Defining Delayed Consequences as Reinforcers: Some Do, Some Don't, and Nothing Changes

Kelly P. Bradley and Alan Poling, Western Michigan University

Results of a survey sent to members of the editorial boards of five behavior-analytic journals in 1990 indicated that there was no consensus among respondents with respect to whether delayed events can function as reinforcers (Schlinger, Blakely, Fillhard, & Poling, 1991). Since that time, several studies with nonhuman animals have demonstrated that events delayed by at least several seconds can increase the probability of occurrence of the responses that produce them. To determine the relative number of contemporary behavior analysts who nonetheless believe that reinforcers must immediately follow the responses that produce them, the present study replicated the procedures used by Schlinger et al., with similar results. That is, respondents did not agree with respect to whether delayed events could be reinforcers.

Key words: reinforcement, reinforcer, delayed reinforcement, verbal behavior

A fundamental concept in behavior analysis is that the consequences of a particular kind of responding (an operant response class) powerfully influence the future likelihood of occurrence of such responding (e.g., Skinner, 1953). Consequences that increase the future likelihood of occurrence conventionally are termed *reinforcers*, and the process whereby behavior is strengthened is termed *reinforcement* (e.g., Fantino & Logan, 1979; Schlinger & Poling, 1998; Skinner, 1953). Given the terms' importance in behavior analysis, it is crucial that the formal descriptions of "reinforcer" and "reinforcement" are empirically accurate and that the terms are used in a consistent manner.

This does not, however, appear to be the case. Consider, for example, the following textbook definitions of *reinforcement* (or variants thereof):

Positive reinforcement is the presentation of a stimulus (called a positive reinforcer) immediately following a response. A positive reinforcer is defined as any stimulus whose presentation immediately following a response increases the probability (i.e., the frequency or rate of occurrence) of that response. (Pear, 2001, p. 31)

The reported data were collected as part of the master's thesis of Kelly Bradley. We thank all respondents for their help.

Address correspondence to Alan Poling, Department of Psychology, Western Michigan University, Kalamazoo, Michigan 49008 (e-mail: alan.poling@wmich.edu).

Reinforcement always refers to an increase in the likelihood or probability of a response when that response is immediately followed by consequences. (Kazdin, 2001, p. 50)

Reinforcement is defined as follows: (1) The occurrence of a particular behavior (2) is followed by an immediate consequence (3) that results in the strengthening of that behavior (the person is more likely to engage in the behavior again in the future). (Miltenberger, 2008, p. 75)

A positive reinforcer is an event that, when presented immediately following a behavior, causes the behavior to increase in frequency (or likelihood of occurrence). (Martin & Pear, 2007, p. 30)

A reinforcer (positive reinforcer) is any stimulus, event, or condition whose presentation immediately follows a response and increases the frequency of that response (Malott, 2008, pp. 2–3)

Positive reinforcement occurs when a behavior is followed immediately by the presentation of a stimulus and, as a result, occurs more often in the future. (Cooper, Heron, & Heward, 2007, p. 25)

Positive reinforcement [is] a class of procedures involving the occurrence of a stimulus immediately following responding that results in an increase in some aspect of the response class over baseline levels. (Johnston & Penny-packer, 2009, p. 73)

Positive reinforcement (S^{R+}) is the contingent presentation of a stimulus,

immediately following a response, that increases the future rate or probability of the response. (Alberto & Troutman, 2009, p. 217)

Although the specific verbage differs, each of these definitions specifies that reinforcers must *immediately* follow the behavior that they strengthen. Other authors, however, do not include this component in their definition, as the following examples illustrate:

Reinforcement is the procedure of providing consequences for a behavior that increases or maintains the strength of that behavior. (Chance, 2006, p. 141).

In operant conditioning, reinforcement is a process whereby a consequence strengthens the behavior on which it is contingent. (Sarafino, 2004, p. 111)

Positive reinforcement is where a stimulus follows behavior and, as a result, the rate of that behavior increases. ... These stimulus events, however, cannot be called positive reinforcers until they have been shown to increase behavior. (Pierce & Cheney, 2008, p. 68)

When a stimulus strengthens behavior by virtue of being presented following the occurrence of such behavior, the stimulus is termed a positive reinforcer and the procedure is termed positive reinforcement. (Schlinger & Poling, 1998, p. 119)

The process of positive reinforcement requires several necessary conditions. First, a consequence must be contingent on responding. Second, the response must increase in probability when the consequence is made contingent on responding. Finally, the application of the consequence must be a necessary and sufficient condition to explain the increase in probability of responding. (Leslie & O'Reilly, 2003, p. 212).

None of these definitions indicate that reinforcers must immediately follow the responses that produce them. *Immediately* literally means “without interval of time” (*Merriam-Webster’s Collegiate Dictionary*, 2009), or “without any delay or lapse of time; instantly” (*Oxford English Dictionary*, 2009). In both basic and applied research settings, as well as in practical applications of behavior analysis, even when reinforcement is described as “immediate” there is inevitably some delay between the occurrence of the

designated operant response and the event that reinforces it. The delay may be a few milliseconds in a laboratory setting when a bar press produces electrical brain stimulation or a few seconds in an autism clinic when appropriate verbalizations are reinforced with edible items, but reinforcement is rarely, if ever, truly immediate.

Of course, it is possible that most behavior analysts, even those who specify in their definition that reinforcers must immediately follow operant responses, recognize that reinforcers need not be delivered with literally no delay to be effective. They may use *immediately* to mean “with little delay” and include this component as a heuristic, to emphasize that delaying reinforcers reduces their effectiveness. Malott (2008), who includes immediacy in his definition of reinforcement (see above), discusses this issue as follows:

The direct effect of reinforcers drops off quickly as you increase the delay, even to 3 or 4 seconds. And even a 1-second delay may reinforce the wrong behavior. If you ask a child to look at you and then give the reinforcer 1 second after that response, you’re liable to reinforce looking in the opposite direction. So one problem with delayed reinforcement is that it may reinforce the wrong response—the one that occurred just before the delivery of the reinforcer. Roughly, a reinforcer must be delayed no longer than 1 second to be considered immediate reinforcement and the closer to 0 seconds, the better; between 1 and about 60 seconds should be considered delayed reinforcement. If the reinforcer is delivered after 60 seconds, it probably won’t reinforce the response. (p. 3)

Here, Malott sets a 1-s delay as the limit for immediate reinforcement and suggests that events delayed by more than about 60 s will not function as reinforcers.

Although behavior analysts differ substantially in how they formally define *reinforcement* (and *reinforcer*), this does not necessarily mean that they would disagree with respect to whether a given interaction between behavior and the environment constitutes reinforcement. From a behavior-analytic perspective, terminology is precise and consistent, hence potentially valuable, if members of the verbal community consistently tact particular stimuli in the same way

(Moore, 1995, 2008; Skinner, 1957). If, for example, behavior analysts characteristically agree that three examples of response-dependent stimulus presentations and their subsequent effects on behavior (i.e., three behavioral scenarios) constitute reinforcement, whereas two other scenarios do not, then *reinforcement* is being used in a precise and consistent fashion. It may be the case that such consistency would be observed among contemporary behavior analysts, even those who define *reinforcement* in different ways.

In 1991, Schlinger, Blakely, Fillhard, and Poling reported that prominent behavior analysts did not consistently agree with respect to whether they considered a given behavioral scenario as an example of reinforcement. Prominent behavior analysts were defined as members of the editorial boards of the *Journal of Applied Behavior Analysis* (JABA), the *Journal of the Experimental Analysis of Behavior* (JEAB), the *Journal of Organizational Behavior Management* (JOBM), *The Analysis of Verbal Behavior* (TAVB), and *The Behavior Analyst* (TBA). The scenario described a situation in which a researcher submitted a grant proposal that was funded 6 months later and subsequently increased the amount of time and effort devoted to writing grant proposals. It was followed by four questions intended to determine, first, whether respondents would label the apparent functional relation between behavior and its delayed consequences as reinforcement and, second, their general opinions regarding delayed events functioning as reinforcers. Based on the results of their questionnaire, which was mailed to respondents in 1990, Schlinger et al. reported that the majority, but by no means all, of the editors of prominent behavior-analytic journals did not consider the time elapsed between a response and its consequence when determining whether the consequence was a reinforcer. Instead, they simply considered its effects on future responding.

For example, the third question asked respondents to answer true or false to the following statement: "In general, if an appropriate functional relation between a response class and a consequence can be demonstrated, the delay between the two is irrelevant in defining the consequence as a

reinforcer" (Schlinger et al., 1991, p. 156). The percentage of respondents who answered "true" was 75%, 68%, 70%, 35%, and 50% for JABA, JEAB, JOBM, TAVB, and TBA, respectively. Although the majority of respondents indicated that delay was not relevant in classifying consequences as reinforcers, there were substantial differences in findings across journals, and for two of the journals, TAVB, and TBA, the majority of respondents did not indicate that delay was irrelevant. Clearly, consensus was lacking.

The purpose of the present study was to replicate the work of Schlinger et al. (1991). Several studies (e.g., Critchfield & Lattal, 1993; Lattal & Gleeson, 1990; Sutphin, Byrne, & Poling, 1998; Wilkenfield, Nickel, Blakely, & Poling, 1992; Williams & Lattal, 1999) that clearly demonstrated that responding can be acquired and maintained with delayed consequences have been published since their questionnaire was distributed and, if the verbal behavior of behavior analysts is indeed guided by experimental findings, it appears that few contemporary respondents would categorically exclude delayed events from the category of *reinforcer*. The present study determined if this was indeed the case.

METHOD

A questionnaire, which appears in Table 1, was sent via e-mail in September 2008 to the members of the editorial boards of JABA, JEAB, JOBM, TAVB, and TBA, which comprised 57, 50, 64, 28, and 26 people, respectively. The e-mail asked board members to complete the questionnaire and return it via e-mail within 30 days of receipt. The e-mail included the questionnaire and an informed consent document as attachments. A follow-up e-mail, repeating the initial request, was sent to all editorial board members in November 2008. The questionnaire depicts a scenario, equivalent to that used by Schlinger et al. (1991), which describes a hypothetical situation in which a researcher receives grant money 6 months after submitting a proposal and the time and effort expended in grant writing subsequently increase. Four questions, also comparable to those asked by Schlinger et al., follow the scenario. The scenario was developed to introduce the issue of delay in defining a

Table 1
The Questionnaire and Responses Thereto

Scenario. There appears to be a functional relation between grant writing and receipt of grant money: A researcher receives grant money 6 months after submitting a grant application and the time and effort spent in grant writing subsequently increase.

1. Receipt of the money in the scenario is a reinforcer regardless of the long delay between the behavior (grant writing) and the consequence.

	True (%)	False (%)	Other (%)
<i>JABA</i>	57	43	0
<i>JEAB</i>	62	38	0
<i>JOBM</i>	53	44	3
<i>TAVB</i>	47	42	11
<i>TBA</i>	71	29	0

2. Receipt of the money in the scenario is a reinforcer, but its effects are dependent on verbal behavior by the researcher. (Please answer only if you responded “true” to Question 1.)

	True (%)	False (%)	Other (%)
<i>JABA</i>	53	35	12
<i>JEAB</i>	60	35	5
<i>JOBM</i>	58	37	5
<i>TAVB</i>	55	36	9
<i>TBA</i>	80	20	0

3. In general, if an appropriate functional relation between a response class and a consequence can be demonstrated, the delay between the two is irrelevant in defining the consequence as a reinforcer.

	True (%)	False (%)	Other (%)
<i>JABA</i>	53	47	0
<i>JEAB</i>	72	28	0
<i>JOBM</i>	56	44	0
<i>TAVB</i>	58	42	0
<i>TBA</i>	71	29	0

4. If you answered “false” to Question 3, how delayed can an event be and still be classified as a reinforcer? (Responses appear in Table 2.)

reinforcer, and the questions were developed to secure respondents’ views regarding this issue.

Question 1 asked all potential respondents whether the receipt of money served as a reinforcer. If a respondent responded that this was the case, he or she was asked in Question 2 whether its effects are dependent on verbal behavior by the researcher. Question 3 asked all potential respondents whether, if an appropriate functional relation between a response class and a consequence can be demonstrated, the delay between the two is irrelevant in defining the consequence as a reinforcer. Question 4 asked respondents who answered that delay is relevant to defining an event as a reinforcer how delayed an event could be and still be classified as a

reinforcer. Questions 1, 2, and 3 used a true–false format. Question 4 was open ended.

RESULTS

In all, 128 of 225 potential respondents (57%) returned completed questionnaires. Return rates (and numbers of returned questionnaires) were 53% (30), 64% (32), 53% (34), 68% (19) and 54% (14) for *JABA*, *JEAB*, *JOBM*, *TAVB*, and *TBA*, respectively. Editor responses to the three true–false questions are summarized in Table 1. Question 1 asked whether “receipt of the money in the scenario is a reinforcer regardless of the long delay between the behavior (grant writing) and the consequence.” For each journal, a majority of respondents answered

“true.” The percentage who did so was 57%, 62%, 53%, 47%, and 71% for *JABA*, *JEAB*, *JOBM*, *TAVB*, and *TBA*, respectively. Across all journals, 9 editors responded with a “true” or “false,” but indicated that not enough information was provided to determine if grant writing was indeed a reinforcer. Written responses that accompanied a true or false response included “rests on the appearance of a functional relation,” “must be empirically validated,” “a reinforcer, not ‘the’ reinforcer,” “depends on what happens in the absence of the consequence,” and “can’t determine if it’s truly a reinforcer unless we present it response independently.”

Question 2 stated, “Receipt of the money in the scenario is a reinforcer, but its effects are dependent on verbal behavior by the researcher (Please answer only if you responded ‘true’ to Question 1).” For those who responded “true” to Question 1, indicating that the receipt of money was a reinforcer, there was no consistent agreement on whether its effects were dependent on verbal behavior by the researcher, although the majority of respondents from each journal indicated that this was the case. The percentage who did so was 53%, 60%, 58%, 55%, and 80% for *JABA*, *JEAB*, *JOBM*, *TAVB*, and *TBA*, respectively. Across all journals, 3 of 72 editors (4%) responded to Question 2 with a verbal response rather than “true” or “false.” Each of them indicated that not enough information was presented in the scenario to determine if money was a reinforcer for grant writing; that is, a functional relation could not be determined.

Question 3 stated, “In general, if an appropriate functional relation between a response class and a consequence can be demonstrated, the delay between the two is irrelevant in defining a consequence as a reinforcer.” For each journal, a majority of respondents answered “true.” The percentage who did so was 53%, 72%, 56%, 58%, and 71%, for *JABA*, *JEAB*, *JOBM*, *TAVB*, and *TBA*, respectively.

Respondents who answered “false” to Question 3 were asked in Question 4 “how delayed can event be and still be classified as a reinforcer?” Of the 50 individuals who responded “false,” 47 provided comments (Table 2). These comments indicate a wide diversity of opinion.

DISCUSSION

The present study essentially replicated the procedures used by Schlinger et al. (1991) nearly two decades ago. One difference is that the present study used e-mail to interact with potential respondents, whereas Schlinger et al. used the postal service for this purpose. Prior studies that directly compared mail and Web-based survey methods reported higher return rates with the latter (e.g., Bachmann, Elfrink, & Vazzana, 2000; Cobanoglu, Warde, & Moreo, 2001) and, consistent with those findings, the percentage of completed questionnaires returned in the present study (57%) was higher than the return rate in the study by Schlinger et al. (45%).

Results from the present study indicate that there was no consistent agreement regarding whether receipt of grant money, delayed 6 months relative to submission of the proposal that was funded and followed by an increase in proposal writing, should be considered as a reinforcer. Similarly, no consensus was apparent regarding whether respondents excluded delayed response–consequence relations from their definition of reinforcement. These findings are similar to those reported 18 years ago by Schlinger et al. (1991). As in that study, the majority of respondents in the present investigation indicated that the receipt of grant money in the scenario was a reinforcer and that, in general, delay is irrelevant in defining a consequence as a reinforcer. There were, however, substantial differences across journals in the percentage of respondents who did so.

It is noteworthy that many prominent behavior analysts continue to refuse to consider delayed events as reinforcers. Since the publication of the article by Schlinger et al. (1991), many studies have examined the effects of delayed events on the class of responses that produces them. For example, a recent (April 17, 2009) search of the *Scopus* database using *delayed reinforcement* as the descriptor and 1992 through 2009 as the years to be considered produced 985 relevant publications. Many of them clearly show that operant behavior in a variety of nonhuman species, as well as in humans, can be acquired and maintained when the

Table 2
Responses to Question 4

“A couple of seconds at most, any more and something else is serving as a reinforcer.”	“The delay is irrelevant in terms of indicating the importance of rules.”
“Other conditional reinforcers, the delay is irrelevant.”	“Depends on other conditional reinforcers.”
“An empirical question.”	“Depends on the context and the organism.”
“Depends on multiple factors, such as schedules of reinforcement magnitude of a reinforcer, learning history, and the individual organism.”	“Many variables to consider; delay, presence of verbal behavior, and an individual’s history of verbal behavior.”
“How delayed can an event be in an animal lab where a response is strengthened in the absence of verbal mediation. In this scenario we need to be clear about which event serves to strengthen which responses.”	“Reinforcers can be delayed for extremely long periods of time. It depends on schedules of reinforcement, schedule of conditional reinforcers, and extinction history.”
“5 seconds.”	“Less than 60 seconds.”
“2–3 seconds.”	“4–5 seconds.”
“How long does it take to get into heaven, meditate on it?”	“Delay is irrelevant, but probably a couple of seconds.”
“It depends on the behavior.”	“A couple of seconds at most.”
“Depends on the schedule of reinforcement, context, behavior, and history.”	“Depends on the organism, history of learning, etc.”
“Depends on multiple factors; In the above scenario, magnitude of reinforcement is sufficient enough to maintain grant-writing.”	“It depends on the biological relevance of the response in question, biological relevance of the consequence, and the particular species.”
“Needs to be assessed for each situation (see Roll, Reilly, & Johanson, 2000).”	“This is an empirical question and depends on multiple factors.”
“Only seconds at most.”	“Depends on each individual.”
“The delay is irrelevant.”	“Will be different for every individual.”
“This will differ between individuals and contexts.”	“Must be clear about which events serve to strengthen which responses.”
“Approximately 30 seconds.”	“Depends on the organism in question.”
“The problem for me is not dependent on the length of the delay, but whether or not there is a simple reinforcement process operating.”	“The delay is irrelevant. In this scenario, hearing that you got the grant is a secondary reinforcer.”
“60 seconds, otherwise something else is the reinforcer.”	“In humans, it depends on the individual’s verbal history.”
“Under a minute.”	“Depends on the species.”
“The delay gradient is a function that asymptotically approaches zero effect as delay increases, and it varies across organisms, situations, etc.”	“As consequences are delayed beyond brief periods (say seconds, not minutes), the contribution of other mediating variables (such as rules) becomes more powerful.”

Continued

Table 2, *cont.*

“At both the behavioral and neural level, without the participation of additional process, only seconds at most.”	“Depends on whether there is a conditioning history with respect to the delayed reinforcement.”
“Depends on multiple factors.”	“Must be determined empirically.”
“Around 60 seconds.”	“A couple of seconds.”
“The impact of the delay depends upon many factors, including, among others, the learning history of the individual, specific schedules of reinforcement, the response, and a host of reinforcing and discriminative stimulus relationships in effect during the interval at the time of the receipt of the putative reinforcing stimulus.”	

consequences of such behavior are delayed relative to the response that produces them (e.g., Critchfield & Lattal, 1993; Lattal & Gleeson, 1990; Lattal & Metzger, 1994; Reeve, Reeve, Brown, Brown, & Poulson, 1992; Schlinger & Blakely, 1994; Sutphin et al., 1998; Wilkenfield et al., 1992; Williams & Lattal, 1999). Although delaying a consequence reduces its ability to affect subsequent behavior (for review and discussion, see Critchfield & Kollins, 2001; Green & Myerson, 2004; Schlinger & Blakely, 1994; Stromer, McComas, & Rehfeldt, 2000), it is clear that delayed events can affect behavior. In fact, delayed reinforcement is frequently used by applied behavior analysts (Stromer et al.). Given the unassailable evidence that delayed events can increase the future likelihood of the response class that produces them, it is hard to understand why contemporary textbook authors continue to exclude delayed events from their definition of *reinforcer* (and *reinforcement*).

There is, of course, a long history of certain behavior analysts (often collectively termed molecular theorists) insisting that behavior is controlled primarily, and perhaps exclusively, by events temporally juxtaposed with the response in question. This position is clearly evident in attempts to find immediate stimulus changes, such as Anger's (1963) conditioned aversive temporal stimuli, responsible for the maintenance of unsignaled avoidance responding. Molar theorists, in contrast, assume that events remote in time from the response in question can affect it. This view is apparent in Herrnstein and Hineline's (1966) argument to the effect that

shock-frequency reduction per se maintains unsignaled avoidance responding. It is tempting to offer the pseudoexplanation that the molar and molecular "schools of thought" persist today and are responsible for the variability of responses we observed. But to say this is to say nothing, except perhaps that teachers and colleagues affect our verbal behavior, and historical events in a social context undoubtedly influenced how people reacted to the questions posed by Schlinger et al. (1991) and by us. In that regard, it is perhaps noteworthy that editors of *TAVB* gave the lowest percentage of "true" answers to the statement "Receipt of the money in the scenario is a reinforcer regardless of the long delay between the behavior (grant writing) and the consequence." Students of Jack Michael, a powerful molecular theorist and a superb teacher, are active members of the editorial board of *TAVB*, and their responses may reflect, at least in part, Jack's enduring influence.

In 1945, Skinner suggested that instead of trying to come to a consensus about the definition of psychological terms, behavioral scientists should instead try to identify the variables that control the emission of such terms. In other words, Skinner suggested that we carry out a functional analysis of the verbal behavior of scientists. Although we did not take this tack, the results of the present study and its predecessor (Schlinger et al., 1991) suggest that for many behavior analysts stimulus control of the terms *reinforcement* and *reinforcer* is complex and depends on multiple dimensions of the

environment. That this is so is evident in the comments of respondents, many of whom noted that more information (e.g., regarding species, procedure, presence or absence of verbal mediation) than we provided is required to determine whether a delayed event serves as a reinforcer.

No consensus is evident in those comments, which were evoked by the statement, "If you answered 'false' to Question 3, how delayed can an event be and still be classified as a reinforcer?" Question 3 (to be answered "true" or "false") read, "In general, if an appropriate functional relation between a response class and a consequence can be demonstrated, the delay between the two is irrelevant in defining the consequence as a reinforcer." A few responses suggest that respondents simply misunderstood the question and reacted to it as if it read something like "A consequence *can* reinforce a response regardless of the delay between the response and the consequence." Others appeared to focus on the process by which responding was affected, and noted that variables other than direct reinforcement are often important. Some respondents provided numeric values, which ranged from 2 to 60 s. Unsurprisingly, an ambiguous stimulus evoked a variety of responses.

Ambiguity is a fundamental problem when data are obtained by asking people to respond to verbal queries, and the variability of responses evident in the present study is to some degree a function of its methodology. Nonetheless, one wonders why a substantial minority of respondents in the present study, and in its predecessor (Schlinger et al., 1991), responded "false" to the statement that read "in general, if an appropriate functional relation between a response class and a consequence can be demonstrated, the delay between the two is irrelevant in defining the consequence as a reinforcer." It is easier to understand why a substantial number of respondents were not willing to label the receipt of grant money in the scenario as a reinforcer because, as respondents' comments indicated, relatively little information was provided. Therefore, even if a respondent did not categorically reject the possibility that delayed events can function as reinforcers, he or she may have been unable to determine whether it had this function in

the scenario. Be that as it may, the present results have two important implications. The first is that empirical findings apparently do not consistently guide how behavior analysts define their terms. The second is that behavior analysts surveyed in this study do not use those terms consistently. Both implications are distressing if one takes seriously Skinner's (e.g., 1957) contention that precise, empirically validated terminology is essential in a science of behavior.

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