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REINFORCEMENT CONTINGENCIES AND SOCIAL REINFORCEMENT: SOME RECIPROCAL RELATIONS BETWEEN BASIC AND APPLIED RESEARCH

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Reinforcement contingencies and social reinforcement are ubiquitous phenomena in applied behavior analysis. This discussion paper is divided into two sections. In the first section, reinforcement contingencies are discussed in terms of the necessary and sufficient conditions for reinforcement effects. Response–stimulus dependencies, conditional probabilities, and contiguity are discussed as possible mechanisms of, and arrangements for, reinforcement effects. In the second section, social reinforcement is discussed in terms of its functional subtypes and reinforcement context effects. Two underlying themes run throughout the discussion: (a) Applied research would benefit from a greater understanding of existing basic research, and (b) basic research could be designed to specifically address some of the issues about reinforcement that are central to effective application.

DESCRIPTORS: reinforcement, contingency, social reinforcement, basic and applied research

Reinforcement is the most widely applied principle of behavior analysis (Northup, Vollmer, & Serrett, 1993). It is safe to say that without Skinner's detailed laboratory analyses of reinforcement (e.g., Skinner, 1938), there would be no field of "applied behavior analysis" today, at least not as we know it. Reinforcement, therefore, can be considered a prototype of deriving application from basic research. It is now commonly acknowledged that complex and socially relevant human behavior can be both maintained and modified by reinforcement contingencies. Despite the overwhelming empirical support for the application of reinforcement principles, much remains to be learned, even at the most basic levels. A more fundamental understanding of reinforcement principles will almost certainly enhance the application of reinforcement procedures.

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The focus of the "basic to applied" series in the *Journal of Applied Behavior Analysis* (*JABA*) is to suggest how basic research findings might enhance application. Although this focus will be maintained in the current paper, a second theme will also be developed, that applied problems should foster basic research. To that end, two specific areas related to reinforcement principles will be highlighted: (a) reinforcement contingencies and (b) social reinforcement. These subtopics were selected because they are ubiquitous in applied behavior analysis; hence, a better understanding of their mechanisms seems crucial to the advancement of the field. Virtually every article published in *JABA* involves reinforcement contingencies, and many of those studies involve conditioned reinforcement such as social praise.

The first section of the paper deals with reinforcement contingencies. Various aspects of reinforcement contingencies have been covered in prior discussion papers, including the general nature of reinforcement (Iwata & Michael, 1994), reinforcement schedules (Lattal & Neef, 1996), and choice (Fisher & Mazur, 1997). Here the discussion will focus on the necessary and sufficient conditions for reinforcement effects—the nature of the reinforcement contingency. Very little recent basic research has focused on the contingency, so the concept is discussed here in an effort to propose how basic and applied research might become integrated in their aims to understand the fundamentals of reinforcement. Thus, the first section deviates from previous articles in the basic to applied series in that it does not detail a specific line of recent basic research. To the contrary, very little recent research has addressed the contingency notion. The second section of the paper deals with conditioned reinforcement. As with reinforcement contingencies, conditioned reinforcement is a key concept in bridging basic research with application, as evidenced by its coverage in several prior discussion papers. Various aspects have been addressed, including observing (Hineline & Wacker, 1993), percentage reinforcement (Lalli & Mauro, 1995), and chaining (Stromer, McComas, & Rehfeldt, 2000). The emphasis of these articles has been on the potential relevance of laboratory-based concepts to applied work. Here the discussion will be on an already widely used but poorly understood area of conditioned reinforcement—social reinforcement.

REINFORCEMENT CONTINGENCIES

Dependency. Lattal (1995) used the term *contingency* to refer to a general description of relations between behavior and other events. Applied behavior analysts are perhaps most familiar with contingencies such as those described in our fundamental reinforcement schedules. In ratio and interval reinforcement schedules, a reinforcer is absent until a specified response requirement is met. The reinforcer *depends* on the occurrence of behavior in the sense that the reinforcer occurs if and only if a response requirement is met. It is clear, however, that a response–reinforcer dependency, albeit sufficient, is not a necessary condition for a reinforcement effect. Skinner ostensibly demonstrated superstition in the pigeon (Skinner, 1948), people have been doing rain dances for centuries (Reynolds, 1975), and gamblers still blow on the dice. Thus, if we use the term *contingency* only in a limited sense, such as being synonymous with *dependency,* we cannot possibly capture all behavior–stimulus arrangements that produce reinforcement effects.

The principal limitation, then, in studying reinforcement only in the context of response–stimulus dependencies is that behavior is not always maintained in that way in natural environments. Lattal (1995) pointed out that organisms "encounter a mix of events that result from their actions and others that occur independently of responding. Such a mix is probably more characteristic of natural settings" (p. 211). The field of applied behavior analysis is in part defined by the necessity to analyze behavior and impart meaningful behavior change in natural settings (Baer, Wolf, & Risley, 1968). Clearly, behavior analysts can shape and maintain new response forms using response–stimulus dependencies (e.g., reinforcement schedules, differential reinforcement). A response–stimulus dependency is a sure way to obtain a reinforcement effect, but such arrangements say little about the minimally necessary conditions for a reinforcement effect.

The current discussion is not intended to eschew the practice of using potent response–stimulus dependencies in behavior-analytic research and application. *JABA* is filled with good examples of how important skills have been shaped and maintained using response-dependent schedules in which the only way to obtain a reinforcer was to meet a specific response requirement. Analogously, much has been learned about the operant nature of severe behavior disorders by using response–stimulus dependencies in assessment preparations. For example, in one test condition of the seminal assessment study by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994), attention was delivered if and only if self-injurious behavior (SIB) occurred. This test condition has been replicated hundreds of times. If SIB rates increase in the attention condition relative to other test and control conditions, a reinforcement effect is demonstrated. This dependency arrangement of SIB–attention (response–stimulus) relations has proven to be very informative about the operant nature of severe behavior disorders. That is, we now know that SIB (among countless other behavior disorders) is sensitive to operant contingencies. However, for a thorough understanding of how reinforcement works in the natural environment, behavior analysts will probably need to study more complicated response–stimulus arrangements.

Conditional probability. From the applied literature on reinforcement schedules, it is clear that socially relevant behavior can be maintained by response–stimulus dependent relations. Consider a second way that behavior might be reinforced in the natural environment: The conditional probability of some stimulus event given the occurrence of behavior is higher than the conditional probability of some stimulus event given the nonoccurrence of behavior. In other words, the stimulus event does not entirely depend on the occurrence of a response, but the response increases the probability of the stimulus event. Extending the SIB example further, it could be that some probability of attention exists independent of the occurrence of SIB, but an increased probability of attention is associated with the occurrence of SIB. This formulation is consistent with the description of contingency provided by Catania (1998). A response–stimulus dependency is an example of a "positive" contingency derived from a comparison of two conditional probabilities: The probability of a stimulus event given a response is something greater than 0, whereas the probability of a stimulus event given the nonoccurrence of a response is 0. In nature, reinforcement contingencies must at times be much weaker (i.e., lie at points between 0 and 1). For example, the probability of gaining attention following SIB might be .20 but the probability of gaining attention had no SIB occurred might be .10. Contingencies weaker than those established by response–stimulus dependencies have not been studied comprehensively in either applied or basic laboratories.

One area of experimentation that seems especially relevant to this discussion is the laboratory research on fixed-time (FT) and variable-time (VT) schedules, in which FT or VT schedules are superimposed on response-dependent schedules such as fixed-interval (FI) or variable-interval (VI) schedules. That is, FI and VI schedules remain in effect against a background of response-independent stimulus deliveries. For example, Lattal and colleagues (e.g., Lattal, 1974; Lattal & Bryan, 1976) showed that superimposing response-independent schedules on response-dependent schedules reduced response rates but did not eliminate them, presumably because the momentary probability of a reinforcer was increased by emission of a response. In short, the reinforcement effect is weakened by the introduction of FT or VT schedules, but there is a reinforcement effect nonetheless.

This information has direct relevance for application not only in terms of understanding how behavior might be maintained in natural environments, but because FT or VT schedules are commonly used as treatment for severe behavior disorders (known as noncontingent reinforcement schedules; e.g., Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993). The notion is that if reinforcers can be delivered on a time-based schedule independent of behavior, the relation between response and stimulus is weakened and the "motivation" to engage in problem behavior should be reduced. For example, why head bang to produce attention if attention is already available? If problem behavior is intermittently reinforced as a result of treatment integrity failures, it is possible that a sufficient contingency of reinforcement exists to support the problem behavior even though an FT or VT treatment schedule is in effect.

A second area of research relevant to the contingency arrangement involving conditional probabilities is highlighted by the work of Hammond (1980). Hammond arranged reinforcer deliveries such that rats' lever presses either increased the probability of food (a positive contingency), decreased the probability of food (a negative contingency), or did not alter the probability of food (a neutral, or zero, contingency). Only the positive contingency arrangement yielded a reinforcement effect. The implications for application are that applied researchers could evaluate the conditional probability of some potential reinforcer (e.g., adult attention) given the occurrence of the target behavior compared to the nonoccurrence of the target behavior. Based on Hammond's results, one would predict that the adult–child interactions are problematic only if the child's target behavior increases the probability of the adult attention.

There are at least three limitations to the conditional probability approach (i.e., comparing the conditional probability of a stimulus event given the occurrence of behavior and the nonoccurrence of behavior). First, the majority of research involving response-independent schedules (FT or VT) superimposed upon response-dependent schedules has involved the use of a response-dependent baseline (FI or VI). It would be useful to know just how strong the "positive" contingency must be before a reinforcement effect will emerge, in the absence of a strong reinforcement history. For instance, subjects could be exposed to an arrangement wherein the occurrence of behavior initially did not increase the probability of some stimulus event (a neutral contingency). The contingency could become gradually more positive until a reinforcement effect emerges. Other subjects could begin with slightly positive contingencies or negative contingencies to control for order effects. This arrangement might more closely simulate the development of reinforcement contingencies in the natural environment.

A second limitation of the conditional probability approach is a practical one. In natural environments it is virtually impossible to operationalize the "nonoccurrence" of behavior in calculating the conditional probability. For example, suppose SIB occurs at Second 27 of an observation and attention occurs at Second 58. Does the instance of attention count as attention given the occurrence of SIB or the nonoccurrence of SIB? What if the attention occurred 12 s after the SIB? 20 min after the SIB? The point is that there is an arbitrary cut-off in ascribing conditional probabilities as they emerge in uncontrolled environments.

To address this issue, behavior analysts may benefit from exploring a contingency calculation used in basic research of a more cognitive orientation. Watson (1997) described the utility of a calculation involving a comparison between the conditional probability of a stimulus event given the occurrence of behavior versus the overall probability of that stimulus event. Note that the overall probability of a stimulus event does not require operationalizing the nonoccurrence of behavior. This interpretation of reinforcement effects in the natural environment is similar to the position set forth by Galbicka and Platt (1989), who described response–stimulus relations that occur against a noisy background of response-independent events.

Descriptive analysis research presents an interesting forum for discussion of naturally occurring schedules (Mace & Lalli, 1991). As an example of how the overall probability might be used to interpret response–stimulus relations, suppose attention follows SIB with a probability of .20, but suppose the overall momentary probability of attention independent of behavior is .35. Without reference to the overall probability, the applied researcher conducting a naturalistic observation might be inclined to interpret the relation between SIB and attention as a variable-ratio (VR) 5 schedule. Every fifth time (on average) that SIB occurred it was followed by attention. With a large enough sample of behavior, and with reference to the overall probability of attention, one could reasonably conclude that SIB was actually correlated with a *decreased* probability of attention (e.g., Vollmer, Borrero, Wright, Van Camp, & Lalli, in press). There are a number of ways in which relations involving overall probabilities could be interpreted. The essential point here is that including the overall probability of attention in a functional analysis would likely produce different effects than an arrangement in which SIB produced attention with a probability of .20 and otherwise no attention was available (probability of 0). A VR 5 would involve a strong response–stimulus dependency in which the only way to obtain attention is to engage in the target response ($p = .20$ vs. $p = 0$). In the latter arrangement, there is a strong probability of attention even if SIB never occurs. It is possible that the former arrangement would yield a reinforcement effect, whereas the latter arrangement may not. A parametric analysis of these two schedule arrangements would be informative in both the basic and applied realms.

A third limitation of conditional probability analyses is that response-independent stimulus events may be contiguous with behavior (e.g., Lachter, 1971; Rescorla & Skucy, 1969). Thus, although the programmed arrangement is such that the target response does not increase the probability of a stimulus event, the probability of actual pairings may be unchanged. In an applied example of this problem, Vollmer, Ringdahl, Roane, and Marcus (1997) showed that an adolescent girl's aggression, reinforced by access to magazines, was maintained even when the schedule was changed from continuous reinforcement to FT. During FT, no aggression was needed to gain access to the magazines. Nonetheless, the frequency of aggression was so high during the reinforcer–reinforcer interval (1 min) that the contingency established during baseline was never disrupted: A flurry of aggression almost always terminated with the scheduled delivery of the magazine. An analysis of within-session response patterns showed that the behavior gradually took on characteristics of FI patterning (rates of aggression increased toward the end of the 1-min interval). From a treatment standpoint, this problem is easily resolved by inserting a brief omission requirement. However, the issue is troublesome conceptually because the actual probability of the stimulus event (magazines) is no higher given the occurrence or nonoccurrence of behavior (aggression). Thus, it is reasonable to conclude that under some circumstances mere temporal contiguity between a response and stimulus event may produce a reinforcement effect, regardless of conditional probabilities.

Contiguity. Contiguity refers simply to a close temporal relation between two events (in this case, a response and a subsequent stimulus event). It has long been known that a single pairing of response and stimulus can produce a reinforcement effect (Skinner, 1956). The implications of this finding for application are extremely important but vastly understudied. Skinner showed that when a single instance of lever pressing by a rat was followed in close temporal proximity by food, the behavior persisted for an inordinate amount of time. By extension, it follows that a child might bang his head against a wall or floor for some unknown reason, but when it is followed by attention (perhaps even just once!) the behavior may persist. Similarly, in the development of verbal behavior, perhaps a single reinforced utterance firmly establishes a particular vocal topography into an individual's repertoire.

Of course, Skinner (1956) went on to show that if the response were no longer followed by a reinforcer, it would eventually be extinguished. He also showed that if a reinforcer intermittently followed the response it would not be extinguished. But what if the response were sometimes followed by food, sometimes not followed by food, and sometimes food was presented when no response occurred? Once that initial response–stimulus contiguity produces a reinforcement effect, what are the necessary and sufficient conditions to maintain the behavior?

There are at least two issues related to contiguity that seem especially relevant to applied researchers. First, at times a change from a response–stimulus dependency (or at least a positive contingency) to a response-independent stimulus event may not be discriminated. That is, due to a history of reinforcement, simple contiguous pairing of a response and a stimulus event is a sufficient arrangement to maintain behavior. Second, it is possible that in some cases response–stimulus relations are sufficient to establish and maintain behavior even in the absence of a prior history with the response–stimulus relation and even when there is no positive correlation between those two events.

The study by Vollmer et al. (1997), in which aggression was maintained during an FT condition, highlights the possibility that a change from a response–stimulus dependency to a response-independent schedule may not be discriminated. A handful of other studies support this conclusion. Rescorla and Skucy (1969) showed that rats' lever pressing was maintained on a VT 2-min schedule (at least in comparison to extinction) when the VT 2-min schedule followed a VI 2-min baseline. Ringdahl, Vollmer, Borrero, and Connell (2001) showed that, with developmentally disabled children, responding under time-based schedules persisted longer than responding under extinction if the time-based schedule was similar to the baseline schedule along the dimension of reinforcement frequency (e.g., baseline = FI 30 s; FT = FT 30 s). Lachter (1971) showed that if baseline contingencies generated high rates of key pecking in pigeons, those rates were less likely to wane under VT schedules. In that study, a run of key pecking almost always preceded food. Finally, in our laboratory here at the University of Florida, we have some new evidence that lever pressing in rats during FT schedules resembles FI-like (scalloping) patterning when the FT follows an FI baseline. Collectively, these findings show that response–stimulus dependencies and response–stimulus positive correlations are not necessary for a reinforcement effect. In addition, these findings suggest that there may be a complex relationship between the reinforcement schedule in baseline and the response-independent schedule used as behavioral treatment.

It follows from the above studies that maladaptive behavior could be inadvertently maintained if a time-based schedule (treatment) is similar to the reinforcement schedule prior to treatment (baseline). That is, if there is nothing to "select against" the pattern of responding generated by the baseline schedule, the response pattern would continue to culminate in reinforcement and the behavior, therefore, could be adventitiously reinforced. Future basic and applied research might address this possibility by varying the discriminability of baseline reinforcement to FT or VT schedules. For example, it may be that a transition from FI 60 s to FT 60 s is less likely to disrupt a reinforcement contingency than, say, a transition from FI 60 s to FT 30 s. In the FT 30-s schedule, some reinforcers would occur before a run of behavior (characteristic of FI schedules) is initiated.

The second general issue about contiguity is that behavior might be maintained by contiguous pairings even without a strong prior reinforcement history. Such contiguity-produced reinforcement effects would be a bad thing if the target behavior were problematic but would be a good thing if the target behavior were desired (e.g., simple contiguous pairings producing a reinforcement effect should aid in generalization to extratherapy environments). Neuringer (1970) showed that when pigeons' first three key pecks were reinforced, the behavior was maintained for 50 experimental sessions under a variety of response-independent schedule arrangements. In this study, the first exposure to food in the experimental context occurred following a key peck. The implications are that only a few instances of response and stimulus occurring closely in time may yield a lasting reinforcement effect. Some possible extensions of Neuringer's work might include arranging experimental conditions as follows: (a) A stimulus event occurs frequently in the absence of a response but also occurs every time a response occurs, (b) a stimulus event occurs frequently in the absence of a response but also occurs intermittently when a response occurs, and (c) a stimulus event occurs infrequently in the absence of a response and occurs infrequently when the response occurs. All of these arrangements seem to mimic how behavior and stimulus events might interact in the natural environment in the early stages of behavioral development. Experimentally manipulated parametric shifts in these arrangements may shed light on the necessary and sufficient conditions for contiguous response–stimulus relations to produce a reinforcement effect.

SOCIAL REINFORCEMENT

The purpose of the preceding section was to describe response–stimulus arrangements that may produce reinforcement effects and to suggest further research on that topic. Equally relevant to the application of reinforcement is to gain a better understanding of the characteristics of commonly used reinforcers. Probably the most commonly used type of reinforcer in applied behavior analysis is social reinforcement.

It is generally assumed that socially arranged consequences are generalized conditioned reinforcers and punishers whose effectiveness is established and maintained through relation to other reinforcing and punishing events. For example, Skinner (1953) suggested that signs of approval and disapproval are generalized conditioned reinforcers and punishers by virtue of the close coupling of such events with a variety of primary reinforcers and punishers throughout early development. Thus, eye contact, facial expressions, and physical contact become powerful reinforcers and punishers in their own right. On the other hand, it is not unreasonable to suppose that for humans and other social species there are unconditioned aspects to such stimuli as well; that is, susceptibility to control by features of others' behavior has been selected in the evolution of social species.

Regardless of their origins, there is little question that socially arranged consequences give rise to and maintain a wide range of behavior, both adaptive and maladaptive. As stated in the discussion on contingencies, there is now considerable evidence that many problem behavior patterns are maintained by social consequences (Iwata et al., 1982/1994). Such information has proven invaluable as a guide to developing effective treatments, but we still know relatively little about the formal and functional characteristics of socially arranged consequences. What features contribute to the effectiveness of such consequences as reinforcers and punishers? What are the conditions under which the effectiveness of such reinforcers and punishers is maintained?

Functional subtypes. Unlike tangible reinforcers and punishers, which can be standardized and delivered in a fairly uniform fashion, social consequences come in a variety of forms—facial expressions, physical contact, vocalizations—and are delivered in a variety of ways. A major challenge then lies in identifying the features that contribute to the effectiveness of social consequences. In research designed to identify the effective components of social reprimands, Van Houten, Nau, MacKenzie-Keating, Sameoto, and Colavecchia (1982) found that verbal reprimands were more effective in suppressing problem behavior when combined with eye contact and physical contact (a firm grasp) than verbal reprimands alone. Similarly, Kazdin and Klock (1973) found that smiles and physical contact enhanced the reinforcing effectiveness of verbal approval in modifying classroom behavior.

Perhaps the effectiveness of physical contact and facial expressions as reinforcers and punishers is at least partly unconditioned; that is, they derive from the important role such stimuli have played in the evolution of social environments. When social consequences also include verbalizations, however (as they often do in human social interactions), specific learning histories are brought to bear. For example, Piazza et al. (1999) found that different forms of verbal attention were differentially effective as reinforcers. For 1 participant, praise was ineffective as a reinforcer if verbal reprimands were concurrently available, but was effective when reprimands were unavailable. For a 2nd participant, a more effective form of social reinforcement (tickling) was found to effectively compete with reprimands, as evidenced by its successful use in training a more socially acceptable behavior (manding for tickling). These results are important in identifying functional subtypes of social attention and have important implications for treatment. For example, it is common for attention-maintained problem behavior to be identified by its sensitivity to one form of response-contingent attention (usually reprimands) but then is treated by arranging contingencies with respect to a different form of attention (usually praise). This strategy assumes that reprimands and praise belong to a common class of social reinforcers. Piazza et al.'s results, however, suggest that not all forms of social reinforcement are equivalent, and call into question the strategy of using interchangeably different forms of social consequences.

In a similar vein, Fisher, Ninness, Piazza, and Owen-DeSchryver (1996) found that the effectiveness of verbal attention as a reinforcer depended on the content of the verbalization. Verbalizations that were more relevant to the target behavior (e.g., "Don't do that, you'll hurt me") maintained higher levels of responding than did irrelevant verbalizations (e.g., "It's a nice day today"). The greater effectiveness of task-relevant verbalizations may derive in part from their discriminative functions—the degree to which they specify or imply some set of contingencies. A task-relevant verbalization such as "please stop hitting, you are hurting me" both specifies a particular response (hitting) and implies certain consequences for continuing to engage in that response. Task-irrelevant verbalizations do neither. Additional work along these lines may provide a bridge to laboratory analyses of instructional control.

Laboratory research with normally developing adult humans shows that instructional control depends on the correspondence between the instruction and the contingencies (Galizio, 1979; Hackenberg & Joker, 1994; Hayes, Brownstein, Zettle, Rosenfarb, & Korn, 1986; Schmitt, 1998), somewhat analogous to task relevance in the Fisher et al. (1996) study. In the Fisher et al. study, as well as in most laboratory studies, accuracy of the instruction has been examined mainly at the extremes; instructions are either completely accurate (task relevant) or not (task irrelevant). Exploring the middle ranges of this continuum should prove useful in discovering the conditions under which compliance does and does not occur. In the Hackenberg and Joker experiment, for example, the correspondence between instructions and contingencies was varied systematically over a wide range. This was accomplished by gradually changing the contingencies while holding the instructions constant. Instructional control was maintained across several conditions, despite growing inaccuracy of the instructions, but eventually was extinguished as the discrepancy between the instructions and the contingencies widened.

These results show that instructional control depends, at least in part, on the correspondence between the instructions and the contingencies, and suggests a method by which to examine compliance when the correspondence between instructions and contingencies is weak or imperfect, as it frequently is in the natural environment. At the same time, the fact that instructional control takes root so quickly in laboratory studies (e.g., Hackenberg & Joker, 1994) demonstrates the powerful influence of subjects' preexperimental histories, most notably the long histories of compliance with the verbal statements of others. Such a history cannot be so readily assumed with some of the special populations who serve as participants in applied research. Some participants even lack the basic sensitivity to social reinforcement that provides the basis for socially mediated compliance. For such participants, specific measures are needed to establish social interaction as a positive reinforcer, yet we still know very little about the optimal arrangement of such conditions.

Promising in this regard are studies showing that the reinforcing efficacy of social interaction can be modified simply by making more highly preferred reinforcers available in the social setting (Hanley, Iwata, & Lindberg, 1999). For 1 participant in this study, a setting in which social interaction was required was rarely selected when other (nonsocial) activities were available. When social interaction was explicitly reinforced with access to a preferred object, however, the reinforcing value of the setting as a whole was enhanced; this setting was selected over previously preferred activities. Whether such changes in the reinforcing value of social interaction were due to respondent-type pairings with strong reinforcers in the setting or to discriminative relations between the setting and operant contingencies is not possible to determine. Additional research is needed to more fully characterize the necessary and sufficient conditions for enhancing the effectiveness of social interaction.

Work along these lines should yield not only practical techniques for modifying behavior of social importance but important conceptual advances as well. As we learn more about the conditions under which social consequences are established and maintained, we will learn more about how these basic social contingencies fit into developing verbal repertoires, a crucial element in recent accounts of verbal and symbolic functioning (e.g., Horne & Lowe, 1996). Examining such relations in people with minimal or deficient verbal repertoires affords applied researchers unique opportunities to make significant contributions to the exciting and rapidly growing field of behavior analysis concerned with complex human behavior.

Reinforcement context. The Piazza et al.

(1999) results described earlier also speak to the role of the overall reinforcement context in modulating the effectiveness of particular reinforcers. That is, the effectiveness of praise as a reinforcer depended on whether or not reprimands were concurrently available. This adds to a growing body of applied research showing how reinforcer value is affected by concurrent sources of reinforcement (Fisher & Mazur, 1997), and points to the need to expand the range of reinforcers included in stimulus preference assessments, including different types of social reinforcers (Fisher et al., 1992; Roane, Vollmer, Ringdahl, & Marcus, 1998).

Differential sensitivity to praise and reprimands likely reflects sources of control outside the experimental context. Because individuals with problem behavior probably have more extensive histories with reprimands than with praise, the reprimands presented during an experiment may serve a discriminative function, occasioning further problem behavior. At the same time, it is not unreasonable to suppose that the value of praise and reprimands as reinforcers and punishers, respectively, is mutually enhancing, in that periodic reprimands enhance the efficacy of praise as a reinforcer, and vice versa (Van Houten & Doleys, 1983).

Although detailed information along these lines is lacking, what is known is that the effectiveness of social reinforcers is influenced by their availability in the environment at large. Several studies have shown that the reinforcing efficacy of social interaction varies as a function of noncontingent access to attention prior to a session (O'Reilly, 1999; Vollmer & Iwata, 1991). Such effects are normally conceptualized as being the result of motivational factors: The noncontingent access to attention reduces the value of attention as a reinforcer for the target behavior. In the O'Reilly study, however, this manipulation produced differential effects on two topographies of problem behavior: Presession exposure to attention attenuated head hitting but had little or no effect on yelling, despite the fact that both responses had previously been shown to be maintained by attention.

This differential sensitivity to an establishing operation again suggests functional subtypes of attention-maintained behavior. Perhaps hitting was a costlier response than yelling, or yelling was maintained in part by consequences other than attention. As such, hitting was more sensitive to the response-weakening effects of the noncontingent access to social reinforcement. It is also possible that the two responses interacted differentially with the form of the attention. Although it was not explicitly stated, attention in this study was likely in the form of reprimands when it occurred in the context of problem behavior but in the form of praise when it occurred in the absence of problem behavior. Because problem behavior occurred rarely in the periods preceding the sessions (when the subject was either alone or receiving social interaction on a rich schedule), the form of the attention prior to and during the session probably differed. As in the Piazza et al. (1999) study, perhaps the two response forms were differentially sensitive to praise and reprimands: For head hitting, presession noncontingent praise substituted for contingent reprimands during the session, whereas for yelling it did not.

Such efforts to quantify the relationship between social reinforcers, and between social and nonsocial reinforcers, may be aided by a behavioral economics framework. Tustin (1994, 2000), for example, examined demand curves—functions relating number of obtained reinforcers to price (defined in terms of the number of responses required to produce a reinforcer). In one set of manipulations in the first study, the price of social reinforcement (in the form of attention and approval) was varied from fixed-ratio (FR) 1 to FR 20 across phases while the price of visual reinforcement was held constant at FR 5. As the price of social reinforcement increased, the number of social reinforcers decreased, and the number of visual reinforcers increased. These results have some important implications for an analysis of social reinforcement. First, the function relating the number of social reinforcers to the price of obtaining those reinforcers shows the same characteristic downturn as other reinforcers. The slope of this curve—called the own-price demand curve—can be used to quantify the value of the reinforcer, which may be useful in comparing the effectiveness of social reinforcers to other reinforcers and of different types of social reinforcement. Second, the inverse relation between number of visual reinforcers and price of social reinforcement suggests that the two reinforcers were *substitutes*—decreases in one produced corresponding increases in the other. (If the two reinforcers had both decreased together, they would be termed *complements*.) The slopes of the demand curves between two reinforcers as the price of one is changed—called the cross-price demand curve—can be used to quantify the interaction between qualitatively different reinforcers.

Viewing the relationship between different reinforcers on a continuum ranging from perfect substitutes to perfect complements may broaden our analysis of social reinforcement and may lend some quantitative rigor to the notion of a generalized reinforcer. From this perspective, generalized reinforcers such as social attention are those that function as substitutes for a wide range of other reinforcers. This has important treatment implications. The effectiveness of a particular form of attention will vary as a function of the types and ranges of concurrently available reinforcers with which it is functionally substitutable. For example, assume that some problem behavior (say, hitting) is maintained by attention in the form of reprimands. Assume further that praise is then used to differentially reinforce behavior incompatible with hitting while reprimands are withheld (extinction). If the extinction component is not conducted with perfect integrity (i.e., hitting continues to be reinforced on an intermittent basis), the effectiveness of the intervention will vary as a function of the substitutability of praise and reprimands as reinforcers. The intervention is most likely to succeed if the reinforcers are substitutable—as increases in praise compensate for decreases in reprimands—and is most likely to fail if praise and reprimands are not substitutable. Between these points lie degrees of substitutability, where reprimands and praise partially substitute for one another. One might expect such conditions to result in intermediate degrees of treatment success, as increases in praise only partially compensate for decreases in reprimands. Such partial substitutability between social reinforcers is more likely the rule than the exception in the natural environment, and is one research area that stands to profit from an economic framework.

SUMMARY

Reinforcement contingencies, in general, and social reinforcement contingencies, in particular, are ubiquitous in applied behavior analysis. Perhaps these principles are taken for granted because behavior analysts already know how to arrange powerful reinforcement contingencies, and they know how to use social reinforcement effectively. In this discussion, we have highlighted several areas of basic and applied research that suggest a need for a more fundamental understanding of reinforcement contingencies and social reinforcement. One theme of both sections is that in nature reinforcement occurs in a highly complex system, a noisy background. In a unified approach to science and application (Mace, 1991), applied research will tell us what the noise sounds like, basic research will help us to isolate relevant features of the noisy background, and as a result, the application of reinforcement will improve.

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