored, extinction may be ill advised. Giving him attention independently of the self-injurious behavior is one possibility (noncontingent reinforcement, sometimes also called free reinforcement) (Catania, 2005; Lattal, 1974; Sizemore & Lattal, 1977); another is to use attention to reinforce alternative responses, and especially ones incompatible with the self-injury. The self-injury will decrease as alternative responses increase.

These side effects are one reason why extinction has fallen out of favor in applied settings compared to procedures such as noncontingent reinforcement. The *Journal of Applied Behavior Analysis* has relatively few examples of extinction with humans. In general, the solution is not to take the reinforcers away. The better way to reduce misbehavior is to reinforce good behavior, but sometimes we inadvertently encourage the use of extinction, the less effective alternative, especially when we present just a few basic facts about behavior, as in the introductory psychology course. Generations of students seem to have taken from cursory accounts of behavioral methods in introductory textbooks the message that if one sees a child doing something one does not approve of, then one should not reinforce that behavior. Instead, one should just ignore it. Left unanswered are the inevitable subsequent questions, such as how parents should handle things when other problematic behavior maintained by the same reinforcer emerges. Rather than teaching parents to ignore the behavior of their children, we should teach them how to use reinforcers more productively, but that alternative is more difficult. Free noncontingent reinforcement coupled with the shaping of other behavior should be recommended to parents or other caregivers, but doing so poses problems of both communication and implementation (Hagopian, Crockett, van Stone, DeLeon, & Bowman, 2000).

Why has extinction for so long remained the primary way to study the effects of terminating contingencies? One concern is that accidental contiguities of responses and noncontingent reinforcers may have effects similar to those of the contiguities that are scheduled when reinforcers are contingent on responding. If noncontingent and contingent reinforcers have similar effects on behavior early in the transition to noncontingent reinforcement, then responding may decrease more slowly than in extinction. But such effects are usually transient, so this is not a big enough concern to rule noncontingent reinforcement out of consideration in either experimental or applied settings. If higher or lower rates of noncontingent reinforcement are available as options, this concern favors the lower rates. If behavior persists for long periods of time under such arrangements, it is more appropriate to look for other sources of the behavior than to attribute it to adventitious correlations of responses and reinforcers.

Positive Reinforcement and Positive Psychology

Positive reinforcement can be used to change a developmentally delayed child who engages extensively in self-injurious behavior into one who has learned communicative skills and has therefore been empowered to deal in more constructive ways with his or her caregivers. If reinforcers were implicated in the development and maintenance of the self-injurious behavior, then taking them away is not the solution. Reinforcement isn't everything, but extinction isn't anything. If the reinforcers are already there, they should not be wasted; they should instead be used constructively. We all shape each other's behavior, and the more we know about how positive reinforcement works, the more likely that we will use it productively and avoid pitfalls such as the coercive practices that can occur if the control over reinforcers remains one-sided. For these reasons, it might be thought that positive reinforcement would be especially important to the practitioners of an approach called *positive psychology*. Unfortunately, they eschew it, along with the establishing events that make it effective; their rhetoric implies that contingent acts of kindness should always be replaced by random ones (cf. Catania, 2001; Seligman & Csikszentmihalyi, 2000, 2001).

Self-Reinforcement as Misnomer

An organism's delivery of a reinforcer to itself based on its own behavior has been called *self-reinforcement*, but any effect such an activity might have cannot be attributed to the action of the specific reinforcers delivered by the organism to itself. In so-called self-reinforcement, the contingencies and establishing events modifying the behavior purportedly to be reinforced cannot be separated from those that modify the behavior of self-reinforcing. For example, a student who has made a commitment to watch television only after completing a study assignment might think this arrangement will reinforce studying. But any increase in studying that follows cannot be attributed to the student's contingent watching of television: The student made the commitment to deal with studying this way because studying had already become important for other reasons. Whatever brought the student to commit to "self-reinforce" studying in the first place probably by itself made studying more likely. It is impossible to pull these variables apart.

What was once called *self-reinforcement* is now more properly called *self-regulation* (Bandura, 1976, 1995; Catania, 1975, 1995; Mahoney & Bandura, 1972). To the extent that the activity has effects, it must do so because the individual who appears to "self-reinforce" can discriminate behavior that qualifies for the reinforcer from behavior that does not.

This usage also finesses the problem that the language of self-reinforcement implies reinforcement of the organism rather than reinforcement of behavior. For example, the commitment to reinforce one's own studying involves setting standards for the discrimination between adequate and inadequate studying, so students who try to deal with their study habits in this way are discriminating properties of their own behavior that have become important to them. The contingencies that generate these discriminations are complex and probably involve verbal behavior. The language of self-reinforcement obscures rather than clarifies these phenomena.

Punishment

Paralleling the vocabulary of reinforcement, a punisher is a type of stimulus, but punishment is neither stimulus nor response. The term *punishment* names a relation between behavior and environment. The relation includes at least three components. First, responses must have consequences. Second, their probability must decrease (i.e., they must become less probable than when not having those consequences). Third, the decrease must occur *because* they have those consequences and not for some other reason. For example, if we knew only that responding decreased, we could not say that it must have been punished; maybe it was previously reinforced responding that had since been extinguished. It would not even be enough to know that the response was now producing some stimulus it had not produced before. We would still have to know whether responding decreased *because* that stimulus was its consequence.

As defined, punishment is the inverse of reinforcement; it is defined by decreases in consequential responding, whereas reinforcement is defined by increases. The vocabulary of punishment parallels that of reinforcement in its object: Responses, not organisms, are said to be punished. If a rat's lever pressing produces shock and lever pressing decreases, it is appropriate to say that the rat was shocked and that the lever press was punished; it goes against colloquial usage, but it is not appropriate to say that the rat was punished. As with reinforcement, this grammatical distinction discourages ambiguities in the observation and description of behavior.

Parameters of Punishment

As with reinforcement, the effectiveness of punishment varies with parameters such as magnitude and delay (Azrin & Holz, 1966). For example, the more intense and immediate the punisher, the more effectively it reduces behavior. A punisher introduced at maximum intensity reduces responding more effectively than one introduced at low intensity and gradually increased to maximum intensity. The effectiveness of the punisher may change over time, such as when a punisher of low intensity gradually becomes ineffective after many presentations. As with extinction, it is easier to reduce the likelihood of a response when some other response that produces the same reinforcer is available than when no alternative responses produce that reinforcer. And, in a parametric relation especially relevant to human applications, punishers delivered after short delays

are more effective than those delivered after long ones; with either pets or children, aversive consequences delivered at some point long after unwanted behavior are not likely to be very effective. If verbal specification of the behavior on which the punisher was contingent matters at all, it can do so only given an extensive and sophisticated verbal history on the part of the individual at the receiving end (Skinner, 1957).

A reduction in responding can be studied only if some responding already exists. A response that is never emitted cannot be punished. Experiments on punishment therefore usually superimpose punishment on reinforced responding. But the effects of punishment then also depend on what maintains responding. For example, punishment by shock probably will reduce food-reinforced lever pressing less if a rat is severely food-deprived than if it is only mildly fooddeprived.

Recovery from Punishment

There are ethical constraints on using punishment to change behavior, but punishment cannot be eliminated from natural environments (Perone, 2003). Without punishment, a child who had been burned upon touching a hot stove or bitten upon approaching an unfamiliar barking dog would remain undeterred from doing so again later on. Artificial punishment contingencies, however, are also constrained by practical considerations. Like reinforcement, the effects of punishment are ordinarily temporary; responding usually recovers to earlier levels after punishment is discontinued. That means that just as reinforcement procedures must plan for what will maintain the behavior when reinforcement ends, punishment procedures must plan for environments in which the relevant contingencies may be absent. It may do little long-term good to eliminate a child's self-injurious behavior with punishment in a hospital setting if the punishment contingency does not exist when the child returns home. The reinforcement of alternative behavior might be easier to maintain.

Relativity of Punishment

The effectiveness of punishers, like that of reinforcers, is determined by the relative probabilities of the punished response and the responses occasioned by the punisher; punishment occurs when a more probable response forces the organism to engage in a less probable response. Even stimuli that ordinarily serve as reinforcers can become punishers under appropriate conditions. For example, food that is reinforcing at the beginning of a holiday feast may become aversive by the time the meal has ended. On the other hand, events that superficially seem aversive, such as falling from a height, may be reinforcing under some circumstances (consider skydiving). Like reinforcers, punishers cannot be defined in absolute terms or in terms of common physical properties. Rather, they must be assessed in terms of the relation between punished responses and the responses occasioned by the punisher.

Any given state of affairs may be reinforcing or aversive depending on its context. Suppose a rat receives shocks during a tone, but during a buzzer nothing happens. If chain pulls turn off the tone and turn on the buzzer, the onset of the buzzer will reinforce chain pulls; by pulling the chain, the rat escapes from the tone and its accompanying shock deliveries. Suppose, however, that the rat instead receives food during the tone, but during the buzzer nothing happens. Now if chain pulls turn off the tone and turn on the buzzer, the onset of the buzzer will punish chain pulls; by pulling the chain, the rat produces a time-out from the tone and its accompanying food deliveries. In other words, the buzzer serves as reinforcer or as punisher depending on its context, even though nothing happens during the buzzer in either context. Similarly, as gauged by absenteeism, whether a school environment is punishing or reinforcing may depend on the conditions that prevail at home; for example, as when going to school is punished for one child because it means having to deal with an abusive school bully, but is reinforced for another because it is a convenient way to escape from an even more abusive parent.

Side Effects of Punishment: Eliciting and Discriminative Effects

Aversive stimuli are likely to have other effects besides those that depend on the punishment contingency (e.g., Azrin, Hutchinson, & McLaughlin, 1965). As with reinforcement, punishment necessarily includes both stimulus presentations and a contingency between responses and stimuli, so the effects of the stimulus presentations must be distinguished from those of the contingency. If an organism is shocked or pinched, some of its responses to those stimuli may have little to do with whether they were brought on by the organism's own behavior. To qualify as punishment, the reduction in responding must depend on the contingent relation between responses and punishers, and not simply on the delivery of punishers.

A comparison of the effects of response-produced and response-independent shock on food-reinforced lever pressing in rats (Camp, Raymond, & Church, 1967) showed that both procedures reduced lever pressing relative to noshock conditions, but response-produced shock had substantially larger effects than response-independent shock. Given that both response-produced and response-independent shocks reduced responding, it would not have been possible to assess the effect of the punishment contingency without the comparison. The difference made it appropriate to call the response-produced shock a punisher. For example, had response-produced shock instead produced only the same reduction as response-independent shock, the appropriate conclusion would have been that the reduction depended wholly on the eliciting effects of shock, and that the punishment contingency was irrelevant. Just as we must distinguish between effects of reinforcer deliveries and effects of the contingent relation between responses and reinforcers, so also we must distinguish between effects of punisher deliveries and effects of the contingent relation between responses and punishers.

Punishers can also acquire discriminative properties, as when a response is reinforced only when it is also punished. For example, one experiment alternated a condition in which a pigeon's key pecks had no consequences with another in which every peck produced shock and some produced food reinforcers (Holz & Azrin, 1961). A low rate of pecking was maintained when pecks produced no shock because then they never produced food either; pecking increased once pecks began to produce shock, however, because only then did they occasionally produce food.

We can ask whether these shocks should really be called punishers. In fact here we must conclude that the shock has become a conditional reinforcer. The main difference between the shock and other, more familiar reinforcers is that it acquired its power to reinforce through its relation to food; were that relation discontinued, it would lose that power. As an example of a possible source of masochism, these procedures may be relevant to human behavior. For example, a battered child might provoke a parent to the point of a beating because the beatings are often followed by more attention from the then-remorseful parent than ever follows less traumatic parent–child interactions. A parent's attention can be a potent reinforcer and may sometimes override the effects of consequences that would otherwise serve as punishers.

Passive Avoidance as Misnomer

It has been argued that punishment is reducible to avoidance, in the sense that all behavior other than the punished response avoids the punisher. For example, if a rat is placed on a platform above an electrified grid, then not stepping down onto the grid might be called passive avoidance of shock; by not responding, the rat passively avoids what would otherwise be a punisher. But whereas punishment is a robust phenomenon that can occur within a short time course (the abrupt introduction of a strong punisher reduces responding quickly), the literature on avoidance shows that though avoidance is robust once in place, it is difficult and time-consuming to get it started. Passive avoidance is therefore best regarded as a misnomer for punishment. It is implausible to say that hypothetical behavior presumed to come from relations that are difficult to establish can explain behavior that is easy to establish. Even if punishment did work this way, so that we learn not to stick our hands into fires because by so doing we avoid the aversive proprioceptive stimuli occasioned by approaching the fire, it would make little practical difference. For those who have to make decisions about whether or when to use punishers, punishment works pretty much the same way whichever theoretical position one assumes.

Negative Reinforcement: Escape and Avoidance

Organisms not only produce stimuli, they also get rid of them. Without negative reinforcement, a child would not learn to escape from the cold by coming indoors or to avoid others who might cheat at games or bully or lie. A rat does not ordinarily expose itself to shock, and if shock does occur, the rat escapes from it given the opportunity. If presenting a contingent aversive stimulus punishes a response, removing or preventing that stimulus may reinforce a response. When a response terminates or prevents an aversive stimulus and becomes more probable for that reason, the stimulus is called a *negative reinforcer* and the operation is called *negative reinforcement.*

In traditional usage, *positive* and *negative*, as modifiers of the term *reinforcement*, refer to whether the consequence produced by responding adds something to the environment or takes something away, but we will see later that there are other, better criteria for the distinction. *Negative reinforcer* refers to the stimulus itself and not to its removal; if removal of shock reinforces a rat's lever press, then shock, not the shock-free period that follows the response, is the negative reinforcer. Negative reinforcement involving the removal of a stimulus that is already present is called *escape.* When it involves the postponement or prevention of a stimulus that has not yet been delivered, it is called *avoidance.* This vocabulary is consistent with everyday usage: We escape from aversive circumstances that already exist, but we avoid potential aversive circumstances that have not yet happened. In clinical situations, escape (e.g., from a medical unit) is often called *elopement.*

Stimuli that can reinforce by their presentation can punish by their removal, and *vice versa.* If we know a stimulus is effective as a punisher, then we can reasonably expect it to be effective as a negative reinforcer, and *vice versa*; this consistency is part of our justification for calling the stimulus aversive. Consistencies are to be expected because these categories have their origins in relations among the probabilities of different response classes. But we must not take too much for granted. The fact that we may easily reinforce jumping with shock removal, whereas we may not so effectively punish it with shock presentation, shows that the symmetry of reinforcement and punishment has limits. Reinforcement is most effective if the reinforced response is compatible with the responding occasioned by the reinforcer. Inversely, punishment is most effective if the punished response is incompatible with, or at least independent of, the responding occasioned by the punisher. Thus, it may be easy to reinforce jumping with shock removal (escape) but hard to punish it with shock presentation.

Escape: Competition between Contingencies and Elicited Behavior

In escape, an organism's response terminates an aversive stimulus. In institutional settings, developmentally delayed children sometimes behave aggressively, in that way escaping from simple demands placed upon them, such as tasks designed to teach them how to fasten and unfasten clothing buttons. For two such children, aggression dropped to near-zero levels when they could escape from demand situations by engaging in other behavior incompatible with aggression (Carr, Newsom, & Binkoff, 1980). But such cases of escape might, of course, imply that typical demand situations in such settings do not provide enough reinforcers.

In positive reinforcement, the reinforcer is absent when the reinforced response is emitted. After the response, the reinforcer is presented and occasions other responses. For example, if a rat's lever press is the reinforced response and food is the reinforcer, food is absent while the rat presses; eating does not occur until food is presented after the press. Thus, lever pressing and eating do not directly compete with each other. In escape, however, the negative reinforcer is present before the reinforced response is emitted; it is removed only after the response. For example, if the negative reinforcer is bright light from which the rat can escape by pressing a lever, the rat may reduce the effects of the light by closing its eyes and hiding its head in a corner. Any movement from that position is punished by greater exposure to the light, so the rat is not likely to come out of the corner and press the lever. Getting a rat to escape from light by lever pressing requires procedures that reduce the likelihood of such competing responses (Keller, 1941).

Avoidance: Hard to Initiate but Easy to Maintain

Avoidance involves the prevention of an aversive stimulus by a response; the aversive stimulus is not present when the reinforced response occurs. The two major varieties of avoidance procedure are *deletion* and *postponement.* Deletion procedures are analogous to swatting a mosquito before it gets to where it can bite you: Once swatted, that mosquito is permanently prevented from biting. Postponement procedures are analogous to putting coins in a parking meter: One postpones the violation flag as long as one puts coins in the meter and resets it, but without additional coins the meter eventually runs out.

In *discriminated* or *signaled avoidance*, a stimulus (sometimes called a *warning stimulus*) precedes the aversive stimulus; a response in the presence of this stimulus prevents the aversive stimulus on that trial. In *continuous* or *Sidman avoidance*, no exteroceptive stimulus is arranged. Each response postpones the aversive stimulus (usually, brief shock) for a fixed time period called the *response–shock (R–S) interval*; in the absence of responses, shocks are delivered regularly according to a *shock–shock (S–S) interval* (Sidman, 1953). Shock can be postponed indefinitely provided that no R–S interval ends before a response has been emitted.

Success with avoidance procedures sometimes depends on whether the experimenter chooses a response that the organism is likely to emit in aversive situations. With rats, for example, responses such as jumping a hurdle or running from one side of the chamber to the other are likely to be elicited by aversive stimuli even in the absence of a response-shock contingency. Once responding has been produced by shock, it may continue when shock is absent. Thus, the rat's first few avoidance responses may occur mainly because of their earlier elicitation by shock.

Avoidance behavior may be persistent after a long history of avoidance; it can be slow to extinguish. But the consequence of effective avoidance is that nothing happens: The aversive event is successfully avoided. Given that an avoidance response is not closely followed by shock, avoidance contingencies implicitly involve delays between responses and their consequences. Thus, despite the persistence of avoidance behavior once it is adequately in place, it is often hard to get it started.

This may explain why safety measures and other preventive procedures are not often shaped by natural contingencies. Someone who has never had a bad experience with fire may be less likely to install a smoke detector than someone who has. One significant problem in medicine is the compliance of patients with regimens such as taking prescribed medications. Many patients stop taking their medications once their symptoms have disappeared even though further doses may have continued benefits. And with preventive medication, such as vaccination, taking a dose is followed by nothing happening right from the start. This problem exists over a wide range of preventive measures, from immunizations to safe sex, and from using sterile surgical equipment to purifying drinking water. Given what we know about avoidance contingencies, it is no surprise that such measures are sometimes difficult to shape up and maintain.

Behavioral Criteria for Distinguishing Positive from Negative Reinforcement

Whether stimuli are presented or removed may be a less important criterion for distinguishing positive from negative reinforcement than whether responses generated by the reinforcer occur at times when they can compete with the reinforced response. Consider escape from cold (Weiss & Laties, 1961). In a cold chamber, a rat's lever presses turn on a heat lamp. Because presses add energy in the form of heat, this procedure could be called positive reinforcement. But cold stimulates temperature receptors in the rat's skin, and turning on the heat lamp terminates this effect of cold. Cold is a potent aversive event, so by this interpretation the procedure should be called negative reinforcement.

The justification for choosing the vocabulary of negative reinforcement lies not with questions of physics, such as whether something is presented or removed, but with the behavioral effects of the stimuli presented before and after emission of the reinforced response. Consider the behavior of the rat in the cold. Before the reinforced lever press, it huddles in a corner and shivers. These responses reduce the likelihood that it will press the lever. Once its lever press turns on the heat lamp, these competing re-

sponses become less likely, but a rat that is no longer cold cannot escape from cold. Responses that competed with the reinforced response occurred before rather than after reinforcement, so this example is more like escape from shock or bright light than like production of food or water. In general, the language of negative reinforcement is appropriate when establishing events produce behavior that is likely to compete with the responding to be reinforced.

Another possible criterion is whether one reinforcement situation is preferred over another. In applied areas, such as management, it is useful to distinguish between two management task contingencies: Managers get employees to carry out tasks by either threatening and criticizing until tasks are completed or, more rarely, by providing praise and recognition after tasks are completed. Given a choice, employees are likely to move from settings in which they receive criticism to those in which they receive praise. Assuming that reductions in threats maintain task completion, we may call that contingency negative reinforcement. Assuming that recognition for completing tasks maintains task completion, we may call that contingency positive reinforcement. The preferences of employees for task contingencies justify this reinforcement classification (G. Bruce, e-mail personal communication, 1998).

The Reinforcer in Negative Reinforcement

When a successful avoidance response occurs, its important consequence is that nothing happens. How can the absence of an event affect behavior? According to one view, avoidance responding is maintained because the organism escapes from some properties of the situation that accompanied past aversive stimuli. This view evolved from earlier procedures in which a warning stimulus preceded shock, and the organism prevented shock by responding in the presence of the warning stimulus. Avoidance was most easily acquired when the avoidance response both terminated the warning stimulus and prevented the shock.

In the context of occasional shocks, a shock-free period can serve as a reinforcer. Avoidance contingencies can be arranged in which the organism can either reduce the total number of shocks in a session or postpone individual shocks, even though the same number of shocks is eventually delivered in both cases. Either condition can maintain avoidance. Situations can be created in which a rat postpones shocks within trials even though it does not reduce the overall shock rate, or in which it reduces the overall shock rate even though responding shortens the time to the next shock (Herrnstein & Hineline, 1966; Hineline, 1970).

Establishing Events in Negative Reinforcement

An establishing event that makes positive reinforcers more effective is deprivation. Food is less likely to reinforce the behavior of a rat that has recently eaten than of one that has not eaten for some time. The analogous event for negative reinforcers is *presentation* (it would be called *satiation* were the stimulus food instead of shock); the presentation of aversive stimuli makes their removal reinforcing. Even more so than with positive reinforcement, these establishing effects must be distinguished from discriminative, eliciting, and other effects of stimuli. Issues of multiple causation may be even more prevalent in cases of aversive control than with positive reinforcement (for examples, see Sidman, 1958).

The aversive stimulus is the establishing event because there is no reason to escape or avoid an aversive stimulus unless it is either actually or potentially present. It is tempting to think of the aversive stimulus as signaling a contingency, but contingencies in which responses turn off shock cannot exist in the absence of shock. When responses produce food in positive reinforcement, that contingency can be signaled whether or not the rat has been food-deprived.

An example may be relevant. Shock is delivered to a rat when a light is either on or off; when the light is on, a lever press removes the shock for a while, but when the light is off, a lever press has no effect (Bersh & Lambert, 1975). Under such circumstances the rat comes to press the lever when the light is on but not when it is off. The discriminative stimulus here is the light because the contingency between lever presses and shock removal is signaled by whether the light is on or off. The shock makes shock-free periods reinforcing, and its presentation is therefore an establishing event; it does not function as a discriminative stimulus because it does not signal the operation of a contingency.

Note that the contingencies that operate in the dark in this example are properly called *extinction* contingencies. Lever presses remove shock when the light is on but not when it is off, but given appropriate contingencies, shock absence would be an effective reinforcer during either. This would not be so were shock never present when the light was off. In all of these cases, contingencies are about the consequences of responding, whereas establishing or motivating events are about whether those consequences are important enough to serve as reinforcers.

Extinction after Negative Reinforcement

As with positive reinforcement and punishment, the effects of negative reinforcement are temporary. And as with those other operations, the effects of terminating contingencies between responses and aversive stimuli must be distinguished from those of simply terminating the aversive stimuli. In shock escape, turning off the shock eliminates responding simply because there is no occasion for escape in the absence of the shock. But in avoidance, turning off the shock source has often been considered an extinction operation. If avoidance responding is maintained at such a rate that shocks are rare, the absence of shocks will make little difference, and responding will continue for a long time. In fact, one widely acknowledged property of avoidance responding is its persistence after aversive stimuli are discontinued. For that reason, avoidance has sometimes been regarded as relevant to cases of the persistence of human behavior, as in compulsions.

Consider the alternatives. With food reinforcement, we can arrange extinction by either turning off the feeder or breaking the connection between responses and the feeder. Both have the same effect: Food is no longer delivered. That is not so with negative reinforcement. In escape or avoidance of shock, shock continues if responses can no longer remove or prevent it. This procedure discontinues the response–shock contingency, but it also increases the number of shocks if responding has kept shock rate low. Thus, by itself this procedure cannot separate the effects of changing the rate of shock from those of changing the contingency.

Discontinuing the aversive stimulus has been the more common extinction procedure in avoidance, but in terms of contingencies presenting the aversive stimulus while discontinuing the consequences of responding more closely parallels extinction after positive reinforcement. The time course of extinction depends on which operation is used and on the way it changes the rate at which aversive stimuli occur (e.g., Hineline, 1981). In any case, extinction after negative reinforcement shows that the effects of negative reinforcement are temporary.

Negative Punishment: Time-Out

The distinction between positive and negative reinforcement is easily extended to positive and negative punishment (though here, too, ambiguous cases are possible). Responses can be punished by some events, such as shock or forced running in a running wheel. Responses also can be punished by the termination of events. For example, removing food contingent on a food-deprived rat's lever presses is likely to reduce the rate of pressing. The problem is that it might be hard to demonstrate negative punishment. If the rat is food-deprived and food is available, it will probably eat rather than press, so we will have few opportunities to punish lever pressing by removing food. For this reason, studies of negative punishment usually have not removed the positive reinforcer itself; paralleling the emphasis on avoidance rather than escape in studies of negative reinforcement, the stimulus in the presence of which responses are reinforced has been removed instead.

For example, suppose two levers are available to a monkey, and presses on one lever produce food whenever a light is on. We can expect presses on the other lever, but we can punish them by making each one produce a time period during which the light turns off and presses on the first lever do nothing. Such periods are called *time-out*, and the procedure is *punishment by time-out from positive reinforcement* (e.g., Ferster, 1958). Time-out originated in experiments like these with pigeons and rats and monkeys but now is probably best known in its

human applications (e.g., Wolf, Risley, & Mees, 1964). For example, time in an isolation room has sometimes been used to punish the problem behavior of institutionalized children. In the casual use of time-out as a punisher by parents and teachers, contingencies are often inconsistently applied, and behavior that occurs during the time-out is too often neglected. The term is occasionally extended to other cases (e.g. *time-out from avoidance*, during which no shocks are delivered).

Higher-Order Classes and Operant Contingencies

Contingencies can operate in combination and present particular challenges when some contingencies are nested in others, in higher-order classes. Sometimes when a response class appears insensitive to its consequences, it is part of a larger class whose other members continue to have the consequences it once shared with them. In such cases, the contingencies operating on the higher-order class may override those arranged for the original class. For example, once generalized imitation has been established, a child may continue to imitate some instance even though that particular imitation is never reinforced. That imitation may seem insensitive to operant contingencies, but it will be maintained by the contingencies that operate on the higher-order class as long as the higher-order class maintains its integrity.

We would ordinarily expect subclasses for which reinforcement has been discontinued to be differentiated from their higher-order classes, but that might not happen if the integrity of the higher-order class depends on its membership in other, interlocking higher-order classes that still include the subclass (e.g., playing the game *Simon Says* on the playground may help to maintain generalized imitation in the classroom even if imitative responses in the classroom are never reinforced). In some cases this might be a problem, but in others it may instead be advantageous, such as when new behavior emerges as a novel instance of the higher-order class (e.g., the generalized imitation of a movement the child has never seen before).

Now consider a boy whose self-injurious behavior is reinforced by attention. Suppose we try to extinguish his self-injurious behavior by ignoring it. We might have trouble from the start because we cannot tolerate the damage he may do to himself. We nevertheless persevere and discover that his self-injurious behavior does not decrease. One possibility is that we have not adequately identified the relevant response class. If the function of this behavior is to produce attention, it may be part of a much larger class of behavior that includes shouting obscenities, acting up, hitting or otherwise abusing the caregivers in the treatment center, and any number of other responses that might get attention (Lalli, Mace, Wohn, & Livezey, 1995). This tells us how important attention is to this child. We must consider a treatment program that uses attention to reinforce more effective and appropriate behavior, but the example also reminds us that we cannot define response classes by what they look like.

The criterion for defining response classes is function, and common consequences are the glue that holds classes of behavior together. The larger class was held together by the common consequences of its members, just as the various topographies of a rat's lever presses (left or right paw, both paws, sitting on it) are held together by the common consequence of producing food. But the human case is distinguished by the embedding of one response class within another. The self-injurious behavior was embedded in the larger class of attention-getting behavior. When a response class seems insensitive to its consequences, such as when the self-injurious behavior seemed not to extinguish, we must entertain the possibility that we have improperly specified the class, and that it is part of a larger class whose other members continue to have the consequences it once shared with them. The hierarchical structure of some classes of behavior may sometimes make it appear that reinforcement is not working, but it may be working on a response class larger than the one in which we have been interested. When reinforcement seems not to be working we should consider whether the response class in which we are interested is part of another larger class (Catania, 1995).

Verbal Behavior and the Hidden Costs of Reward

Reinforcement may be obscured when human verbal and nonverbal behavior interact. For example, instruction-following is more than the following of particular instructions; it is a higher-order class of behavior held together by common contingencies (e.g., Shimoff & Catania, 1998). Following orders in the military is a product of extensive and powerful social contingencies, often based on aversive consequences, but in actual combat, the long-term contingencies that maintain instruction-following in general as a higher-order class may be pitted against the immediate consequences of following a particular order (Skinner, 1969).

Verbal behavior is involved in the distinction between intrinsic and extrinsic reinforcers. An *intrinsic* reward or reinforcer is one that has a natural relation to the responses that produce it, whereas an *extrinsic* one has an arbitrary relation to those responses (e.g., music is an intrinsic consequence of playing an instrument, but the music teacher's praise is an extrinsic one). Events presumed to function as reinforcers because their function has been instructed have been called extrinsic reinforcers (e.g., as when a child is told that it is important to earn good grades), but labeling them so does not guarantee their effectiveness. It has been argued that extrinsic consequences undermine the effectiveness of intrinsic ones, and despite much evidence to the contrary, the argument has persisted and continues to have impact on the use of operant contingencies in schools and other settings (Cameron, Banko, & Pierce, 2001; Cameron & Pierce, 1994; Eisenberger & Cameron, 1996).

In one experiment (Lepper, Greene, & Nisbett, 1973), one group of children received gold stars for artwork such as finger painting; after the gold stars were discontinued, children in this group did less artwork than those in a second group that never received gold stars. The gold stars, extrinsic reinforcers, were said to have undermined the intrinsic reinforcers, the natural consequences of painting. The children had been told to earn the gold stars, however, and the experiment did not test the stars' effectiveness as reinforcers. There were no data to show that children painted more when they got gold stars.

The claimed deleterious effects are only inconsistently demonstrable, and they are small and transient when they do occur (Cameron et al., 2001; Cameron & Pierce, 1994), and problems are more likely to arise with extrinsic reward that is not contingent on performance than with contingent reward (Eisenberger & Cameron, 1996). In any case, if there is an effect, its transience and small size are hardly consistent with the argument that extrinsic reinforcement may ruin the lives of children. Nonverbal effects of reinforcers must be distinguished from the social contingencies that maintain the verbal governance of behavior. When situations involve verbal behavior there is a good chance that verbal governance will override more direct effects of reinforcement.

Reinforcers versus Bribes

In the literature of the "hidden costs of reward," reinforcers have sometimes been equated with bribes (Kohn, 1993), but it is unlikely that the arrangements described as bribes by such critics of the practice of reinforcement involve the direct effects of reinforcers. The language of bribery has an extensive history in law and ethics as an offer of goods or favors in exchange for favorable treatment in business, politics, or other human endeavors. Critics of the practice of reinforcement have extended this language to the common parental practice of specifying a consequence when asking a child to do something (e.g., "If you put away your toys, you can watch television"). There are good reasons to advise parents against the practice of bribery in this sense, but the reasons are different from those offered by the critics. They have correctly recognized the potentially different effects of natural and artificial consequences, but they have also seriously conflated cases of verbal stimulus control with those involving other varieties of contingencies.

Parents sometimes complain that their child only cooperates with requests when there is an immediate and explicit payoff. This problem is one of stimulus control. The parent may sometimes say, "It is time to put your toys away," and at other times may say, "If you put away your toys, you can watch television." But unless the child who

has complied with the request gets an opportunity to watch television whether or not the contingency has been explicitly stated, the child will learn to comply only when the parent states it.

Given that a bribe specifies behavior and its consequences, offers of bribes instead function as stimuli that set the occasion for particular contingencies. The child who is frequently bribed in this sense will learn to discriminate between conditions in which bribes are in effect and those in which they are not, so the parent who often uses bribes will no doubt eventually find that the child complies only when a bribe is offered.

The child will not learn to initiate appropriate behavior if the initiation rests with the one who offers the bribe. Over the long run, therefore, compliance with bribes will probably interfere with the effects of more constructive contingencies. If reinforcement works at all in such cases, it is in strengthening compliance with bribes, which is hardly the best way to make use of reinforcers. When such unintended stimulus control develops, it is important to teach the parent to reinforce compliance without explicitly stating the contingency, or at least to reinforce compliance both when the contingency is explicitly stated and when it is not.

As for the parent who has heard the language of bribes applied to the practice of reinforcement and is therefore reluctant to deliver reinforcers, it is crucial to teach that parent not to accompany the arrangement of contingencies for a child's behavior with statements of those contingencies. And that is probably good advice for teachers and clinicians too.

Reinforcer Classes and Reinforcer-Specific Effects

Operant contingencies involve consequences, and like responses they can profitably be studied in terms of classes (Cuvo, 2000). Successive reinforcers arranged in experimental settings are ordinarily similar but not identical. For example, individual pieces of grain made available when a pigeon's pecks operate its feeder will differ slightly in shape and color; a parent's hugs or smiles or positive comments that reinforce a child's behavior will undoubtedly vary from one instance to the next.

The discussion of higher-order classes examined the different responses that might produce attention and thereby maintain the self-injurious behavior of children with severe developmental disabilities. Because it shares its consequences with other responses, such as shouting obscenities or throwing things, the self-injurious behavior may be part of a larger class we might call attention-getting behavior. Within this class some types of responses may be more probable than others or may be differently available in different settings (Lalli et al., 1995). For example, a child might be more likely to engage in self-injury if nothing to throw is close at hand, or more likely to shout obscenities given one audience than given another. Nevertheless, their membership in a common class makes it likely that these responses will vary together as a function of establishing events or other variables.

But what if attention from staff members on this child's hospital unit does not function like attention from the child's mother when she visits the unit? If we find that one kind of attention cannot substitute for the other, we might best treat attention from these two different sources as two separate reinforcer classes. This is important to know because assessments of problem behavior on the unit may yield different results from those taken at the child's home; therefore, therapeutic interventions shaped up by staff attention on the unit may be incompatible with the kinds of behavior shaped up by the mother's attention at home. An effective treatment program must deal with the mother's behavior as well as the child's or the treatment gains realized on the unit will be lost soon after the child's discharge.

The significance of reinforcer classes has especially been demonstrated in research on the acquisition of arbitrary matching by children and by nonhuman organisms (Dube & McIlvane, 1995; Dube, McIlvane, Mackay, & Stoddard, 1987; Dube, McIlvane, Maguire, Mackay, & Stoddard, 1989; Kastak & Schusterman, 2002; Kastak, Schusterman, & Kastak, 2001; Pilgrim, Jackson, & Galizio, 2000; Schomer, 2002). Experiments on arbitrary matching typically incorporate correction procedures and other features

that reduce the proximity of errors to later reinforcers, and that reduce the likelihood that the organism will attend to dimensions of the environmental that are irrelevant to the task. Nevertheless, some children, as well as some pigeons, learn slowly.

In a typical matching study, all correct responses, whether to one comparison stimulus or the other, produce the same reinforcer. But if the reinforcers as well as the stimuli and responses of the arbitrary matching tasks enter into functional classes, this may be a mistake. While the contingencies may work to separate the different matching classes, such as green peck given square sample and red peck given circle sample, the common reinforcers may work to keep them together. With the matching task modified for children so that correct responses from the different problem classes each produce a different visual reinforcer (e.g., different cartoon pictures displayed on a video monitor), the acquisition of accurate arbitrary matching usually proceeds far more rapidly than when all responses produce the same reinforcer (e.g., Pilgrim, 2004; Urcuioli, 2005). The moral is that, whenever possible, we should arrange different reinforcers rather than a single reinforcer for the maintenance or the shaping of different response classes.

Reinforcement and Cultural Selection

The relations among behavior and its consequences in operant contingencies seem simple, but they have subtle properties, some of which become evident only in special contexts. For example, when side effects are not taken into account, contingencies can appear to be ineffective. Side effects of operant contingencies may have affected their acceptance because they allow the effects of contingencies to be masked in various ways. It is therefore prudent to consider the circumstances in which the properties of operant contingencies may mislead us as we deploy them and evaluate their effects. In the interests of preventing misconceptions and misunderstandings, it is probably even more important to remind ourselves of them whenever we present what we know about operant contingencies to those outside of behavior analysis. To those who argue that these contingencies should not be studied because they can be misused, the appropriate rejoinder is that detailed familiarity with their properties may be the best defense against their misuse. Alone or in combination, the factors considered here may sometimes give the appearance that operant contingencies do not work. On examination, we might instead conclude that they work more ubiquitously and more profoundly than we had originally imagined.

Phylogenic selection is Darwinian selection as it operates in the evolution of species. Ontogenic selection is operant selection as it operates in the shaping of behavior within an individual lifetime. A third level of selection is cultural selection, which involves the selection of behavior as it is passed on from one individual to another (Skinner, 1981). Selection at any one of these levels need not be consistent with selection at the other two. For example, it may not matter how valuable one way of doing things is relative to some other way, if one is easy to pass on from one individual to another, whereas the other can be passed on only with difficulty. The one that is easier to pass on may spread quickly and come to dominate in a culture relative to the other, even if the other would be more beneficial in the long term.

A case in point is the application of techniques of reinforcement relative to those of punishment. Unfortunately, the advantages of reinforcement do not make it more likely than punishment to spread through a culture (Catania, 2000). The problem is that delivering a punisher typically produces more immediate effects on behavior than delivering a reinforcer. Whatever else happens over the long term, a parent who shouts at or strikes a child thought to be misbehaving is likely to see some immediate change in the child's behavior, such as the onset of crying. That change will usually include the termination of the behavior of concern to the parent, even though it may have little to do with whether the behavior will reappear on later occasions, especially in the parent's absence. If stopping the child's behavior is part of what reinforces the parent's application of punishment, the immediacy of that reinforcer will be an important factor in maintenance of the use of punishment by the parent.

With reinforcement, on the other hand, the effects of delivering a reinforcer may not show up until some time has elapsed. In shaping, if a current response is reinforced closer to the target response than any other the shaper has seen before, the likelihood of that response will increase. Even so, many other responses might go by before the shaper sees another one like it. Unlike the punishment case, in which an immediate effect is typically that the target behavior stops, any immediate effect of reinforcement involves behavior unrelated to the target response (e.g., consuming an edible reinforcer). The time periods over which reinforcers change subsequent responding probably play a crucial role in determining how long it takes to teach shaping to students. If that makes it easier to teach aversive techniques than to teach those of reinforcement, perhaps that is also why punitive measures are so commonly used to maintain civil order in so many cultures.

Even as reinforcement begins to be more widely appreciated in our culture, we must not be complacent about teaching what we know about it. Despite the advantages of reinforcement, it is easier to teach the use of punishers than to teach the use of reinforcers, and reinforcement can be misunderstood or be obscured by other processes in various ways. Some people are very good at shaping even without explicit instruction, but mostly the effective use of reinforcers has to be carefully taught.

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