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Delayed consequence delivery in applied settings: examining unsignaled feedback delay in visual- visual matching tasks

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Delayed Consequence Delivery in Applied Settings: Examining Unsignaled Feedback Delays in Visual-

Visual Matching Tasks

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Abstract

A reinforcer is a stimulus presented closely following a response which results in a future increase in frequency of that response. In an ideal applied setting, a stimulus should be presented immediately. But, it may not always be possible to present stimuli immediately in the applied setting. The current study compares the effects of consequence delivery delivered immediately to consequences delayed by five seconds. Three typically developing males, ages 25-30 participated in visual-visual matching tasks using arbitrary stimuli. Half of the stimuli were always presented with immediate consequences, while the other half was only followed by delayed consequences. Participants quickly achieved mastery of the matching tasks when consequences were immediate, but did not achieve quick mastery (within five sessions) when consequences were delayed by five seconds. These results support the accepted wisdom that immediate consequences are always best for skill acquisition and that high treatment integrity is crucial. Additionally, it provides an example of adapting basic research practices for use in applied contexts.

Delayed Consequence Delivery in Applied Settings: Examining Unsignaled Feedback Delays in Visual-Visual Matching Tasks

Individuals diagnosed with Autism Spectrum Disorders (ASD) often present deficiencies in responding in three areas of typical human development (DSM-IV, 2000). First, these individuals do not respond to social stimuli with the same regularity that their typical peers might. Second, it is often difficult or impossible for people diagnosed with ASDs to communicate effectively without environmental assistance in the form of picture exchange systems or speech-generating devices. Finally, individuals with ASDs often demonstrate highly restricted or repetitive interests in specific kinds of stimulation, and this interest often leads to self-stimulatory behavior such as motor stereotypy. When taken together, these three challenges result in individuals who may only learn new functional skills through very precisely controlled teaching strategies. Clinicians have found great success when using the application of the principles of behavior analysis in the treatment of these individuals, in particular the use of the principle of reinforcement.

Properly defined, reinforcement occurs when a stimulus presented or removed shortly following a response results in an increase in the probability of the occurrence of that response (Skinner, 1953). Thus, clinicians have used stimuli demonstrated to have a reinforcing effect for the behavior of individuals with whom they are working to increase desirable, functional behavior. Though this principle is widely used, there is one aspect of the definition which does not escape some measure of subjectivity. That is, a reinforcing stimulus must be changed *closely following* the targeted response. At present, the conventional wisdom among clinicians has determined that it is best if *closely following* was equal to *immediately following* for the purposes of effective behavioral shaping. However, clinical practice is typically not automated. Teachers are not as precise with regards to the time of delivery as food hoppers connected to mechanical devices or specially calibrated timing switches. Consequences may often be delivered as immediately as possible, though at other times it may be preceded by a time delay. This time

delay could be as short as 1 or 2 seconds, or could be as long as 10 seconds or more in some treatment settings. When faced with a population which has difficulty attending continuously to instruction and may be actively engaging in self-stimulatory behavior, such delays may interfere with learning.

Lattal (2010), presented an extensive overview of how delay of reinforcement has been studied with respect to its effects on the operant behavior of animal subjects. In this overview, the author attempts to answer three main questions. First, can the effects of the temporal relation between response and reinforcer be isolated from other environmental changes which accompany delays? Lattal suggests that they can, as long as the delays are relatively short, on the order of a few seconds. If delayed longer than a few seconds the effect becomes indistinguishable from an absence of response-reinforcer dependency. Second, what effect do delays have on operant behavior? Research, as noted by Lattal, has found that delays can reduce the effectiveness of response shaping, can induce response differentiation in the absence of effective response training, and can reduce the accuracy and rate of responses already established through immediate reinforcement. Third, how can we effectively interpret delay of reinforcement effects? Lattal emphasizes that delay to reinforcement both imposes contingencies and is imposed by contingencies. Because it is hard to separate temporal contiguity from the effects of a reinforcement schedule, it may be best to consider delay to reinforcement in terms of how it affects behavior.

Lattal also describes several variations in how delay to reinforcement procedures can be implemented. Delays can be either signaled or unsignaled. If a delay is unsignaled, there is no stimulus change indicating that a delay is going to take place. Also, delays can be either fixed or variable. A fixed delay remains constant throughout a given study, and variable delays are potentially different for each trial. Finally, delays can be resetting or nonresetting. A resetting delay is one in which the delay period starts over if any target response occurs during the prescribed delay. Nonresetting delays terminate at a predetermined interval regardless of subject responding during that same period.

Throughout the basic behavioral literature, assessments have been conducted with animals to assess some of the effects that delays of reinforcement have on behavior (Arbuckle & Lattal, 1988; Keeley, Feola, & Lattal, 2007; Odom, Ward, Burke, & Barnes, 2006; Pierce, Hanford, & Zimmerman, 1972; Royalty, Williams, & Fantino, 1987; Wilkenfield, Nickel, Blakely, & Poling, 1993). In particular, Williams (1976) examined the effects of delayed reinforcer delivery on the lever-pressing behavior of pigeon subjects. In this study, pecks were reinforced according to a variable-interval schedule. Then, a delay-of-reinforcement contingency was added onto the schedule, in which a period of un-signalized delay was added following the target response. Behavior was reduced significantly in strength even with just a 3-s delay between response and consequence.

Additionally, several studies using animal subjects have incorporated multiple schedules and differing values of fixed-time components to examine the effects of responding when non-contiguous with consequence delivery. In Sizemore and Lattal (1977), the authors used a yoked-control procedure to assess the differences between response-dependent reinforcement schedules and response-independent reinforcement schedules. Their data suggest that differences in rates of responding by pigeons were not entirely due to differences in reinforcer distribution, but were rather influenced by the non-contiguous nature of their reinforcer delivery.

In Sizemore and Lattal (1978), the authors again used tandem variable-interval fixed-time schedules with pigeons. The duration of the fixed-time component of the schedule was varied to assess the effects of unsignalized delays. As the length of the delay was increased, the pigeons' response rates decreased. This suggests a weakening of the response reinforcer contingency and the contiguity between the two was also weakened.

Animal studies have shown that the less an absolute delay between response and consequences the less the variability of responding for rat and pigeon subjects. If these studies were to be replicated with human participants, behavior analysts could use the results to make more specific claims about the

principle of reinforcement with regards to its application to the applied setting. The results would add to the growing field of translational research which utilizes the conclusions derived through basic research to the clinical problems of applied behavior analysis, particularly those regarding losses of treatment integrity. One such study, Okouchi (2009), used undergraduate students as participants, and reinforced specific response sequences using a point economy. This study suggested that typically developing adults should be able to acquire a target response under a sizable consequence delay of 10 s or more.

Treatment Integrity is defined as the extent to which an independent variable is implemented as intended (Peterson, Homer, & Wonderlich, 1982). There are many ways in which the treatment integrity of clinical intervention may be less than adequate in applied settings where the diagnosis and treatment of problem behavior is the primary goal of practitioners. Behavior programs may not be correctly implemented by all direct care staff, operational definitions may be too general, consequences may be delivered inconsistently for target behavior, data collected by direct care staff may be unreliable, and staff training insufficient for optimal performance. Additionally, without consistent supervision and feedback the behavior of caretakers may not conform to contingencies prescribed by behavioral specialists (Vollmer, Sloman, & Pipkin, 2008).

One crucial aspect of maintaining high treatment integrity is to ensure the prompt and reliable delivery of reinforcers, as prescribed in behavioral guidelines. Inconsistency of reinforcer delivery may be a particularly troubling threat to validity in treatment scenarios in which adaptive skills and alternative responses to problem behavior are being taught to a developmentally disabled population. Often it may be difficult or impossible to deliver reinforcement for each alternative response in the daily treatment setting. Hanley, Iwata, and Thompson (2001) used multiple schedules of reinforcement with discriminative stimuli to facilitate the thinning of reinforcer delivery over time. By alternating between signaled periods of extinction and periods of reinforcer availability following functional communication training (FCT), the authors were able to maintain near zero rates of problem behavior, while still maintaining an alternative response at acceptable levels.

Barbetta, Heward, Bradley, and Miller (1994) examined immediate vs. delayed consequences in an applied context. Participants were three children with developmental disabilities. The dependent variable was sight word reading performance in conditions with either immediate error correction at each trial wherein a mistake was made, or error correction delivered for each incorrect response following three series of trials. The immediate error correction condition produced a greater frequency of correct responses, as well as increased scores on daily tests administered on the sight words learned that day for all three participants.

Most of these experiments utilized schedule manipulation to increase tolerance for delays in applied settings. However, a variable of interest in these settings which was not addressed is the disruption of the relation between response and reinforcer delivery by an increase in the temporal period between them. The basic research supports the notion that greater delays lead to greater deprecations in responding, but some delay may be inevitable in clinical practice. There is little published applied research directed towards assessing how variations in the delay between response and reinforcer delivery affect subsequent performance on targeted skills.

The applied question of this study was an examination of how varying levels of treatment integrity with respect to delays in consequence delivery affect the rate of skill acquisition during visual-visual matching tasks for typically developing adults. Another purpose of the present study was to use a procedure and variables similar to those utilized previously by animal studies with typical human participants. A more in-depth analysis of consequence delay was conducted to confirm or deny the applicability of principles explored in the basic lab to applied problems in clinical populations, as well as attempting to answer the second and third questions posed in Lattal 2010; with regards to the effects of delays on operant behavior and ways to interpret delay effects.

Method

Participants and Setting

Three typically developing adults between the ages of 20 and 40 participated in the present study. All of these participants were familiar with basic computer operation and volunteered their time for participation. Additionally, all were presented with a briefing which covered the general purpose of the study, which was explained as “an examination of different kinds of feedback.” However, the participants were kept naïve with respect to the actual research questions and the differences between the experimental conditions. The decision to select typically developing adults, as opposed to selecting straight from the target population, those diagnosed with an autism spectrum disorder, stemmed from the fact that these participants would essentially be acquiring useless skills during the assessment. Ethically, it would be questionable to teach non-functional relations to clients of a behavioral education.

Response Measurement and Inter-observer Agreement

The dependent variable was the number of correct first responses given for each trial type in a block of 18 trials. Data collection occurred concurrently with the participant’s performance. The experimenter sat behind the participant while he or she worked at the computer screen. Selection responses were defined as any discrete click of the mouse on any of the three available comparison stimuli. Each click of the mouse also produced an auditory stimulus to facilitate easier data collection and inter-observer agreement, which was collected via video recordings that were made of each session. Additionally, these recordings were used for subsequent data analysis with regard to errors, latency to responding, or the emergence of adventitious behavior.

The independent variable was the manipulation of a non-resetting time delay between pre-defined selection responses and consequence delivery. Each selection was followed by either immediate consequences, or a consequence delayed by 5 seconds, depending on the stimulus set. Each block of 18 visual matching trials contained both immediate and delayed trials.

Experimental Design and Procedures

Using Microsoft PowerPoint™, participants were presented with a series of non-identity matching tasks using sample and comparison stimuli consisting of nonsense visual designs. The stimuli had been previously grouped by the author into arbitrary stimulus classes. Participants sat at the computer and used the mouse to select from an array of three visual comparison stimuli when presented with a sample stimulus. The performance of each participant was analyzed by using a multi-element design. Only the first selection response made by the participant at each trial presentation was recorded, and the number of correct first responses with immediate consequence delivery was compared to correct first responses with delayed consequences. Additionally, in Phase 2, a concurrent multiple-baseline design was used to compare performance across participants.

Pre-test. Before introducing the independent variable, each participant was first exposed to a pre-test which consisted of a single presentation of each trial configuration to assess potential bias towards any of the sample-comparison stimulus pairings. During this pre-test there were no programmed differential consequences for choosing any of the three comparison stimuli in the presence of a given sample stimulus. That is, the stimuli were presented on the screen, and any selection response resulted in the immediate presentation of the next trial without any feedback with regards to the accuracy of the response.

Phase 1- Differential Feedback. In this first phase, correct responses to each relation presented on the screen was pre-designated to result in either immediate feedback, or a delay of 5 s before feedback. The feedback, in this case, consisted of a screen displaying the word “Correct!” on a separate PowerPoint™ slide. Because the participants were typically developed adults, combined with the fact that there is no consequence for an incorrect response, the feedback screen can be assumed to function as a reinforcer. Trials were presented in blocks; 18 trials composed one block. In each block, nine of the relations resulted in immediate feedback, and nine resulted in delayed feedback. For each subsequent

session, the order of presentation of immediate versus delayed feedback was varied. In early sessions, trials would alternate between immediate and delayed feedback, but in later sessions participants were likely to experience several immediate or delayed trials in a row. Errors resulted in no change to the visual stimuli present on the screen. This means that errors were indistinguishable from correct responses in the delay condition during the 5 s interval before feedback was presented.

Phase 2 – Feedback reversal. Once each participant demonstrated stable responding for both feedback types, the independent variable was reversed for the stimuli in the delay component. This means that the visual stimuli which had previously always been paired with a 5 s delay were now presented with immediate feedback for correct response selection. The timing of this change was staggered across participants. The rate of acquisition now that consequences were presented immediately was compared to rates of acquisition while feedback was delayed. Once the participants had achieved mastery level responding of 89% or higher correct for two consecutive sessions for both conditions, further sessions were terminated and they were debriefed on the goals of the study. All participants received small material compensation for volunteering their time to the author. Upon the conclusion of the study they received five dollar gift cards to local retail chains.

Results

Participant 1 achieved quick mastery of stimuli with immediate consequences, but was unable to achieve mastery level responding for five sessions for stimuli with delayed consequences (Figure 1). In addition, following the transition to immediate consequences for stimuli previously only followed by delayed consequences, Participant 1 was still not able to achieve the established mastery criterion of two consecutive sessions at 80% or higher correct first responses. In particular, it should be noted that this participant was unable to successfully produce the desired response for one of the target stimuli, even when consequences were immediate upon selecting the correct stimulus. On each presentation of this “problem stimulus” the participant engaged in an apparently adventitious sequence of

response choices which remained the same in every instance that this stimulus appeared. This participant was able to quickly master the stimulus set initially presented with immediate consequences, but the confounds of presenting trials with delayed consequences interfered with his performance even when trials involving the exact same stimuli were presented with immediate consequences.

Participant 2's performance (Figure 2) most closely conformed to expected outcomes. In the initial delay component, Participant 2 very quickly demonstrated the relations among stimuli in the stimulus set presented with immediate consequences. Conversely, he was unable to achieve mastery on the relations for any of the stimuli followed by delayed consequences, never achieving more than four out of nine correct responses as measured on the first trial for each relation. Then, in Phase 2, the stimuli initially trained using delayed feedback were presented with immediate consequences. Following this, the participant rapidly mastered the relations among stimuli in the second set within three sessions.

Participant 3 initially showed similar separation in data paths between immediate consequences, which produced rapid mastery within three sessions, and delayed consequences (Figure 3). However, by session five this participant began to perform more accurately on the trials with delay. As a result, it was decided that Phase 1 was to be extended to assess if mastery could be achieved even in the absence of immediate consequences. By session eight, this participant had met mastery criteria for relations in both sets of stimuli, without requiring immediate consequences for the delayed set.

Discussion

For typically developing individuals, consequence delays of five seconds proved too great for the rapid acquisition of a target response. Though participant 3 was eventually able to demonstrate mastery of stimuli with the delayed feedback, it occurred several sessions after he achieved mastery criteria with stimuli trained with immediate consequences. All three participants demonstrated effective session behavior, including sitting in a chair for an extended time, attending closely to the target stimuli, responding rapidly to changing stimuli, and adhering closely to verbal direction; as is to be expected from

gainfully employed, professional adults. However, these same kinds of session behavior are rarely as prevalent in targeted populations of developmentally disabled individuals.

There is some research which has shown that it is possible for typically developing adults to learn a response class even with consequence delays. In Okouchi (2009), researchers found participants were performing a target response even with delays on the order of 30 s. Though Participants 1 and 2 did not demonstrate the acquisition of the target response, their exposure to the stimuli was relatively brief when compared to the Okouchi study. However, Participant 3 demonstrated that through exposure, the response would gradually be acquired despite the interfering delay.

Of particular note are the patterns of responding exhibited by Participant 2 during the second phase of the assessment. During this phase, all stimuli were presented with immediate consequences, including stimuli previously paired with delayed consequences. Yet, as shown in Figure 2, this participant was still not able to achieve mastery level responding for these stimuli. When his individual responses were analyzed it was clear that Participant 2 was engaging in a seemingly ritualized pattern of responses when presented with one particular stimulus. This pattern consisted of selecting both of the incorrect stimuli in each stimulus group before selecting the correct response. All other relations, however, he achieved quickly and without difficulty upon the transition to Phase 2. So, for at least one of the participants not only were the stimuli not mastered, but exposure to delayed consequences resulted in adventitious reinforcement of an undesirable response chain.

An important aspect of these results is that they strengthen the notion that immediate reinforcer delivery is always best when attempting to teach a response. Though this is perhaps less useful to a clinician or teacher who is already working with multiple students simultaneously or when dealing with consequences which may not be immediately presentable. These consequences could include trips to the store which are rewarded for exceptional behavior during a school week, for example. Still, it is

important for any instructor to note that without immediate feedback, it is likely that errors will continue to occur.

Fortunately, conditioned reinforcers are often more readily available than unconditioned reinforcers for use in skill acquisition programs. Therefore, the results of the present study provide support for the establishment and use of conditioned reinforcers. Verbal praise is inexpensive and quick to deliver, and upon its establishment becomes a valuable tool for instruction. Additionally, token economies may be an effective way to bridge the gap between the performance of a desirable response and the delivery of an extremely potent reinforcing event which cannot be physically delivered without a delay.

One inherent weakness of the current study is that it does not include the target population, individuals diagnosed with autism spectrum disorders, among the participants. For various reasons, it was decided that it would be desirable to run the sessions with typically developing individuals first, in order to assess the validity of the methodology put forth. Now that an apparently effective series of investigations has arisen, a modified version of the procedure could be applied to a developmentally disabled population.

An additional shortcoming of the present study is that no formal reinforcer assessment was conducted with the participants to determine if the “Correct!” screen reliably increased future responding. That being said, participants achieved very fast mastery of previously unknown relations, and maintained that mastery over several sessions. Future research might conduct a more formal reinforcer analysis. Another study focusing on delayed punishment contingencies would have a great deal of social validity with respect to teaching appropriate behavior in both typically developing and developmentally disabled individuals.

With respect to treatment integrity, the present research demonstrates that a programmatic delay of five seconds is too great to expect skill acquisition. It is reasonable to assume that if a typically

developing adult cannot achieve mastery under these conditions, it should be difficult for a person diagnosed with an ASD, as well. However, until such time when those effects are observed experimentally, that remains a tentative assumption. Future research might also benefit from including shorter delays than five seconds, and assessing performance under those conditions.

It is by adapting methodology from basic literature and applying it towards an applied question that research demonstrates its value. The present study extends upon previous research in the area of delayed reinforcement by assessing the performance of typically developing people under the effects of delayed consequences. Additionally, by demonstrating that delayed consequences do not show effective control over target responses the present study supports to the argument that consequences should always be delivered as close to immediately as possible. Future research could conduct a more in-depth analysis of how different levels of integrity with respect to consequence immediacy affect behavior.

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Table 1

Stimuli used in Immediate Consequence and Delayed Consequence components

Immediate Consequences

Delayed Consequences

Figure Captions

Figure 1. Number of correct first responses on each trial presentation of both conditions during training sessions of Phase 1 and Phase 2 for Participant 1.

Figure 2. Number of correct first responses on each trial presentation of both conditions during training sessions of Phase 1 and Phase 2 for Participant 2.

Figure 3. Number of correct first responses on each trial presentation of both conditions during training sessions of Phase 1 for Participant 3.

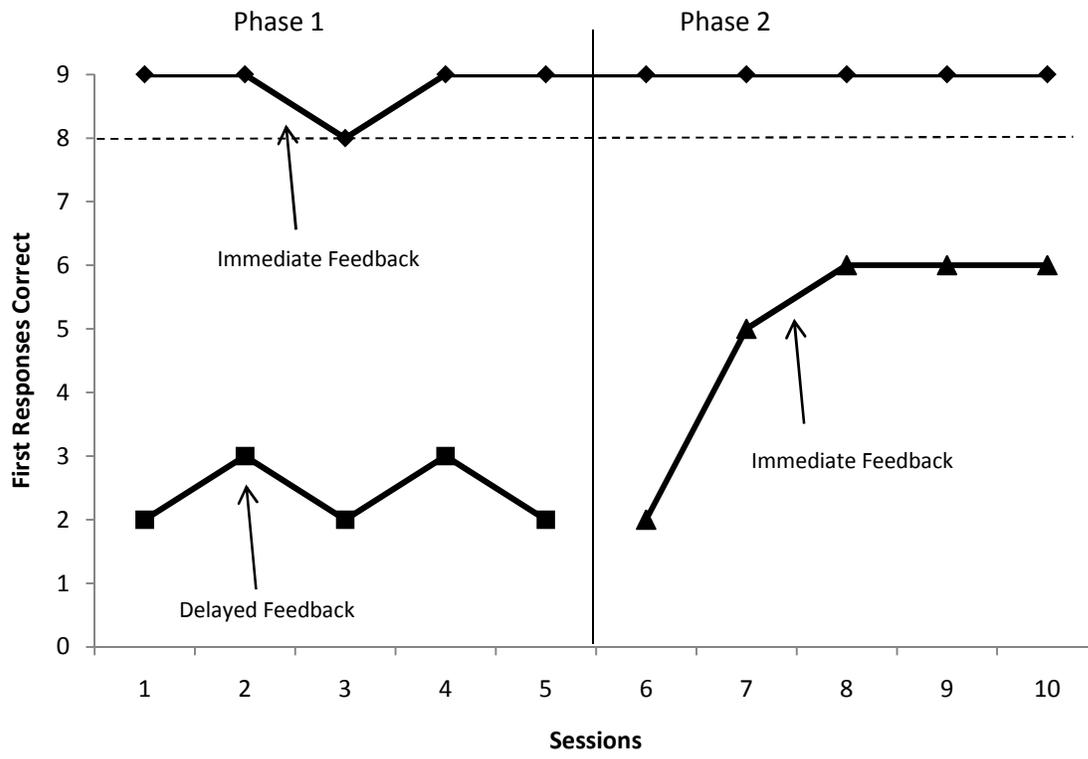


Figure 1.

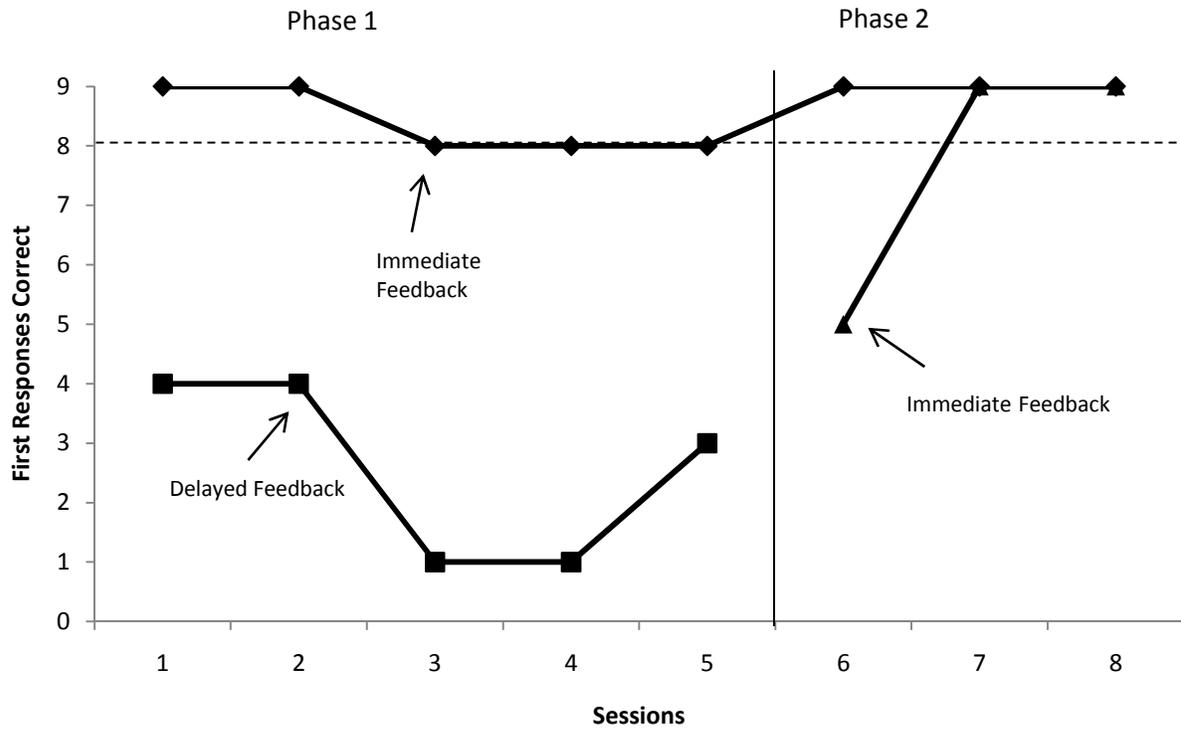


Figure 2.

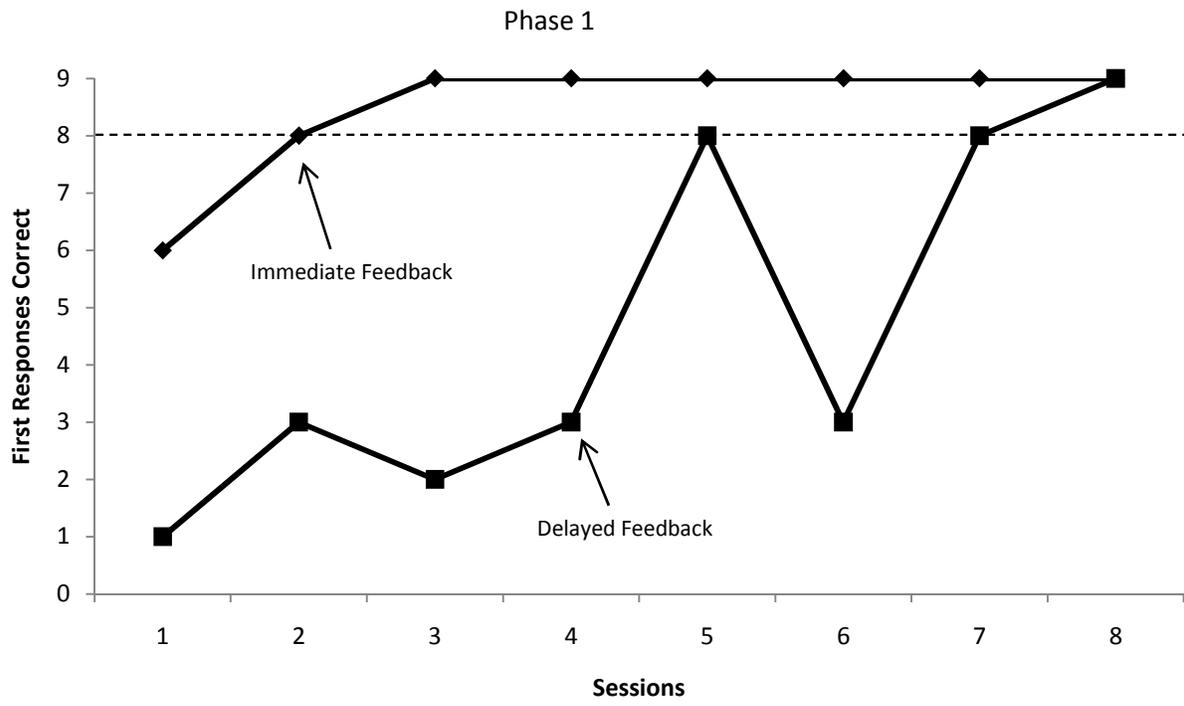


Figure 3.