Establishing Conditioned Reinforcers in Individuals with Developmental Disabilities: Comparison of the Stimulus-Stimulus Pairing Procedure and the Discriminative Control Procedure

by

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GLOSSARY OF TERMS AND ABBREVIATIONS

Abolishing operation (AO): A type of motivating operation (see below) which temporarily decreases the reinforcing value of a given stimulus, and decreases behaviours which lead to delivery of that stimulus.

Automatic reinforcement: Process of behavioural acquisition and maintenance in which the sensory products of the behaviour are reinforcing (i.e., increases the behaviour it is contingent upon) without contrived contingent reinforcers.

Behaviour chain: A sequence of stimuli and responses which occur together, and which are reinforced together as one behavioural unit.

Baseline (BL): Phase of a single-subject experiment in which the target behaviour is measured but the treatment is omitted. All variables other than the treatment are identical to the treatment phase.

Concurrent-chains schedule: Two concurrent schedules of reinforcement, with each one composed of two or more chained schedules, and where each chain schedule is signalled by a specific discriminative stimulus. When the requirement of the first schedule, also called the initial link or choice phase, is met, the organism is exposed to the discriminative stimulus for the second schedule, also called the terminal link or outcome phase.

Conditioned reinforcement: Process of behavioural acquisition and maintenance in which a stimulus acts as a reinforcer (i.e., can increase the rate of a response it is contingent upon) due to its relation to other pre-existing reinforcers.

Conditioned reinforcer: A stimulus that functions as a reinforcer because of its relation with other pre-existing reinforcers.

Continuous reinforcement (CRF) schedule: A schedule of reinforcement in which every response is followed immediately by a reinforcer. Also known as a fixed ratio 1 (FR1) schedule.

Conditioned stimulus (CS): In Pavlovian conditioning, a previously neutral stimulus which has come to elicit a particular response in the individual after being paired with some other conditioned stimulus or unconditioned stimulus eliciting that same response.

Discriminative control procedure (DCP): Type of discrimination training to establish a discriminative stimulus *with the intention* of also establishing the stimulus as a conditioned reinforcer as a secondary effect.

Discrimination training: Establishing a stimulus as a discriminative stimulus for responding by alternating trials in which the discriminative stimulus for responding is presented and a specific following response is reinforced, with trials in which an alternative stimulus is presented and the previous specified response is not reinforced.

Discriminative stimulus (S^D): A stimulus that has been correlated with greater availability of a reinforcer upon the emission of a given response. Roughly synonymous with a "cue" signalling that a response will be followed by a reinforcer.

Fixed Ratio 1 (FR1) schedule: A schedule of reinforcement in which every response is reinforced. Also known as a continuous reinforcement (CRF) schedule.

Interobserver agreement (IOA): Procedure to establish the concordance of independent observers who observe and record the occurrence of a target behaviour. The degree of concordance is typically expressed as a percentage of agreement.

Motivating operation (MO): A stimulus/event which temporarily alters the reinforcing value of a given stimulus, and alters the likelihood of any behaviour which lead to delivery of that stimulus.

Neutral stimulus: A stimulus which does not elicit the target response (with regards to Pavlovian conditioning) or which does not currently have reinforcing value (with regards to positive reinforcement).

Noncontingent reinforcement (NCR): Delivery of positive reinforcers without a specified response requirement.

Operant behaviour: Behaviour modified by its consequences.

Operant response (R): A discrete occurrence of operant behaviour.

Pavlovian conditioning: Form of learning where an originally neutral stimulus comes to elicit a conditioned response by pairing the neutral stimulus with an unconditioned or conditioned stimulus that already elicits the response.

Preference assessment: A procedure used to directly assess the relative preference for stimuli. Common methods include single stimulus preference assessment, pairwise preference assessment, and multiple stimulus preference assessment.

Primary reinforcer: A stimulus which acts as a reinforcer without learning, due to biology. Also known as an unconditioned reinforcer.

Reinforcer: A stimulus that increases the future occurrence of a target behaviour when presented immediately following that behaviour.

Reinforcer assessment: Procedurally involves measuring a target behaviour for some time period in the absence of a programmed consequences in order to establish a baseline of responding, then delivering a target stimulus contingent on the same target behaviour. Increased responding during contingent reinforcement verifies the reinforcing properties of the stimulus.

Reinforcer Probe: A brief reinforcer assessment, usually conducted following application of a particular procedure in order to measure the impact of the procedure on the reinforcing value of a stimulus. *See also reinforcer assessment.*

Satiation: A motivating abolishing operation in which (a) the reinforcing value of a stimulus is reduced and (b) the likelihood of the occurrence of behaviour leading to that stimulus as a consequence is reduced. Satiation is induced by the recent consumption of the reinforcing stimulus.

Stimulus-stimulus pairing (SSP): A procedure in which two stimuli are presented in rapid succession, with the second stimulus expected or known to have some reinforcing value. This procedure has been used to condition the reinforcing value of the first stimulus due to its relation with the second stimulus.

Unconditioned reinforcer: See primary reinforcer.

Unconditioned stimulus (US): A stimulus which elicits a particular response without prior learning.

Variable-ratio (VR) schedule of reinforcement: A schedule of reinforcement in which a reinforcer will occur following emission of a certain number of responses, and where the required number of responses varies around an average number.

Abstract

Individuals with developmental disabilities may be sensitive to a limited number of conditioned reinforcers. Therefore, the development of effective procedures to establish conditioned reinforcers in this population is of major practical importance. However, therapeutic procedures targeting the acquisition of novel conditioned reinforcers have not been extensively evaluated in the applied literature. Stimulus-stimulus pairing, a procedure consistent with a Pavlovian conditioning paradigm, has demonstrated inconsistent results. A second alternative suggests that stimuli may be conditioned as reinforcers due to their role as discriminative stimuli during operant responding. In Experiment 1, I evaluated the level of conditioned reinforcement produced by these two methods. For four of the five participants of Experiment 1, both procedures induced levels of responding above the baseline range. However, the effects were often variable and delayed. Only one participant showed differentiated levels of responding across procedures. Experiment 1 did not explore the mechanisms involved in conditioned reinforcement. Therefore, in Experiment 2 I examined the effects of satiating the primary (unconditional) reinforcers, which could reveal the learning principle involved. Experiment 2 also demonstrated the acquisition of conditioned reinforcers through both procedures. However, the satiation manipulation did not significantly change the levels of operant responding established through conditioned reinforcement, which would be consistent with a Pavlovian hypothesis.

Keywords: Conditioned reinforcement, stimulus-stimulus pairing procedure, discriminative control procedure

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Dedication

I dedicate this thesis to my mother and father for all their love, support, and teaching.

TABLE OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION

A conditioned reinforcer may be defined as a stimulus that functions as a reinforcer because of its relation with other pre-existing reinforcers (Williams, 1994a). Most human behaviour does not result in the delivery of biologically relevant reinforcers. The array of stimuli that may have an inherited (unconditioned) reinforcing value are limited, and include only those which in our biological ancestry have been important for our survival (Martin & Pear, 2011, p. 53). Therefore, it is likely that a significant proportion of human behaviour is under the control of learned or conditioned reinforcers. The establishment of conditioned reinforcers greatly expands the experimenter and clinician's ability to shape and maintain operant behaviour. Although most typically developed individuals are able to respond to conditioned reinforcers very early in development (e.g., Pelaez, Virues-Ortega, & Gewirtz, 2012), individuals with developmental disabilities may be sensitive to a limited number of conditioned reinforcers. Therefore, the development of effective procedures to establish conditioned reinforcers in this population is of major practical importance (e.g., Tarbox, Ghezzi, & Wilson, 2006).

It has been a matter of some debate over the last 5 decades what behavioural processes account for the establishment of conditioned reinforcers. First, a neutral stimulus may become a conditioned reinforcer through a process of stimulus-stimulus pairing very much as a conditioned stimulus (CS) may acquire eliciting properties in a Pavlovian conditioning paradigm (Fantino, 2008). Second, it may also be possible that a neutral stimulus becomes reinforcing over a number of trials during which such stimulus has been established as a discriminative stimulus (Keller & Schoenfeld, 1950). Finally, a third alternative suggests that a neutral stimulus may become a conditioned reinforcer in the context of a behaviour chain where the interim stimuli exercise a dual role of discriminative and reinforcing stimuli (Williams, 1988). Figure 1 presents a schematic portrayal of these three procedures.

In the present study we analyzed the relative effects of applied procedures that capitalize on these behavioural processes. The development and optimization of applied strategies aimed at establishing conditioned reinforcers is a crucial prerequisite of any reinforcement-based intervention among individuals with developmental disabilities (Dozier, Iwata, Thomason-Sassi, Worsdell, & Wilson, 2012). In addition, we examined the effects of a procedural adjustment in order to, first, maximize the usability and effectiveness of conditioned reinforcement procedures, and, second, clarify the nature of the behavioural processes explaining conditioned reinforcement in applied settings.

1.1 The Stimulus-Stimulus Pairing Procedure and the Pavlovian Conditioning Hypothesis

The Pavlovian conditioning hypothesis has received limited attention in the experimental literature (for exceptions, see Tonneau & Gonzalez, 2004, and Tonneau, Arreola, & Martinez, 2006). However, in the absence of direct empirical evidence on this hypothesis, it would appear that Pavlovian processes are often implicitly considered the main mechanism involved in the transfer of conditioned reinforcing value to a previously neutral stimulus (Shahan, 2010; Williams, 1994a). Moreover, stimulus-stimulus pairing (SSP), the applied procedure presumably based on this hypothesis, is the most prominent procedure for establishing conditioned reinforcers described in most behaviour modification textbooks (Martin & Pear, 2011; Cooper, Heron, & Heward, 2007; Miltenberger, 2013).

In the applied literature, Pavlovian-like pairing procedures have been used frequently in applied settings as a means of establishing vocal responses as reinforcers, and less often to establish new leisure stimuli as conditioned reinforcers. During SSP procedures, a neutral stimulus is paired with an established conditioned or unconditioned reinforcer until the previously neutral stimulus acquires conditioned reinforcing value itself. For instance, Longano and Greer (2006) paired a conditioned reinforcer (praise) with the presence of books (neutral stimulus) in a case series with children with autism. The pairing procedure induced a clear increase in spontaneous engagement with books without presenting any other form of contingent reinforcement. Conversely, in a recent case report, McKenzie, Smith, Simmons, and Soderlund (2008) paired the presence of a wristband (neutral stimulus) with reprimands (aversive stimulus) for self-injurious eye-poking by a woman with profound mental retardation. Results indicated that, after the pairing procedure, the wristband presence alone suppressed eye-poking (see more applied examples in Salvy, Mulick, Butter, Bartlett, & Linscheid, 2004, and Vorndran & Lerman, 2006).

Stimulus-stimulus pairings have also been used to establish new vocalizations in individuals with developmental delays. According to this literature, the increased production of vocalizations is assumed to be a function of both a pairing procedure (concurrent presentation of parental vocalizations and various primary reinforcers) and the similarity of parental vocalizations and those produced by the individual. Presumably, reinforcing effects will be transferred not only to parental vocal productions but also to the vocalizations emitted by the child, which would become selected as a consequence of their newly established reinforcing effects.

Skinner (1957, p. 58) speculated that the automatically reinforcing properties of vocal sounds may explain why most young babies begin producing early vocal sounds at an ever increasing rate, even when they are not exposed to parent-delivered shaping contingencies operating on their vocal behaviour. Vocal sounds may have become automatically reinforcing due to a pairing history. The presence of caregivers and their vocal sounds and words may have been correlated in the child's environment with various reinforcing actions such as feeding, touching, and relieving aversive conditions. Thus, once these vocal sounds have been established as conditioned reinforcers, as the young child emits vocal sounds (initially involuntarily), the sounds themselves serve to reinforce vocal production. These sounds in turn will then more easily come under the control of contingencies of reinforcement provided by others.

Skinner's concept of automatic reinforcement and its role in strengthening early vocal behaviour of infants has been studied in applied verbal behaviour studies focusing largely on SSP procedures aimed at establishing initial vocal responding in children with autism (Sundberg, Michael, Partington, & Sundberg, 1996). According to a review by Stock, Schulze, and Mirenda (2008), the SSP procedure holds strong promise for increasing early spontaneous vocalizations. However, the results of the implementation of the procedure have been mixed. According to their review, better results were reported when pairing procedures involved more pairing trials per minute. Also the procedure tended to be ineffective with individuals with developmental disabilities as opposed to typically developing children.

Esch, Carr, and Grow (2009) used an enhanced SSP procedure making vocal stimuli more salient in order to facilitate discrimination between stimuli that were paired with reinforcement from those which were not. This included use of an orienting prompt ("look" or a clicker noise) immediately preceding delivery of the target vocal stimulus, and exaggerated prosodic patterns ("motherese") when delivering the vocal stimuli. In line with previous research and despite these modifications, they too found an inconsistent effectiveness of the SSP procedure across participants. Although they did manage to show some gains for all participants in the SSP condition, in about half the cases target words did not increase to high levels until programmed reinforcement was added. However, the use of "motherese" speech may be a potential confound owing to the reinforcing effects that this form of vocal stimulation seems to have over young children (Pelaez, Virués-Ortega, & Gewirtz, 2011). Finally, a recent analysis by Petursdottir, Carp and Matthies (2011), again failed to establish preference toward speech sounds using SSP.

The use of SSP procedures to increase vocalizations may only be tangentially relevant to the Pavlovian hypothesis. Intervention effects are not only a function of a pairing protocol, but also a result of a rather obscure relation between a shaping process mediated by sensory consequences that is assumed to occur spontaneously – the individual vocalizations come under the control of the sensory consequences of emitting vocalizations resembling those previously paired with primary reinforcers by adults. Moreover, the few empirical studies available have not documented the presence of a shaping process mediating the effects of SSP over vocalizations, nor have they documented the increase in reinforcing value of vocalizations over time.

In summary, it is generally believed that a Pavlovian mechanism underlies the establishment of conditioned reinforcement through SSP. However, the effects of SSP as a means to establish conditioned reinforcers have been inconsistent in the applied literature. Similarly, a prominent variation of the SSP procedure to facilitate vocal sounds has produced positive results only inconsistently. The literature on the use of SSP suggests that (a) although the SSP procedure may be effective under some circumstances, the factors that mediate its effect remain unclear, (b) the involvement of complex processes including automatic reinforcement and shaping as mediators of the effects of SSP for the development of initial vocalizations recommends that this topography should not be used as target behaviour for a preliminary analysis of the relative effectiveness of SSP relative to other procedures to establish conditioned reinforcers, and (c) the applied literature on SSP does not provide compelling evidence on the involvement of a Pavlovian mechanism in the establishment of conditioned reinforcement.

1.2 The Discriminative Control Procedure

A second hypothesis suggests that stimuli are established as conditioned reinforcers through a history of presentation as discriminative stimuli (S^D). Keller and Schoenfeld (1950) argued that the main process driving the establishment of a conditioned reinforcer results from the repeated presentation of the neutral stimulus as a discriminative stimulus for an operant response: “In order to act as a [conditioned reinforcer] for any response, a stimulus must have status as an S^D for some response” (p. 236). These authors particularly pointed to the basic study by Schoenfeld, Antonitis, and Bersh (1950) where they demonstrated that a light presented during food delivery was not sufficient to establish the light as a conditioned reinforcer. Keller and Schoenfeld also referred to experiments where stimuli, such as the sound of the discharging tray where the food was delivered, were established as discriminative stimuli (for approaching the tray) and conditioned reinforcers (for lever pressing).

Zimmerman (1959) demonstrated that lever-pressing in rats could be maintained by contingent access to a stimulus that was first established as a discriminative stimulus for an alternative operant response. Based on this method, Lovaas et al. (1966) were the first to implement the discriminative control procedure (DCP) in an applied setting. They found that children with autism who did not acquire social stimuli as conditioned reinforcers through a typical SSP procedure were able to acquire social reinforcers through a DCP. They established previously neutral social stimuli (e.g., the word "good", a pat on the back) as conditioned reinforcers by presenting them as discriminative stimuli for a motor response, which was subsequently followed by a primary reinforcer. As illustrated in Figure 2, the experimenter presented a social stimulus (e.g., saying "Good!"), signalling the availability of a primary reinforcer (an edible). During a later phase, the schedule of delivery of the primary reinforcer was thinned gradually to a variable-ratio 20 (VR20) schedule of reinforcement (i.e., an average of every 20 responses resulted in delivery of the primary reinforcer). The authors examined the newly established conditioned reinforcing effects of the social stimulus using a reinforcer test in which bar pressing resulted in the delivery of the social stimulus. Results indicated that for both participants the social stimulus readily acquired conditioned reinforcing properties in that it maintained bar pressing for many responses. In this study the DCP followed a reported failure to establish conditioned reinforcement effects through a standard SSP procedure. The relative effectiveness of the DCP to establish independent conditioned reinforcing strength to the social stimuli though is somewhat obscured by the VR schedule used, as this schedule makes reinforcer delivery unpredictable and can account for response maintenance (Martin & Pear, 2011, p.198).

The DCP and its conceptual basis did not have an immediate impact in the basic or applied literatures. For instance, Fantino (1977) in his classic chapter on conditioned reinforcement acknowledges this hypothesis only briefly in a footnote (p. 314). Williams (1994a) also indicated that this hypothesis "... ha[s] been discredited by considerable research." (p. 262). This view continues to be held by researchers more recently; for example, Tonneau (2001) indicated that "...it is widely assumed that this discriminative-stimulus hypothesis of operant conditioned reinforcement is false..." (p. 107). The issues surrounding the dismissal of the DCP seem to thus center on two key issues: (a) there is evidence that it is not necessary to establish a stimulus as a discriminative stimulus before the stimulus may act as a conditioned reinforcer, and (b) there is evidence that stimuli may act as discriminative stimuli without concurrently acting as conditioned reinforcers (Kelleher & Gollub, 1962).

In view of these conflicting evidences it would be of major importance to compare directly procedures based on SSP and the DCP in an applied setting. Only recently, Holth, Vandbakk, Finstad, Gronnerud, and Sorensen (2009) have provided a direct comparison of these two procedures. These authors found that the DCP proved comparatively more effective in maintaining an arbitrary response in seven children with and without developmental disabilities. By contrast, a pairing procedure with an identical number of trials only caused significant reinforcing effects in two of the participants. However, the results of this study may be limited by two key features, namely small samples of behaviour, and that the procedures were sequentially implemented with the SSP procedure following the DCP for all participants.

The question remains whether the DCP points to a distinct learning process, or is simply an implicit pairing procedure. As indicated by Lovaas et al. (1966), the increased efficiency of the DCP may be simply a function of orientation responses toward the S^D (prospective conditioned reinforcer), which are more likely under an operant experimental procedure that requires the individual to respond. Therefore, attention prompts should be implemented in any comparative analysis.

Applied behaviour analysts, and a significant proportion of basic researchers, have often considered the Pavlovian mechanism *the* behavioural process accounting for conditioned reinforcement effects. However, taken together, the SSP literature and studies like those by Holth et al. (2009) and Lovaas et al. (1966) call for a re-appraisal of the evidence in support of the Pavlovian hypothesis. The examination of the basic literature on conditioned reinforcement may provide further evidence consistent with this view. Since the 1960s conditioned reinforcement effects have been studied in pigeons and rats using concurrent-chains schedules. Selected aspects of this literature relevant to the current study are presented in the section below.

1.3 Conditioned Reinforcement and Concurrent-Chains Schedules

The extensive experimental literature on concurrent-chains schedules and conditioned reinforcement is conceptually relevant to the current study but may be only marginally useful for the development of applied procedures to maximize conditioned reinforcement effects in applied settings. In a typical concurrent-chains schedule the experimenter programs two concurrent schedules, each one composed of two chained schedules (see a diagram of the procedure in Figure 3). Each chain schedule is signaled by a specific discriminative stimulus. When the requirement of the first schedule, also called the initial link or choice phase, is met, the organism is exposed to the discriminative stimulus for the second schedule, also called the terminal link or outcome phase. The discriminative stimulus of the terminal link functions as a conditioned reinforcer for responding during the initial link. A primary reinforcer, typically food, follows responding on the terminal link. By manipulating the schedules of reinforcement in the initial and terminal links in the two concurrent schedules and analyzing the organism's choice toward either chain, it has been possible to examine the effects of a variety of variables that seem to affect the establishment of the discriminative stimulus of the terminal link as a conditioned reinforcer.

Most of the early literature on conditioned reinforcement was developed under the premise that a stimulus would acquire reinforcing power simply by being paired with a primary reinforcer (Pavlovian hypothesis). Therefore, only rarely did these studies provide any dissociation between the two explanatory realms (Pavlovian vs. discriminative). For instance, one of the major findings of this literature, which has given rise to the so called delay-reduction theory, is that reduced delay to reinforcer access rather than reinforcement rate is a crucial factor for the development of conditioned reinforcement effects (Fantino, Preston, & Dunn, 1993). Both the Pavlovian and the discriminative hypotheses would make exactly the same predictions pertaining to delay reduction. For instance, delay-reduction could be discussed either in terms of effects of contiguity on conditioning (Pavlovian hypothesis), or in terms of delayed access to the reinforcer - which is known to devalue the reinforcing stimuli. According to Fantino

(2008) “[i]n most experiments on conditioned reinforcement, the putative conditioned reinforcers are predictive of primary reinforcement, and both the traditional pairing [Pavlovian] hypothesis of conditioned reinforcement and the functional [discriminative] view make the same prediction: The stimulus should function as a conditioned reinforcer” (p. 99).

There are, however, a few exceptions in the early literature on conditioned reinforcement that may indicate a potential dissociation between the two interpretations. Gollub (1958) and Fantino (1969) compared two multiple-link concurrent schedules: chain and tandem schedules. In the chain schedule the individual was exposed to a distinct discriminative stimulus when each link was completed. By contrast, in the tandem schedule the individual was continuously exposed to a single stimulus. The results indicated that the animals’ choice was clearly biased toward the tandem schedules. This could be interpreted as evidence in favour of the Pavlovian approach. Namely, the stimulus in the tandem schedule was actually paired with the primary reinforcer in the terminal link, while the discriminative stimuli in the chain schedule were not – except for the last one they were all cues for no reinforcement (see also Duncan & Fantino, 1972). Fantino (1965) also provides some interesting data that may help to dissociate the Pavlovian and discriminative accounts. In this study, the author used a classic concurrent-chains schedule to establish choice. Once choice was firmly established, he placed responding during the terminal link on extinction. Specifically, responding on the terminal link no longer resulted in the delivery of food. If the conditioned reinforcer had acquired that role simply due to its discriminative properties, extinction should have eliminated its effects. On the other hand, the Pavlovian approach would predict that responding in the initial link would be preserved after sufficient pairing even if the conditioned reinforcer is no longer correlated with the primary reinforcer, which was exactly what Fantino observed. These studies would suggest that conditioned reinforcers are those directly paired with the primary reinforcer, and provide some support in favor of the Pavlovian hypothesis. However, subsequent studies provided evidence in the opposite direction.

Schuster (1969) and Squires (1972) used concurrent-chains schedules to demonstrate that increasing the opportunities for pairing of an additional discriminative stimulus in the terminal link reduced preference toward the chain with the stimulus that was paired more frequently (see Fantino & Romanovich, 2007, for a review of this evidence). The Pavlovian hypothesis would have predicted the opposite, namely, increased pairing should have resulted in increased conditioned reinforcement effects. This finding suggested that a stimulus that had acquired a presumably higher level of conditioned reinforcing value through more frequent pairing with the primary reinforcer did not bias choice toward the chain of schedules containing that stimulus.

The findings by Schuster (1969) and Squires (1972) point to a more general limitation to the concurrent-chains literature in terms of its relevance to typical applied settings. Specifically, a stimulus that is established as a conditioned reinforcer in the terminal link may not affect choice in the initial link (see Fantino, Freed, Preston & Williams, 1991, for further evidence in this respect). More generally, it is unclear the extent to which stimuli established as conditioned reinforcers in the terminal link may be able to support performance using contingent reinforcement. Although the concurrent-chains literature infers conditioned reinforcement effects based on choices by the organism among sets of complex schedules, rarely have researchers examined the effects of newly established conditioned reinforcers as the sole support for new performances (see Experiment 2 of Grace & Savastano, 2000 for an exception).

In summary, the concurrent-chains paradigm may not be the best approach to dissociate the mechanisms of conditioned reinforcement. As Ono and colleagues (2005) put it “the function of terminal-link stimuli in concurrent-chain procedures remains unresolved. To some extent it may be considered in terms of a conditioned reinforcing function, and to some extent in terms of discriminative functions” (Ono, Yamagishi, Aoutsuka, Hojo, Nogawa, 2005).

Finally, the limited ecological validity of concurrent-chain schedules in applied settings poses an additional concern. This procedure could be considered excessively artificial and hardly representative of daily life activities. Only one study was located which used the concurrent-chains paradigm with a clinical population (see Experiment 1 of Lalli, Mauro, & Mace, 2000). It should be noted that this study simply replicated findings from the basic literature without a direct bearing in establishing socially significant conditioned reinforcers. Therefore, we did not use concurrent-chains schedules as an experimental paradigm in the present study.

1.4 Applied Implications of Conditioned Reinforcement

Conditioned reinforcement procedures are a central component of behaviour-analytic services to individuals with developmental disabilities. For instance, a recent survey conducted among teachers of individuals with developmental disabilities as part of a knowledge translation process indicated that “identifying enjoyable activities” was the major challenge the teachers encountered (Virués-Ortega et al., 2014). Effective reinforcers are necessary to support performance during acquisition under most training scenarios for individuals receiving behaviour-analytic services (e.g., Maurice, Green, & Luce, 1996).

By comparing the SSP and DCP and providing evidence dissociating the behavioural processes involved in either procedure, the results of the current study help to set the standard for developing effective strategies to establish new reinforcers. As discussed above, the SSP procedure is currently the most prevalent approach, yet it has produced positive results only for a fraction of participants. In addition, the results of the present study may provide a conceptual basis, or the lack thereof, for common practices that are currently not based on evidence. For example, most applied programs use various forms of praise along with edible reinforcers in the assumption that social stimuli may eventually become a well-established conditioned reinforcer (e.g., Siegel, 2003, p. 121; Partington, 2008, p. 20). However, there is little evidence to support this assumption. In fact, a recent study failed to identify any incremental reinforcing effects of various forms of social praise delivered with tokens, as opposed to tokens alone (Stevens, Sidener, Reeve, & Sidener, 2011). The present study may help to clarify under what circumstances a particular stimulus may become a reinforcer. The results of this research may have direct implications in programming and curriculum design for individuals with developmental disabilities receiving behavioural services.

There are several experimental manipulations, which could be conducted to explore the relative plausibility of the Pavlovian versus the discriminative control hypotheses. One way is by assessing the effect on conditioned reinforcement of devaluing the primary reinforcer. The Pavlovian conditioning literature suggests that reducing the reinforcing value of the primary reinforcer only has marginal effects on the conditioned reinforcer (Parkinson, Roberts, Everitt, & Di Ciano, 2005). Therefore, limited responding during conditioned reinforcement tests would be consistent with the discriminative control hypothesis, namely, if the value of the conditioned reinforcer were derived from its discriminative properties, the devaluation of the final reinforcer would be expected to have a negative impact on performance maintained by the conditioned reinforcer. There is experimental evidence demonstrating that a conditioned stimulus acting as a conditioned reinforcer will support the acquisition of instrumental responding after the devaluation of the unconditioned stimulus/primary reinforcer (see for instance Fantino, 1965, Fisher & Fantino, 1968, and Parkinson et al., 2005). Also, there is some literature that suggests that conditioned responses, which presumably may have some reinforcing effects in this context, may lose effectiveness if the unconditioned stimulus becomes habituated. Token reinforcers, considered to be conditioned reinforcers, certainly have been shown to vary considerably in effectiveness depending on the current value of the backup reinforcers (Hackenberg, 2009; Moher, Gould, Hegg, & Mahoney, 2008). Some applied studies have suggested that conditioned reinforcers may acquire reinforcing value and then remain impervious to subsequent fluctuations in the reinforcing value of the primary reinforcer, though these claims have been mostly speculative. For example, Rose and Levin (1991) have proposed such a process as an explanation for the maintenance of drug craving in individuals addicted to nicotine, even when satiated, due to the effects of conditioned reinforcers associated with smoking. The manipulation of conditions that alter temporarily the reinforcing value of the primary reinforcer (motivating operations) would provide an indication of the nature of conditioned reinforcement in applied settings. In brief, if the reinforcing effects of a conditioned reinforcer established with SSP will endure the devaluation of the primary reinforcer, the Pavlovian hypothesis will be strengthened. By contrast, a temporary abolishing operation during the discriminative control procedure, may reduce all behaviours correlated with the access to the reinforcer (Laraway, Snycerski, Michael, & Poling, 2003; Michael, 1993). Therefore, the manipulation of motivating operations has the potential to dissociate the discriminative and the Pavlovian mechanisms. If the effectiveness of the conditioned reinforcer diminishes as a consequence of satiation of the final reinforcer, then the Pavlovian hypothesis would be weakened.

1.5 Goals of the Study

The first goal of the present study was to explore specific variations of known procedures to establish conditioned reinforcers in applied settings, in order to allow us to compare and optimize these procedures. In both of the following experiments, I compared the relative effects of SSP and the DCP. In Experiment 1, I conducted a straightforward comparison of the two procedures without any added procedural variations in order to initially identify differences between the procedures across participants with a wide range of cognitive/learning functioning levels.

The second goal of the present study was to explore the extent to which the acquisition of conditioned reinforcers in an applied setting better accommodates the Pavlovian or the discriminative control hypotheses. Experiment 2 explored the relative plausibility of the Pavlovian versus the discriminative control hypotheses by assessing the effect of devaluing the primary reinforcer on conditioned reinforcement.

2. GENERAL METHOD

2.1 Stimuli and Target Responses

Arbitrary responses, neutral (non-preferred) leisure stimuli, and primary reinforcers (highly-preferred edibles) were identified before each experiment started and were used for the duration of the experiment.

2.1.1 Arbitrary Responses. I identified two arbitrary responses for each individual to be used as target behaviours. Selected responses needed to remain at near-zero levels during pretesting in order to discard automatic reinforcing effects. Easily performed motor responses of similar response effort were chosen for each participant (e.g., raising their hand above the shoulder, pressing a button). During pretesting, each putative neutral response was prompted twice, and then the participant was instructed to remain seated and do as he or she pleased. No programmed consequences followed the target behaviour. If the response remained at near-zero levels (less than 1 response per minute during the first session), it was considered a neutral response and the response was selected as a potential arbitrary response to be used for the rest of the experiment. I tested as many responses as necessary until I identified two neutral responses for each participant.

2.1.2 Neutral leisure stimuli. I identified two leisure stimuli for each participant to be used as neutral stimuli. I tested various leisure items to confirm that they did not have reinforcing effects. In order to minimize past exposure to potentially neutral items, I used materials that were not present in the individual's home or intervention program according to the caregiver's report. In order to avoid choosing items which may have acted as punishers for the participant, I also asked caregivers if any of the items I had chosen were likely to be aversive to the participant.

Neutral items were pre-screened through a pairwise preference assessment (8 items) according to the methods described by Fisher et al. (1992) modified by adding a set of trials in counterbalanced positions in order to control for location bias. Participants sampled all items prior to the assessment. On each trial, the experimenter presented a pair of items and asked the participant to select the preferred item by saying “pick one” (participants could either verbally indicate or touch the item). If the participant did not respond within 10 s, the experimenter initiated the next trial. Upon selection, the participant had 15 s or 30 s access to the item (the time was initially 30 s but was shortened for later recruited participants to maximize potential response times as well as better detect variability of responding). All pairs of items were presented twice with left and right positions alternating to control for position bias. Only items selected in 40% or less of the trials were selected as potentially neutral leisure items. During the reinforcement test the presentation of the leisure stimulus was made contingent upon a neutral response. Again, the chosen neutral response was prompted twice, but with each response immediately followed by the delivery of a leisure item. Following the prompted trials, the participant was instructed to remain seated but was otherwise allowed to do what he or she wanted during this time. Any time the response was emitted, the stimulus was delivered contingent on the response on a fixed ratio 1 (FR1) schedule. Attempts to leave the table were blocked and the participant was gently guided back to the task.

Leisure stimuli were tested for at least three trials. A leisure stimulus was considered neutral if the response level remained at near-zero levels, which was determined on a case-by-case basis via visual inspection, across all trials during the reinforcement test. Stimuli and responses found to be reinforcing during pre-testing were discarded. Testing continued until the desired number of neutral leisure items were identified.

2.1.3 Reinforcer assessment. I conducted another pairwise preference assessment in order to identify highly preferred edible items (Fisher et al., 1992). The preference hierarchy was composed of eight items pre-screened by a caregiver or staff familiar with the participant. The three top-ranked items were selected as potential primary reinforcers. The delivery of each of the three top-ranked items was alternated to prevent satiation of any single item.

Arbitrary responses, neutral leisure items and highly preferred edible items were assessed as part of a reinforcement test. During contingent reinforcement, neutral leisure items or highly preferred edible items were delivered immediately following arbitrary responses. Response rate of the arbitrary response was used as the dependent variable. During reinforcer testing, the chosen arbitrary response was prompted at the beginning of the first session incorporating a change in the programmed consequences. Sessions were 5 min in duration with 2 min inter-session breaks. At least three sessions per stimulus were conducted, and they continued until a steady pattern of responding was observed for each. I expected arbitrary responses to remain at near-zero levels in the absence of programmed consequences or when neutral leisure items were presented contingently upon performance. By contrast, the arbitrary response was expected to increase during contingent reinforcement with highly preferred edible items.

3. EXPERIMENT 1

The applied literature has revealed limited and inconsistent evidence for the use of SSP for establishing conditioned reinforcers (e.g., Stock et al., 2008), and even more limited evidence in support of the DCP (Holth et al., 2009; Lovaas et al., 1966). Prior research comparing these methods have been insufficient to establish their relative effectiveness, and have suffered from methodological flaws and small samples of behaviour. Before conducting any analysis to determine the relative plausibility of the Pavlovian or discriminative control hypotheses, it would be essential to compare the level of conditioned reinforcement induced by SSP and the DCP directly. In Experiment 1, I compared the effectiveness of SSP and DCP in producing conditioned reinforcement effects.

3.1 Participants and Setting

I recruited individuals diagnosed with developmental disabilities without age or gender restrictions. Participants were recruited from two service providers for individuals with developmental disabilities in Manitoba and British Columbia. The Psychology/Sociology Research Ethics Board of the University of Manitoba approved the procedures of the study. Parents or legal guardians of all participants provided signed informed consent.

Sessions were conducted in an assessment room, therapy room, office, or a room in the individual's home, with most objects removed from the area in which the study was conducted except materials being used in the study. The setting did not change for a given participant for the duration of the experiment. Sessions were conducted with the experimenter and the participant both seated across from each other at a table at an appropriate height for the participant to comfortably manipulate objects placed on the table. In order to minimize fatigue, the overall length of time a participant was involved on a given day was one hour.

Individuals were tested for basic discrimination abilities using the Assessment of Basic Learning Abilities (ABLA; Martin, Thorsteinsson, Yu, Martin, & Vause, 2008). Only participants at an ABLA Level 2, 3 or 4 were invited to participate. This inclusion criterion ensured that participants were able to learn simple discriminations, but were unlikely to acquire conditioned reinforcers via stimulus equivalence (Hayes, Kohlenberg, & Hayes, 1991). Passing Level 6 of the ABLA (auditory-visual discriminations) suggests that some of the prerequisite skills necessary to form equivalence classes are present (Vause, Martin, Yu, Marion, & Sakko, 2005).

Five participants with varying ages and developmental disabilities participated in Experiment 1. P1 was a two-year old male, had a diagnosis of autism spectrum disorder, and scored at Level 4 of the ABLA. P2 was an eight-year old male, had a diagnosis of autism spectrum disorder, and scored at Level 4 of the ABLA. P3 was a 13-year old male, had a diagnosis of autism spectrum disorder, and scored at Level 3 of the ABLA. P4 was a six-year old male, had a diagnosis of autism spectrum disorder, and scored at Level 2 of the ABLA. P5 was 36-year old male, had a diagnosis of intellectual disability, and scored at Level 2 of the ABLA.

3.2 Response Measurement, IOA, and Procedural Integrity

We identified two arbitrary responses: one response was used for reinforcement probes and the second was used during the DCP sessions. For P1 the target responses were raising his hand above the shoulders and clapping his hands. The former was used during reinforcement probes and the latter during the DCP sessions. For P2, the target responses were raise hand and touch card. The former was used during reinforcement probes and the latter during DCP sessions. The two responses for P3 were raise hand and touch card. The former was used during reinforcement probes and the latter during DCP sessions. For P4, I identified raise hand and clap hands as target responses. The former was used during reinforcement probes and the latter during DCP sessions. Finally, I could only identify one target response for P5: press button. This response was used during both reinforcement probes and DCP sessions.

Two independent observers scored 26% of all sessions in real time or from video recordings. I obtained interobserver agreement for the target (arbitrary) response during the reinforcement probes used in all experiments (across baseline and treatment). Mean count per session interobserver agreement was used for rate of target responses (Martin & Pear, 2011, p. 266). I divided the smaller count of behaviour occurrences per session by the larger count and multiplied by 100%. I then summed interobserver agreement of each individual session and divided by the total number of sessions. Mean interobserver agreement across participants was 99% (range, 93% to 100%).

Two observers obtained procedural integrity estimates based on 56% of the sessions. During the DCP, the observers monitored (a) the percentage of trials during which the leisure item was presented as discriminative stimulus, and (b) the percentage of training trials during which the delivery of the primary reinforcer occurred within 2 s of the occurrence of the target behaviour. The aspects of the procedure that were monitored during the SSP included (a) the percentage of training trials during which the leisure item was presented, and (b) the percentage of trials in which the primary reinforcer was presented within a 3-s window following the presentation of the leisure item. I assessed procedural integrity by dividing the times a desired aspect of the procedure was observed by the times it was expected to occur, or vice versa, depending on which number was larger, and converting that ratio into a percentage. During DCP, procedural integrity was 95% (range, 74% to 100%) for leisure item presentation, and 96% (range, 80% to 100%) for primary reinforcer delivery. During SSP, procedural integrity was 98% (range, 91% to 100%) for leisure item presentation, and 98% (range, 95% to 100%) for primary reinforcer delivery.

3.3 Procedure and Design

I used a mixed design with a multi-element component in which the DCP and SSP procedure were alternated. In addition, baseline length was varied across participants in order to accommodate datasets to a multiple-baseline design across participants. The alternation of treatments within the multi-element component of the design followed a fixed BBCCBC sequence. This sequence incorporated all binary combinations of treatment conditions (BB, CC, BC, CB), thereby controlling for order effects. Training blocks, whether composed of reinforcement or pairing trials, were implemented in-between probes for conditioned reinforcement effects. The number of training trials per reinforcement probe was fixed at 20 trials for both the DCP and SSP procedure.

*3.3.1 Baseline (reinforcement probe)***.** During baseline we implemented reinforcement probes without training trials in-between probes for either treatment (DCP and SSP procedures). Occurrence of the arbitrary response was reinforced with access to a neutral leisure item for 15 s. Before each session the arbitrary response was prompted twice allowing the individual to contact the contingency operating for that session. Aside from these initial prompts, all reinforcement probes were free operant arrangements without direct manipulation of antecedent events. Two different neutral leisure stimuli, which were to be later used during the discriminative and pairing procedures, were used across sessions.

Owing to the fact that context specificity during unpaired presentation of a neutral stimulus may cause latent inhibition during conditioning (Kaye, Preston, Szabo, Druiff, & Mackintosh, 1987), we changed the context when treatment started – context was controlled by manipulating the orientation that the participant and experimenter were sitting within the room, including baseline and each of the types of treatment sessions conducted.

Reinforcement probes were typically 5 min in duration. For two participants (P2 and P3) early reinforcement probes were 10 min in duration but this was adjusted to 5 min when it appeared that the longer probes were aversive to the participants (i.e., participants engaged in increased fidgeting, elopement, and refusal behaviours), particularly during baseline. For one participant (P1) all reinforcement probes were 3 min in duration due to his inability to remain engaged for longer periods possibly associated with his young age. Results of reinforcement probes are presented as responses per minute for all participants.

*3.3.2 Discriminative control procedure***.** During the training trials of the DCP, the experimenter presented a leisure item identified as neutral during pre-testing. The neutral leisure item signalled the availability of reinforcement for engaging in the arbitrary response. Common least-to-most prompting procedures were used to establish the operant target response as quickly as possible (Steege, Wacker, & McMahon, 1987). For most participants, this involved a sequence of increasing prompts on an as needed basis. We started with a nonspecific verbal prompt (i.e., stating the participant's name), followed with a specific verbal prompt (i.e., an instruction to perform the arbitrary response), a modeling prompt (i.e., the experimenter demonstrating the arbitrary response), and a full physical prompt (i.e., hand-over-hand guidance through the arbitrary response). The prompt sequence was only followed up until the point at which the arbitrary response occurred. The arbitrary response resulted in the delivery of a high-preference edible item. As indicated above, during subsequent conditioned reinforcement probes the arbitrary response resulted in 15 s free access to the neutral leisure item.

*3.3.3 Stimulus-stimulus pairing procedure***.** During the SSP procedure the experimenter started by presenting a neutral leisure item. The item was different from the one used during the discriminative control procedure. The experimenter presented the item within the visual field of the participant and then presented an edible reinforcer immediately following the neutral leisure item. When the participant was not attending immediately, the research assistant initiated an attending prompt, using the instruction "Look at me!" or a physical prompt (orienting the participant's head) to insure an observation response immediately before both stimuli were presented. No further response was required of the participant.

3.4 Results and Discussion

Figure 4 (left panel) shows the results of pretesting with participants from Experiment 1. For each participant, arbitrary responses were identified which remained at zero or near-zero levels when no programmed consequence were contingent upon the target behaviour. Following identification of arbitrary responses with at least 3 data points, reinforcement probes of high-preference edibles and low-preference leisure items were conducted. For P1, P2, P4, and P5 two highly reinforcing edibles were identified due to high rates of responding during reinforcement probes. For P3, three highly reinforcing edibles were identified. I identified two neutral leisure items through reinforcement probes for each participant and assigned them to either SSP or DCP at random (by flipping a coin). For P1 the leisure items identified were the Twilight book (SSP) and the hand puppet (DCP). For P2 the items were a tambourine (SSP) and a plush duck (DCP). For P3 the items were a *luchador* figurine (SSP) and a children's illustrated dictionary (DCP). For P4 the items were a plush dog (SSP) and a snake necklace toy (DCP). For P5 the items were a globe bouncy ball (SSP) and a plush dog (DCP).

Figure 4 (right panel) presents the comparison of SSP and DCP during baseline and treatment for all participants of Experiment 1. Reinforcement probes of the arbitrary response when the leisure item was delivered as a consequence was the dependent variable measured. P1 showed some elevated responding starting with the second SSP session and the first DCP session; however, responding under both conditions subsequently gradually lowered, and eventually returned to baseline levels of responding. P2 demonstrated immediate and substantial rises in responding following implementation of both treatments, responding at roughly the maximum number of responses possible given that engagement with the leisure item was not subtracted from the session time. His responding remained high under the SSP condition for all remaining treatment sessions. However, his responding under the DCP condition was highly variable across sessions. P3 demonstrated some elevated responding during the third session of each of SSP and DCP, but his responding returned to near-baseline levels in subsequent sessions. P4 demonstrated slightly higher responding during one session of SSP and one session of DCP, but largely remained at or near baseline levels of responding. P5 demonstrated responding at baseline levels for both SSP and DCP.

The results of Experiment 1 provide some support for both SSP and DCP. Specifically, for four of the five participants both procedures induced levels of responding above the baseline range. However, the effects were often variable (P1-P4) and delayed (P3, P4). Interestingly, differential effects were established across procedures for only one participant (P2), which contradicts the results of previous research (Holth et al., 2009). Nonetheless my results are not directly comparable to those of Holth et al., as theirs are based upon very limited samples of behaviour. Delayed effects suggest that conditioned reinforcers may be established through extended pairing trials, which is generally consistent with the Pavlovian hypothesis (e.g., Wilkinson et al., 2006). However, Experiment 1 does not provide critical evidence for and against either of these two hypotheses. Therefore, further analyses of the principle (Pavlovian or operant) underlying the effect of these methods is warranted.

4. EXPERIMENT 2

In addition to providing experimental evidence for the effectiveness of SSP and DCP, it is also important to provide evidence to identify which learning mechanism is most likely responsible for these effects: namely Pavlovian or operant. The applied literature on conditioned reinforcement has not established the extent to which fluctuations in the reinforcing value of the primary reinforcer may alter the reinforcing effects of the conditioned reinforcer. This piece of evidence seems crucial to the plausibility of the Pavlovian hypothesis, namely if the transference of reinforcing effects are the result of a classical conditioning process it seems likely that the conditioned reinforcer would acquire some form of independently reinforcing properties. One way in which this may occur, for example, would be through the establishment of a conditioned emotional response (Rolls, 2000). This would lead to the stimulus producing the emotional response, and thus could retain its reinforcing effects independently from fluctuations in the reinforcing effectiveness of the primary reinforcer (Williams, 1994b).

In brief, if the reinforcing effects of a conditioned reinforcer established with SSP can endure the devaluation of the primary reinforcer, the Pavlovian hypothesis would be strengthened. By contrast, a temporary abolishing operation during the discriminative control procedure may reduce all behaviours correlated with the access to the reinforcer (Laraway et al., 2003; Michael, 1993). Therefore, the manipulation of motivating operations has the potential to dissociate between the discriminative and the Pavlovian mechanisms. To this end, I manipulated the motivating operations affecting the primary reinforcer by providing unlimited access immediately before reinforcement probes.

4.1 Participants and Setting

Three individuals participated in Experiment 2. Individuals were tested for basic discrimination abilities using the ABLA (Martin et al., 2008). As with Experiment 1, participants in the study needed to be able to pass at least Level 2 of the ABLA. P6 was an 11-year old female, had a diagnosis of alcohol-related neurodevelopmental disorder, and scored at Level 6 of the ABLA. P7 was an 11-year old male, had a diagnosis of autism, and scored at Level 2 of the ABLA. P8 was a 46-year old female, had a diagnosis of intellectual disability, and scored at level 2 of the ABLA. Given that the key manipulation of Experiment 2 (satiation) required conditioned reinforcement effects to be present, we selected for Experiment 2 only those participants for whom clearly conditioned reinforcement effects were established. Experiment 2 used the same recruitment procedures, ethical evaluation, informed consent standards, and setting described for Experiment 1. The recruitment of participants for Experiments 1 and 2 was conducted simultaneously.

4.2 Response Measurement, IOA, and Procedural Integrity

For P6 I identified raising her hand above the shoulders and flipping a playing card over as arbitrary responses. The former response was used during reinforcement probes and the latter during DCP sessions. For P7, I identified raise hand and touch card as arbitrary responses. The former was assigned for later reinforcement probes and the latter was assigned for DCP. For P8, I identified tap table and touch ground as target responses. The former was used during reinforcement probes and the latter during DCP sessions.

The methods of IOA and procedural integrity used in Experiment 2 were those described for Experiment 1. Two independent observers scored 26% of all sessions in real time or from video recordings to establish IOA. Mean interobserver agreement across subjects was 98% (range, 75% to 100%).

Two observers obtained procedural integrity estimates based on 86% of the sessions. Procedural integrity was also measured as described in Experiment 1. During DCP, procedural integrity was 95% (range, 80% to 100%) for leisure item presentation, and 98% (range, 95% to 100%) for primary reinforcer delivery. During SSP, procedural integrity was 95% (range, 75% to 100%) for leisure item presentation, and 98% (range, 95% to 100%) for primary reinforcer delivery.

4.3 Procedure and Design

The design of Experiment 2 was similar to the design described above for Experiment 1 with the exception of the inclusion of an additional satiation phase (ABC). Although initial baselines were the same length for each participant in Experiment 2, introduction of the satiation phase was staggered. The phases of the experiment are described below.

4.3.1 Baseline. Same as Experiment 1.

4.3.2 Stimulus-stimulus pairing procedure and discriminative control procedure. Same as Experiment 1.

4.3.3 Treatment comparison plus satiation. During the satiation phase participants were pre-exposed to the reinforcer and had “unlimited” access to the primary reinforcer (edible items) during a 5 min period after each 20 trial block of SSP or DCP. Although access to the edibles were “unlimited” during this period of time, participants were handed the edibles one at a time by the experimenter in order to avoid over-eating. Immediately following the satiation phase, and prior to the leisure item reinforcement probe, a reinforcement probe of the edible item was conducted in order to provide evidence that some satiation of the edible item had occurred.

4.4 Results and Discussion

Figure 5 shows the results of pretesting with participants from Experiment 2. For each participant, arbitrary responses were identified which remained at zero or near-zero levels when no programmed consequences were contingent upon the target behaviour. Following the identification of arbitrary responses by way of three or more data points suggesting behavioural maintenance, I conducted reinforcement probes of high-preference edibles and low-preference leisure items. For all three participants, two highly reinforcing edibles were identified as demonstrated by the high rates of responding during reinforcement probes. We also identified two neutral leisure items through reinforcement probes for each participant and assigned them to either SSP or DCP by flipping a coin. For participant P6 the leisure items identified were a small white board with dry erase marker (SSP) and a small bouncing ball (DCP). For P7 the items were a small plastic tiger (SSP) and a tambourine (DCP). For P8 the items were a small plastic frog (SSP) and a plastic toy cupcake (DCP).

Figure 6 presents the levels of the arbitrary response during reinforcement probes throughout baseline, treatment comparison, and treatment comparison plus satiation for all participants of Experiment 2. All participants in Experiment 2 demonstrated conditioned reinforcement effects during the SSP and DCP treatment comparison. P6 showed consistently high levels of responding during treatment, which occurred nearly at the maximum number of possible responses. The effect was observed immediately upon starting the first reinforcement probe of the treatment phase. Responding during treatment was above the range of responding during baseline, with most baseline reinforcement probes at zero excepting one in which the participant responded repeatedly. P7 demonstrated variable responding, with zero to near-zero levels of responding during baseline. As found for some participants of Experiment 1, P7 showed delayed and variable treatment effects. P8 showed increases in responding immediately after the implementation of the treatment phase, and generally maintained moderate to high responding during treatment but with significant variability, a pattern that was already encountered in Experiment 1.

For these three participants the satiation manipulation failed to induce any significant changes in responding during the reinforcement probes for SSP or DCP (Figure 6). This general finding is consistent with the Pavlovian hypothesis. However, a simultaneous reinforcer assessment conducted for P7 and P8 showed that no satiation effects were actually induced at least for these two participants. Further evaluations would be necessary to determine if effective satiation, and not simply a procedural manipulation that attempts to induce it, has an effect upon conditioned reinforcement. Future studies could evaluate edible items that could be safely satiated. The highly preferred edibles used with the current participants were highly energetic foods and unsafe to leave ad libitum.

5. GENERAL DISCUSSION

The extensive experimental literature on conditioned reinforcement accrued over the last 50 years has not yet established clearly the relative effectiveness of training procedures based on Pavlovian conditioning or discriminative control as the basis for establishing conditioned reinforcement effects of leisure items in applied settings. Furthermore, explicit training procedures to increase reinforcers for individuals with developmental disabilities in therapeutic ABA-based programs are very common. However, there is little evidence to support either method. Moreover, the scant evidence available has shown a lack of consistency of these methods for producing conditioned reinforcement effects (e.g., Holth, 2009; Stock et al., 2008). The present study provided a direct experimental comparison of these interventions involving larger samples of behaviour than in previous studies.

Several interesting results emerged from both experiments in the present study. The results of Experiment 1 and Experiment 2 indicated that both SSP and DCP are equally effective means to induce conditioned reinforcement effects. Seven of the eight participants evaluated showed some level of conditioned reinforcement beyond baseline levels. For all three participants chosen for Experiment 2, moderate to strong treatment effects were observed, but with no clear differences in conditioned reinforcement effects induced by either methods. P2 of Experiment 1 was the only participant to demonstrate a noticeable difference between the effects of the procedures, with SSP emerging as more effective than DCP, although the results for DCP varied considerably across sessions. For P1, P3, and P4, conditioned reinforcement effects were noticeable but small, while for P5, no conditioned reinforcement effects were established.

The results of the present study differed considerably from those of previous research. The small body of evidence comparing SSP to DCP (e.g., Holth et al., 2009; Lovaas et al., 1966) has produced variable results but overall appears to indicate that DCP may be superior for most participants. However, the Lovaas et al. (1966) study did not involve a methodologically sound comparison of the two methods; rather, DCP was implemented with participants for whom SSP had been ineffective. Holth et al. (2009) included a comparison of both procedures, but had several limitations, including relatively small samples of behaviour, and a consistent ordering of SSP sessions following DCP sessions. The present study may provide a better picture of the effects of these procedures owing to (a) obtaining larger samples of behaviour, and (b) excluding order effects by incorporating all possible transitions into the multi-element sequence of conditions.

A very important consideration in interpreting these results may have to do with attending. As Lovaas et al. (1966) pointed out, the discriminative control procedure may operate by insuring that attention responses co-occur with the pairing trials, thereby insuring the effectiveness of the conditioning process. Children with autism often fail to attend to stimuli used in behavioural procedures. Thus, lack of attention may preclude acquisition during pairing. By contrast, discriminated responding during the discriminative control procedure insures that the individual has attended to the stimulus. There is some empirical evidence suggesting that transfer of stimulus functions, often attributed to stimulus equivalence, may be transferred by a Pavlovian pairing procedure as shown by Tonneau and Gonzalez (2004). According to these authors, the delivery of pairing trials under a three-term contingency format may simply strengthen the conditioning process “by fostering observing responses and attending to the relevant stimulus pairs” (p. 251). Thus, the use of the attending prompt during SSP in this study may have helped to reduce the chances that the eventual lack of effectiveness of this procedure could be attributed to lack of attending, possibly equalizing the effectiveness of the two procedures. The primary reinforcer and the neutral stimulus are in fact equally paired during SSP and DCP. Our findings support the view that any of the procedural additions of DCP, chiefly the presence of an operant response, are not essential components to establishing conditioned reinforcement effects. Upon equal levels of effectiveness, the hypothesis underlying the simplest intervention (i.e., SSP) gains in plausibility. Therefore, our results are compatible with the view that conditioned reinforcement is acquired through a Pavlovian mechanism during both SSP and DCP.

Our results have revealed some general features of the acquisition of conditioned reinforcement effects in applied settings using pairing methods. Conditioned reinforcement effects were often variable and acquired over an extended number of trials. These seem to be attributes of conditioned reinforcement that do not adapt well to common methodological strategies for experimental demonstration. For example, a multiple baseline may become an ineffective means of demonstration as treatment effects become increasingly delayed (see for instance Kratochwill et al., 2013). However, the current study, owing to the collection of ample samples of behavior, seem to suggest that delayed effects, variable reinforcing effects, and the need of massive training trials may be likely attributes of the acquisition of conditioned reinforcement in applied settings.

5.1 Limitations

The main goal of Experiment 2, namely, to evaluate the impact of satiating the primary edible reinforcers on the conditioned reinforcing value, was found to be only partially feasible. None of the participants showed clearly diminished responding during the reinforcement probes following the satiation manipulation. If reduction in consumption of the primary edible reinforcer could be considered evidence for satiation, then the continued conditioned reinforcement effect after satiation provides evidence in support of the Pavlovian mechanism. However, the reinforcer assessments conducted immediately before the reinforcement probes in two of the three participants indicated that satiation had not occurred. For P7 and P8, the post-satiation reinforcer assessments suggested that the reinforcer was at least equally able as in baseline to motivate an arbitrary response (Figure 6). Although the additional edible reinforcer probes post-satiation phase were not introduced during the sessions with P6, she did verbally indicate she was "full" following the second DCP session in the satiation phase, and she continued to respond strongly during the leisure item reinforcement probe. A possible adjustment to increase the effectiveness of satiation would have been to lengthen the satiation phase sessions. However, this approach could have raised ethical concerns due to overeating, which is a significant health concern among individuals with developmental and intellectual disabilities (Stavrakaki, 2002).

While our findings are generally compatible with a Pavlovian mechanism, the evidence provided by the current study is indirect. This is because the current study did not directly test for any elicited Pavlovian response. Such a response, perhaps an internal positive emotional response, would be necessarily implied to be occurring if indeed true Pavlovian conditioning underlies the establishment of conditioned reinforcers.

A potential limitation of using DCP with this population may be that for lower functioning participants there may be challenges or delays in forming simple discriminations, which is a critical aspect of DCP. Participants P4, P5, P7, and P8 passed Level 2 of the ABLA, which is a simple position discrimination task, but failed Level 3 which involves a simple visual discrimination (Martin et al., 2008). In this respect, the SSP procedure may be more versatile, in that it does not require any specific level of discrimination ability. That said, there was no difference in effectiveness observed for these participants between the two methods. For participants P4 and P5, there was no effect observed using either method. For participants P7 and P8, moderate effects were observed equally across both DCP and SSP. Thus, it is unlikely that the level of learning ability of the participants differentially affected the effectiveness of the two treatment methods.

Part of the reason that there were few if any gains in reinforcing strength of the leisure items for several of the participants may relate to the nature of the experimental setting. It is possible that in an experimental setting conditioned reinforcement deteriorates in parallel to the proportion of unpaired presentations of the primary reinforcer at a level that is likely to be untenable by the social environment of the individual. For instance, it is unlikely that praise, presumably a form of conditioned reinforcement, will be paired frequently with primary reinforcers in the natural environment. Conditioned reinforcers may be paired only infrequently with primary reinforcers but frequently with other conditioned reinforcers of various magnitudes. It is also possible that conditioned reinforcers retain their motivational value with only infrequent pairing. For example, various experimental preparations have demonstrated conditioning after inducing extinction (Baeyens, Eelen, & Crombez, 1995; Rescorla, 1996). Indeed, without continued association with a primary reinforcer, a simple conditioned reinforcer may be expected to lose its reinforcing value quickly (Fantino, 2008). Other procedures such as establishing a stimulus as a generalized reinforcer may also prolong its reinforcing value (Martin & Pear, 2011, p. 55). An additional possibility would be that conditioned reinforcers acquire a form of inherent motivational value that will establish the conditioned stimulus as a reinforcer in the absence of any future pairing. In the current study we did not evaluate the long-term maintenance of conditioned reinforcement effects after pairings of the neutral item with the primary reinforcer had been discontinued.

5.2 Future Research

There are several possible extensions of this research. First, the role of number of pairing trials could be evaluated further. Procedurally, this would help address the concern that for some participants, a greater number of conditioning trials may be necessary to produce conditioned reinforcing effects. In addition, if conditioned reinforcement is the result of Pavlovian conditioning, increased pairing would result in gradual gains of reinforcement effects. On the other hand, if the conditioned reinforcer acquires such value as a function of its ability to signal the subsequent presentation of the primary reinforcer, a progressive increase in reinforcement trials may not have any cumulative impact on reinforcement effects.

A difference between the present study and prior studies comparing SSP with DCP (e.g., Holth, 2005; Lovaas et al., 1966) or comparing SSP with other procedures (e.g., Dozier et al., 2012) may be that these prior studies largely involved social and vocal stimuli as neutral stimuli. Stimulus type may differentially impact which procedures would be most effective. For example, certain forms of vocal stimulation are automatically reinforcing and may be particularly well suited to be used as reinforcers (e.g., Pelaez, Virués-Ortega, & Gewirtz, 2011). Moreover, the technology to evaluate the preference and reinforcing effects of vocal and social stimuli is not as well-established as it is for edible and leisure items included in the present study. Further research will be necessary to identify whether there is an interaction between stimulus type and conditioned reinforcement effects.

Additional research may also involve manipulating the proportion of unpaired presentations of the unconditioned stimulus (US) in the SSP, and the proportion of unsignalled presentations of the primary reinforcer in the DCP. This could be accomplished by manipulating the contingency between conditioned and unconditioned stimuli in SSP, and introducing a noncontingent reinforcement (NCR) schedule during DCP. In basic experimental studies, Gamzu and Williams (1971, 1973) found that pigeons do not learn to peck a lighted key paired with food if food is presented with the same probability when the key light is off as when it is on, and pigeons trained with a positive contingency stop pecking the lighted key when the contingency is reduced to zero by the addition of unsignaled food. Therefore, the reduced contingency during the pairing procedure may have a negative effect on conditioned reinforcement. On the contrary, if conditioned reinforcement is based on discrimination, the addition of a NCR component, although it may suppress partially target behavior during training (e.g., Britton, Carr, Landaburu, & Romick, 2002), it may not have an effect on the discriminative properties of the discriminative stimulus.

6. CONCLUSIONS

The general conclusions of the present study are summarized below:

1. Both SSP and DCP induced some conditioned reinforcing effects in most participants toward originally neutral leisure items. Conditioned reinforcement effects were strong in 2 participants, moderate in 2 participants, small in 3 participants, and non-existent in 1 participant.
2. The conditioned reinforcement effects induced by SSP and DCP were relatively stable for two of the eight participants, and highly variable for all other participants. High variability suggests that the conditioned reinforcers had low reinforcing value and became quickly satiated.
3. The occurrence of conditioned reinforcement effects was delayed in three of the eight participants that underwent the treatment comparison. This suggests that for some participants conditioned reinforcement effects may occur only after extended training. This is consistent with the Pavlovian hypothesis.
4. The similar effects induced by either SSP and DCP suggest that the additional procedural components present in DCP, relative to SSP, may be irrelevant in the production of conditioned reinforcement. This is consistent with the Pavlovian hypothesis.

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8. FIGURES

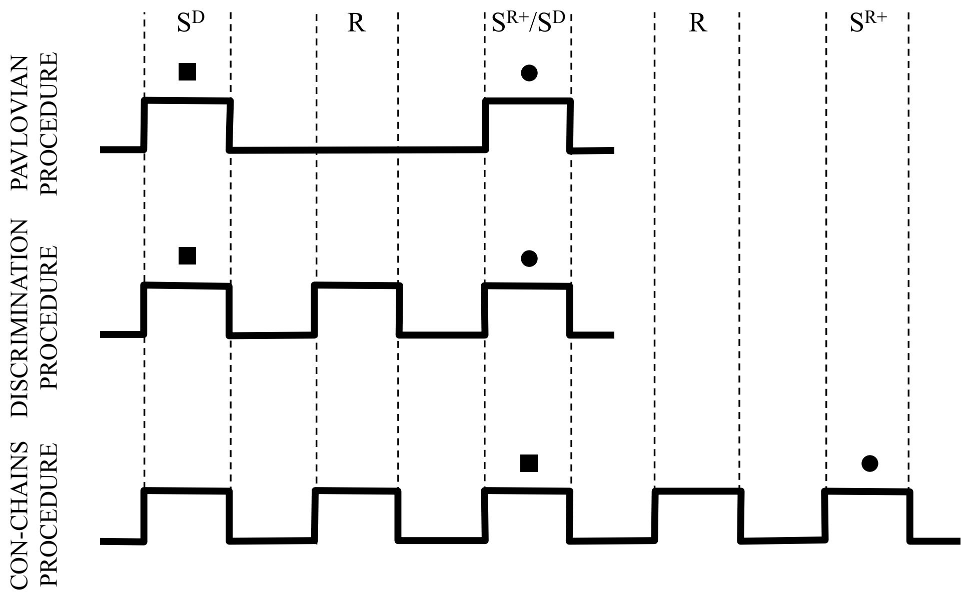

Figure 1. Schematic portrayal of the various procedures typically used to induce conditioned reinforcement effects. The elevated sections indicate the occurrence of one of three possible events: delivery of a discriminative stimulus, S^D, delivery of a reinforcing stimulus S^{R+}, and occurrence of a response, R. Squares represent the presentation of neutral stimuli (putative conditioned reinforcers) and circles represent the presentation of primary reinforcers.

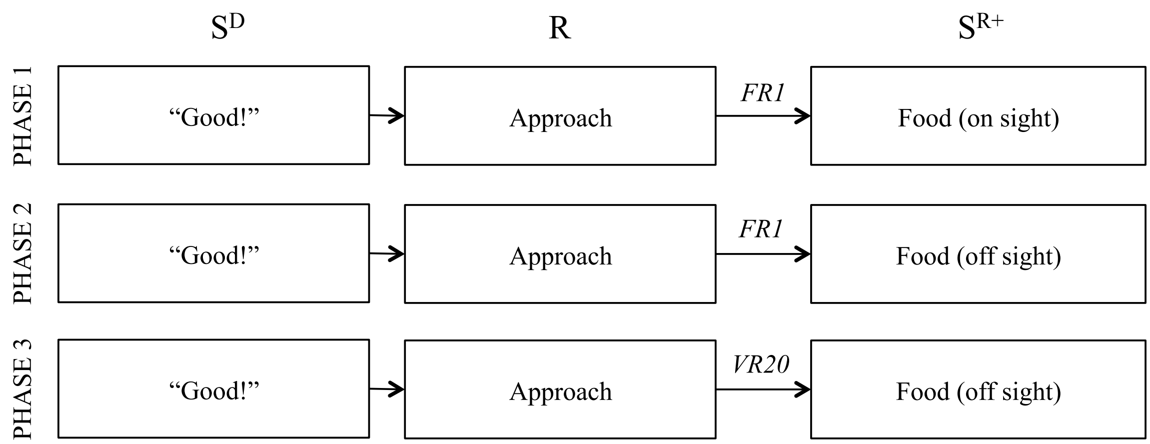

Figure 2. Diagram of training procedure employed in Lovaas et al. (1966). FR1 = Fixed ratio 1; R = Operant response; S^D = Discriminative stimulus; S^{R+} = Reinforcing stimulus; VR20 = Variable ratio 20.

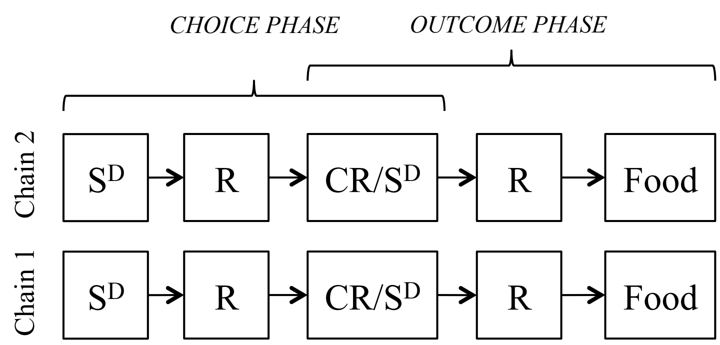

Figure 3. Diagram showing the components of a typical concurrent-chains experiment. The schedules of reinforcement may vary across chains and phases. The discriminative stimulus of the outcome phase is the putative conditioned reinforcer.

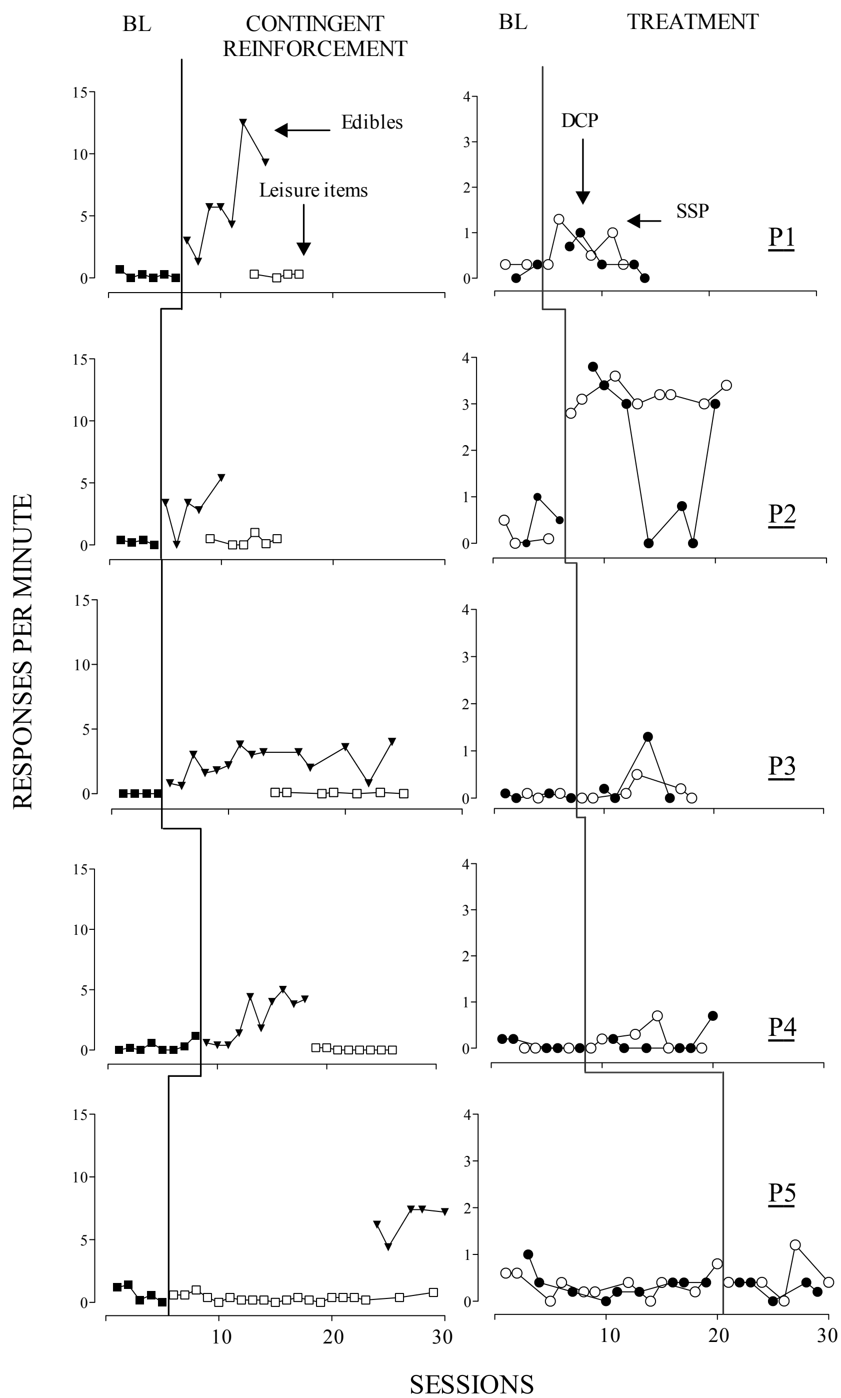

Figure 4. Reinforcement probes during pre-testing (left graph) and following stimulus-stimulus pairing and the discriminative control procedure trials (right graph) (Experiment 1).

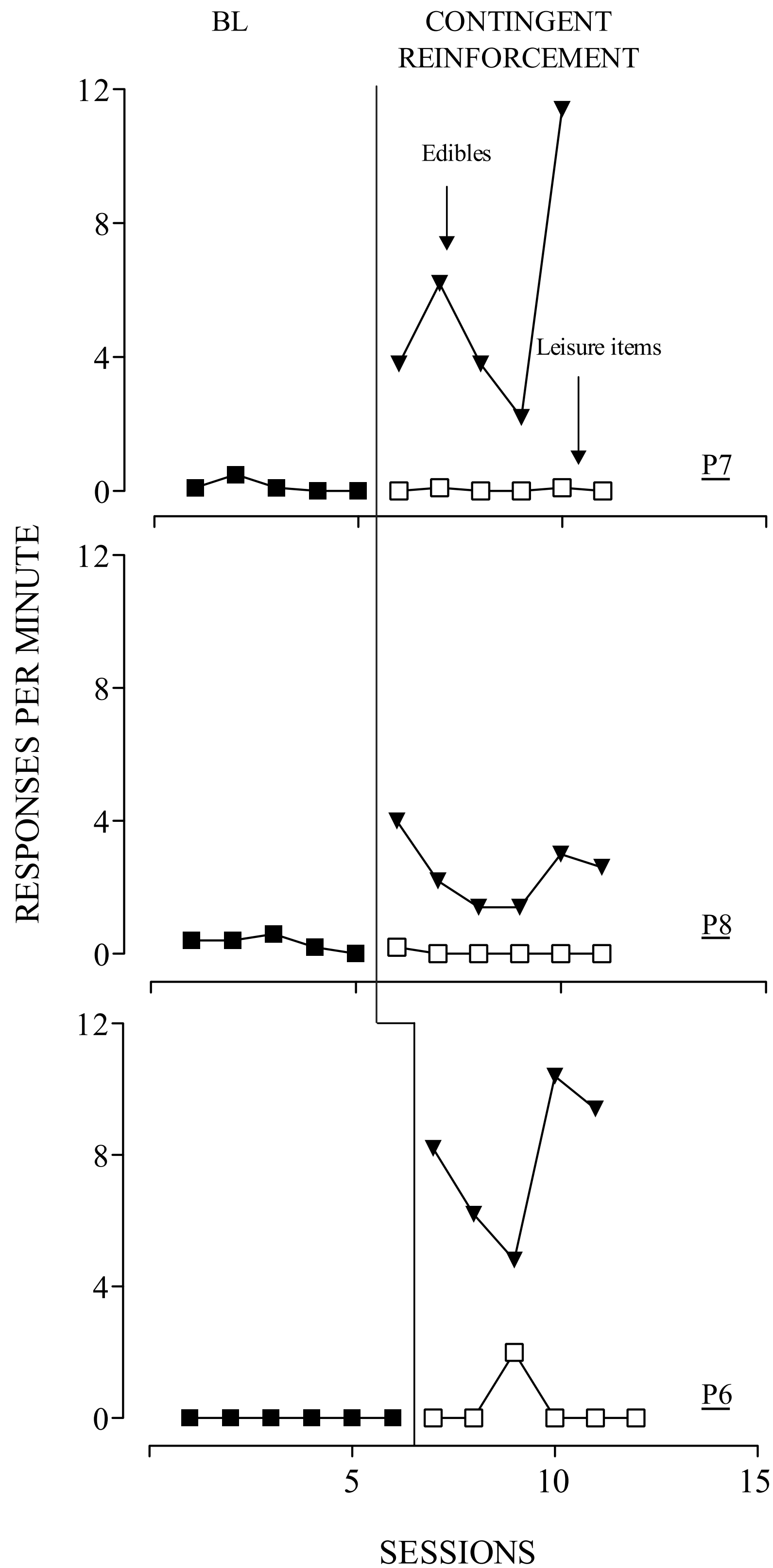

Figure 5. Reinforcement probes during pre-testing (Experiment 2).

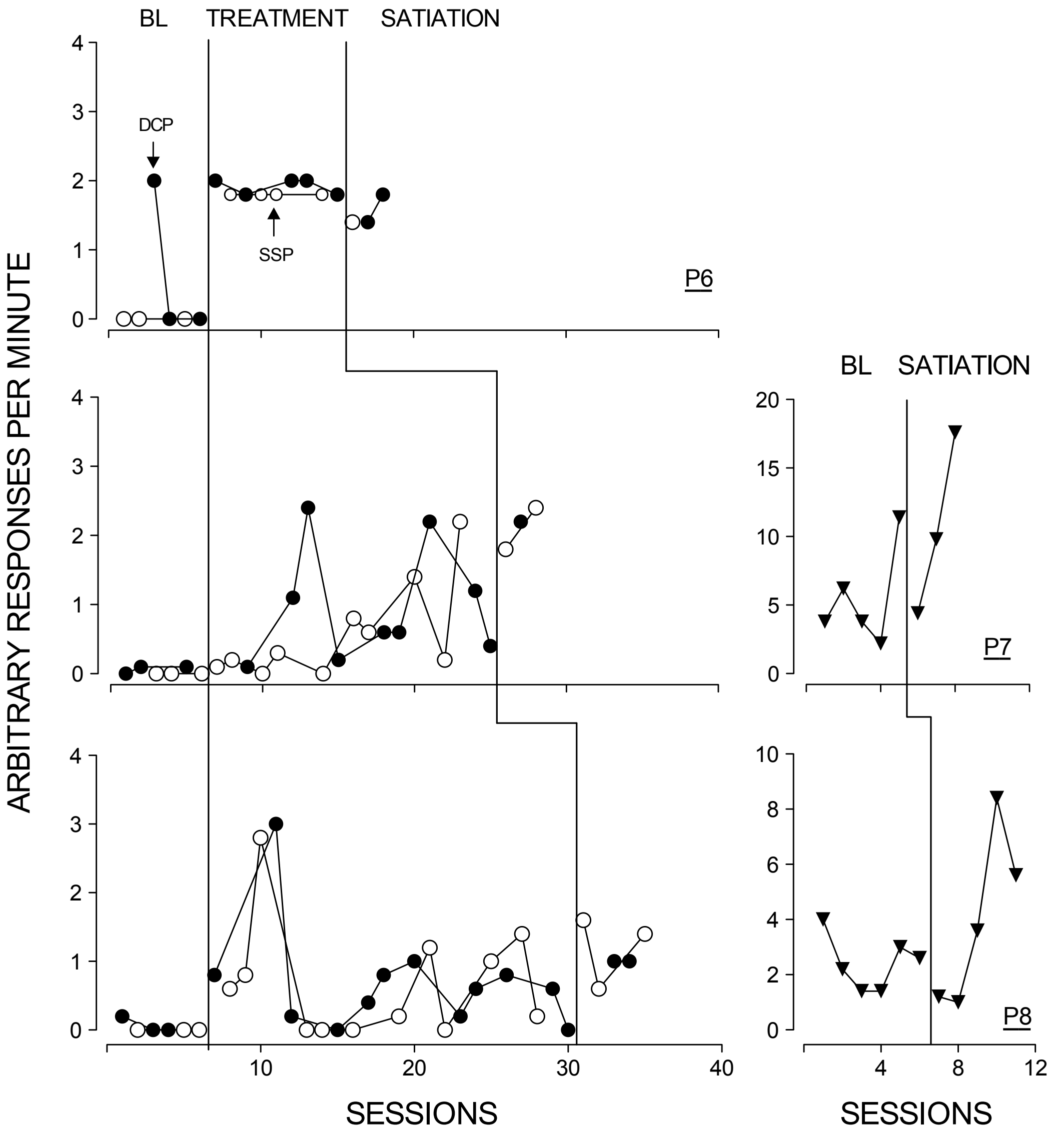

Figure 6. Comparison of conditioned reinforcement effects of stimulus-stimulus pairing and the discriminative control procedures during treatment and during reinforcer satiation (left graph), and a simultaneous reinforcer assessment of edibles (right graph) (Experiment 2).