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A comparison of response-contingent and noncontingent pairing in the conditioning of a reinforcer

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A COMPARISON OF RESPONSE-CONTINGENT AND NONCONTINGENT PAIRING IN
THE CONDITIONING OF A REINFORCER

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Arts

in

The Department of Psychology

by
Sarah J. Miller
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Abstract

Two pairing procedures were compared in the conditioning of a secondary reinforcer. Pairings of a neutral stimulus and primary reinforcer were delivered either contingent upon a participant response or noncontingently (i.e., independent of a participant response). Maintenance of responding when responses resulted in the neutral stimulus alone was compared before and throughout pairing using progressive-ratio probes. Results yielded undifferentiated responding between the contingently-paired and noncontingently-paired stimuli and a stimulus never paired with reinforcement, indicating that no conditioning effect occurred. Potential factors in producing this lack of differentiation are discussed, including differences in methodology between this study and past studies.

Introduction

Delivering preferred stimuli to reinforce desirable behavior underlies the behavior-analytic approach to intervention with children with developmental disabilities (BACB Guidelines for Responsible Conduct). A reinforcer is a stimulus that when delivered following the occurrence of a behavior results in an increase in the likelihood of that behavior in the future. A reinforcer can be classified as either a primary or secondary reinforcer. A primary reinforcer is a stimulus to which organisms are sensitive to respond to as a reinforcer without a learning history such as food, water, and escape from pain. A secondary reinforcer, also called a conditioned reinforcer, is a stimulus or event that gains reinforcing value as a result of associations with other reinforcers during the life of that organism (Catania, 1998). For example, money is presumably a conditioned reinforcer in that the delivery of money following a behavior will often result in an increase in that behavior, yet money itself cannot directly satisfy any biological need. Rather, it has gained reinforcing value because of its ability to access primary reinforcers as well as most other conditioned reinforcers. While money as a conditioned reinforcer is nearly universal, conditioned reinforcers can be more idiosyncratic as a result of unique pairings throughout an individual's life.

Beyond describing how humans become sensitive to nonbiological stimuli as reinforcers, there is great educational and therapeutic value in determining the mechanisms by which neutral stimuli become conditioned as reinforcers. As stated above, delivering reinforcers for desirable behavior is a part of many behavioral interventions; however, children with developmental disabilities frequently present with a limited range of stimuli that serve as reinforcers. Preference assessments have been developed to assist in the identification of those stimuli that will serve as reinforcers (Fisher et al., 1992; DeLeon & Iwata, 1996). In cases in which a preference

assessment identifies only a few stimuli as potential reinforcers, behavior analysts would ideally be able to expand their client's range of reinforcing stimuli by pairing known reinforcers with other stimuli in order to condition new reinforcers (Myers & Myers, 1966). This expansion could minimize issues associated with the repeated delivery of a single reinforcer (e.g., food satiation or excessive caloric intake). Despite the importance of promoting sensitivity to varied reinforcers, many of the procedural features that contribute to conditioning novel stimuli as reinforcers are unclear in the current research.

Previous research on conditioned reinforcement has generally used a Pavlovian, or respondent conditioning, approach to the acquisition of reinforcing efficacy (Williams, 1994) in which a neutral (i.e., to be conditioned) stimulus (e.g., a tone) is presented for a period prior to the delivery of a stimulus with demonstrated reinforcing properties (e.g., food); after repeated pairings, the conditioned stimulus would then be tested to evaluate if it would maintain a response (we present further discussion of the methods for assessing conditioned reinforcer value below). Although most studies have shared this basic preparation (Leiman, Myers, & Myers, 1961; Myers & Myers, 1966; Bilbrey & Winokur, 1975; Hyde, 1976), there are many procedural differences in the manner in which pairings may be arranged that may impact the acquisition of reinforcing efficacy to the stimulus. These differences include the number of pairings between a stimulus and primary reinforcer, the schedule of reinforcer delivery, the initial reinforcing or punishing effect of the stimulus, the delay to primary reinforcement following onset of the stimulus, and the contingency for reinforcement (Kelleher & Gollub, 1962; Bilbrey & Winokur, 1975; Myers & Myers, 1965). The current study focuses upon the contingency for reinforcement, specifically whether the experimenter arranges pairings contingent or noncontingent upon a participant response.

A response-contingent pairing is one in which, following a target response, the experimenter presents the neutral stimulus followed in close temporal proximity by the primary reinforcer. For example, in a study by Leiman, Myers, and Myers (1961), participants were seated in front of a box with three identical lights. A switch was below each light and participants were instructed to push the switch that correlated with the illuminated light on each trial (only one light was illuminated at a given moment); they were informed that if they pressed the correct switch, they would receive a candy. Participants were divided into three groups in which group 1 received a candy paired with a buzzing sound, group 2 received a candy paired with a buzzing sound, and group 3 received the candy alone. Once participants correctly responded on 10 consecutive trials, extinction began. During extinction, responses from group 1 continued to result in the buzzing sound but not the candy while responses from group 2 resulted in neither the buzzing sound nor the candy; responses from group 3 resulted in the buzzing sound and no candy (the buzzing sound was never paired with candy for group 3). Group 1 responded correctly on significantly more trials during extinction than groups 2 or 3, indicating that the buzzing sound, when delivered alone, maintained responding to a greater extent for group 1 (for whom it was previously paired with candy) than group 3 (for whom it was never paired with candy).

A noncontingent pairing is one in which an experimenter presents the neutral stimulus followed closely in time by the primary reinforcer on a time-based schedule (i.e., independent of a response). For instance, Hanley, Iwata, Roscoe, Thompson, and Lindberg (2003) arranged noncontingent pairings in an attempt to increase the reinforcing value of low-preference tasks for adults with developmental disabilities. After observing low engagement levels with a task (e.g., writing or hygiene tasks), the authors delivered preferred edible items on a time schedule during

sessions in which the low-preference activity was also present. Engagement in these low-preference tasks increased during this phase and maintained at elevated levels after the experimenters no longer delivered the edible items.

When selecting a contingency for reinforcement, research revealing a preference among organisms for receiving contingent reinforcement over noncontingent reinforcement may be informative. For instance, Singh (1970) tested both rats and humans in alternating conditions of work (contingent reinforcement) and no-work conditions (noncontingent reinforcement). During work conditions, reinforcement (pellets for rats, marbles for children) was available on various fixed-ratio schedules, and during no-work conditions, reinforcement was delivered on a time schedule calculated from the average rate of reinforcement earned in the previous work condition. Following training under both conditions, the organisms were allowed to choose between the work and no-work conditions by entering the areas uniquely associated with each reinforcement schedule and were allowed to switch conditions at any point. Both rats and humans demonstrated a preference for the work condition (i.e., contingent reinforcement), with a majority of subjects allocating more time toward, and earning more than half of their reinforcers in, the work condition (i.e., presumably the stimuli correlated with the contingent reinforcement condition became more potent reinforcers than the stimuli correlated with noncontingent reinforcement and thus supported additional approach behavior even though the rate of primary reinforcement delivery was equivalent). Singh and Query (1971) replicated this finding with 40 additional children.

Luczynski and Hanley (2010) reported similar findings in a study with two children in which they arranged 3 experimental conditions during which they presented children with an academic task and (a) delivered preferred edible items contingent upon completing academic

tasks (termed the contingent reinforcement or CR condition), (b) delivered the same edible items on a yoked time schedule (termed the noncontingent reinforcement or NCR condition), and (c) did not deliver any edible items (termed the no-reinforcement condition); each of these conditions was associated with a unique colored card during each session. After exposure to each condition, the experimenters provided the participants the opportunity to select which condition they would experience in a given session by presenting the colored cards in an array and allowing the child to make a selection. The results indicated that both children preferred the CR condition over the NCR and no-reinforcement conditions; this preference maintained even as the authors increased the intermittency with which they delivered contingent reinforcement (up to a fixed-ratio 8 schedule).

Although these and other studies suggest that contingent reinforcement may be preferred to noncontingent reinforcement even when the same quantity and quality of reinforcement is presumably delivered, this preference may be an artifact of experimental designs. Osborne (1977) suggested that many studies demonstrating a preference for contingent reinforcement inadvertently contained additional reinforcement in the contingent condition. In such studies, the noncontingent condition generally consisted of food that was freely available in the experimental area (e.g., a bowl containing many food pellets from which the organism could eat), while the contingent conditions generally required a response from the organism and then delivered a single food pellet as reinforcement (Jensen, 1963; Neuringer, 1969). In these cases, certain stimulus changes (e.g., the sound of the pellet dispenser in the case of rodent subjects) were uniquely associated with the delivery of reinforcement in the contingent condition and could have served as additional reinforcement. Osborne states that studies that equated all stimulus changes in each condition found a near-exclusive preference for noncontingent reinforcement;

this equating was often achieved by delivering a single food pellet on a fixed-time schedule during the noncontingent conditions using the same delivery mechanism as in the contingent conditions. While the above Singh (1970), Singh and Query (1971), and Luczinsky and Hanley (2010) studies do not appear to have contained any stimulus changes uniquely associated with the contingent reinforcement condition, it is a variable that warrants close attention in experimental design.

In addition to ambiguity over a true preference for contingent reinforcement, it has not yet been demonstrated that the use of response-contingent or noncontingent delivery of pairings yields a difference in conditioned reinforcer strength, as may be expected if contingent reinforcement has higher reinforcing value to an organism than noncontingent reinforcement. The studies discussed above have demonstrated the efficacy of both contingent and noncontingent pairing in conditioning reinforcers but have not directly compared the two methods.

Beyond differences in methodology for pairing and delivering stimuli and primary reinforcers, studies have also varied greatly in their procedures for evaluating the reinforcing efficacy of a conditioned stimulus (CS) (see Williams, 1994 for a more complete review). Following pairing, studies have typically evaluated either (a) the additive effect of the CS when combined with a primary reinforcement (S^R) schedule or (b) the effect of the CS in isolation (Williams, 1994).

One technique for evaluating a CS's additive effect is to establish a baseline rate of responding on a variable-interval (VI) or differential reinforcement of low-rate (DRL) schedule with an S^R and then superimpose the delivery of the CS on a separate, denser schedule; these are often called second-order or chain schedules (Kelleher, 1966; Williams, 1994). The value of the

CS would be determined by increases in response rates relative to baseline. However, although the CS may frequently be presented alone, it will continue to be presented in close temporal proximity to the S^R at certain times during the schedule. This continued presentation prior to the delivery of the S^R makes it difficult to separate the effects of the CS upon behavior from the effects of an intermittent schedule of S^R , as the CS may be functioning as a discriminative stimulus for upcoming S^R in such a schedule (Fantino, 1977). Any increase from baseline response rates as a result of a denser schedule of CS presentations may not be due to the CS's reinforcing efficacy, but rather due to ambiguity to the organism as to the amount of time left in the inter-food interval (i.e., the CS is presented multiple times and occasionally is presented a few seconds before food delivery, but the organism does not know after which presentation the CS will be followed by food delivery, thus it may respond as though the CS is always signaling upcoming S^R). This ambiguity confounds the evaluation of the CS's influence alone. Research has also found that stimuli never paired with primary reinforcement can accelerate baseline rates in a similar manner, shedding doubt as to whether an increase from baseline can truly be attributed to conditioned value if unpaired stimuli that, according to a Pavlovian approach to conditioned reinforcement, should not have any conditioned value have a similar effect upon behavior (Stubbs, 1971).

Methods that study the effects of a CS in isolation no longer deliver the S^R during a reinforcer assessment in an attempt to reduce confounds associated with second-order schedules. These methods include measuring resistance to extinction and strengthening a novel response by delivering the CS alone as a putative reinforcer for a novel response. To test *resistance to extinction*, the experimenter strengthens an operant response via the delivery of the S^R and the CS simultaneously and then removes the delivery of the S^R to determine the persistence of

responding under conditions in which only the CS is delivered. This allows for an evaluation of the CS's effect on behavior in the absence of an S^R schedule. However, because a major component of the previous condition is maintained (the delivery of the CS following the same response), it may be less salient to the organism that the contingencies have changed (the S^R will no longer be delivered). This ambiguity could maintain responding longer than extinction from a primary reinforcement schedule in which a previously associated stimulus (in this case, the CS) is not delivered (Williams, 1994). This is primarily a concern when comparing two groups' performances during extinction from primary reinforcement in which one group continues to receive the CS and the other receives neither the S^R nor the CS.

The other method of evaluating a CS in isolation, using the CS to *reinforce a novel behavior*, typically requires the initial pairing of the CS with an S^R (perhaps contingent upon a bar press or delivered on a fixed-time schedule), followed by delivering the CS alone following a novel response (e.g., a chain pull) (Hyde, 1976). Presumably if chain pulling increases, the CS is functioning as a reinforcer within that context. This method allows for a more functional evaluation of the CS as a reinforcer than the resistance to extinction method, as it fulfills the definition of a reinforcer by increasing the future likelihood of a behavior when it is delivered following that behavior. However, this method is prone to a rapid loss of conditioned value, which could preclude a comprehensive evaluation of its effects upon a novel behavior. To avoid this, the CS and S^R sometimes continue to be paired on one schedule while evaluating the CS's effect upon a novel behavior with a separate schedule of reinforcement. This has often been accomplished by delivering the S^R on a time schedule while also preventing it from being delivered within a certain time of the novel response to avoid adventitious reinforcement (Zimmerman, Hanford, & Brown, 1967; Rashotte, Marshall, & O'Connell, 1981). Another

alternative is to include short probes in which the CS is delivered alone intermixed with pairing sessions. These brief probes would allow for an evaluation of the CS's effect upon responding while potentially limiting the loss of conditioned value and avoiding adventitious reinforcement as in arrangements where the S^R continues to be delivered during assessment. Both methods allow for the evaluation of the CS in isolation while still maintaining its strength through continued pairing.

Roane (2008) advocated the use of progressive-ratio (PR) schedules to evaluate reinforcer potency in which the requirements for accessing reinforcement systematically increase throughout the session. Each time the requirement for reinforcement is met, it increases by a given "step size" to determine the next requirement for reinforcement within that session. For example, for a step size of 5, the initial requirement for reinforcement may be 5 responses, and, after completion of that requirement, increase to 10, then 15, and so on. PR schedules are evaluated in terms of "break points" or the last completed schedule requirement, and stimuli associated with higher break points are considered more potent reinforcers. Roane, Lerman, and Vorndran (2001) used PR schedules to compare stimuli that had equivalent selections during a typical preference assessment that required a simple response. They found that as the requirement for reinforcement increased, differential amounts of responding occurred (i.e., for each participant one stimulus was associated with a higher break point relative to the other). This demonstrated that while stimuli may appear to be equally reinforcing in low-effort situations, differences in reinforcer potency can be identified with the systematic increase in effort associated with PR schedules.

The purpose of the current study was to evaluate whether stimuli delivered with primary reinforcement contingent upon a participant response acquire reinforcing efficacy at a different

rate or strength than stimuli delivered noncontingently with primary reinforcement. We first evaluated the effects of the stimuli in a baseline condition using progressive-ratio probes. We then conducted pairing sessions for each stimulus and used PR probes to evaluate whether the stimulus had acquired reinforcing efficacy and the strength of its efficacy.

Methods

Participants and Setting

We recruited three individuals between four and five years old from a local daycare to participate in this study. All individuals were typically developing and had no obvious developmental impairments. Sessions were conducted either in an unoccupied room or at a table in the hallway between classrooms.

Procedure

We initially conducted two preference assessments. The first was conducted with edible items in order to identify highly preferred items to deliver as primary reinforcers in the remainder of the study. The second preference assessment was conducted with colored index cards that were presented as to-be-conditioned stimuli in order to ensure they were not differentially preferred prior to entering into the evaluation. We then conducted pre-conditioning progressive-ratio (PR) probes to establish baseline rates of responding when responses resulted in the colored cards (i.e., we established the baseline reinforcing efficacy of each card). Following the PR probes, we conducted pairing sessions in an effort to condition the cards as conditioned reinforcers. Intermittent with pairing sessions, we conducted progressive-ratio probes to evaluate if any changes in the reinforcing efficacy of the cards had developed. We evaluated the effects of pairing a stimulus with a demonstrated reinforcer in a multiple baseline design across participants and compared the effects of contingent and noncontingent pairing in a multielement design within each participant.

Primary Reinforcer Preference Assessment. We conducted a systematic paired-item preference assessment as described by Fisher et al. (1992) using 10 edible items selected by the experimenter in order to identify highly preferred edible items to deliver as primary reinforcers.

During each trial of the edible item assessment, the experimenter randomly presented two edible items and asked the participant to choose one. Upon selection, the participant received a small piece of the item to consume, and after consumption, the experimenter presented the next pair of items. Each item was paired with all other items in the assessment once. If the participant did not choose an item within 10 s of the prompt, the experimenter terminated the trial and indicated “no choice” in the data. Following completion of the assessment, the experimenter ranked the items based upon the number of times they were selected. From this hierarchy the experimenter selected the four highest-preferred edible items to be used as reinforcers during the pairing sessions. Prior to the start of each series of three pairing sessions, the experimenter presented the four edible items to the participant and asked the participant to choose the item for which he/she would like to work; the purpose of this assessment was to lessen the likelihood of satiation throughout sessions.

Conditioned Reinforcer Preference Assessment. The conditioned reinforcer preference assessment consisted of the same procedures as the primary reinforcer assessment except that edible items were replaced by colored cards. The eight basic colors (red, yellow, green, blue, purple, orange, brown, and black) were presented to each child in pairs, and again, a hierarchy was determined based on the child’s selections. Upon selecting a card, the experimenter presented the next pair. Three equally preferred colors (determined by the child selecting them an equal number of times), or as close as possible, were used as the target cards during the pairing and control sessions. Following identification of three equally-preferred colors, a simple matching-to-sample task was conducted to ensure the participant could differentiate between the three colors.

Conditioned Reinforcement Test Probes. We identified a simple operant task for each participant based upon their current skill levels in consultation with their teachers. Tasks consisted of pre-academic activities that required a motor response to complete or fine motor activities (for Mabelle, the task was clipping clothespins onto a string and for Mika and Lexi, the task was folding washcloths into fourths). During these probes, participant responses resulted in the presentation of one of the three selected color cards. Separate probes were conducted for the response-contingent (RC) card, the noncontingent (NC) card, and the control (CT) card. Following completion of the programmed schedule requirement, we presented the card associated with the current probe condition. We arranged card delivery during these sessions according to a progressive-ratio (PR) schedule of reinforcement. That is, the criteria for reinforcement increased arithmetically by one response following each schedule completion (i.e., at the start of the session only one response was required to produce a card presentation, then two responses, then three, etc.). This allowed for an evaluation of the reinforcing efficacy of each card. The experimenter delivered a verbal prompt to engage in the task at the beginning of each probe session and did not prompt the participant to respond after the initial instruction. We terminated sessions following 2 min without a response, following a participant request to stop, or at 30 min total session time. Prior to each probe, Mika and Lexi both received two forced exposures in which the experimenter physically guided them to complete the task and then presented the colored card for 5 s. The purpose of these forced exposures was to ensure the participants experienced the contingency and were added following completing the procedures with Mabelle.

During NC probes, we presented the colored card that was associated with noncontingent pairing with food items; during RC probes, we presented the colored card that was associated

with response-contingent pairing with food items; during CT probes, we presented the colored card that was never paired with food items during this experiment. We conducted at least three probe sessions prior to initiating pairing sessions to establish that none of the cards differentially supported responding prior to pairing. We conducted one probe following each block of conditioning sessions (described below) to assess the differential effects of RC and NC pairing relative to the CT condition. The order in which each card was probed was counterbalanced across probes such that each condition was equally affected by possible order effects. The order in which each counterbalanced sequence of probes occurred was random across participants. We conducted all three probes in the same day, one immediately after the other, after which we returned to pairing. We continued to alternate between pairing and probe sessions until probe data either reflected stable differential responding between cards or no increasing or decreasing trend was present. Each session also included a discriminative stimulus (S^D) for the condition the participant was in. This consisted of placing a laminated piece of construction paper, approximately 7 x 9 in and of the same color as the card that was to be delivered as the reinforcer, in front of the participant and underneath the available leisure items on the table. The purpose of the S^D was to facilitate discrimination between the conditions.

Conditioning Sessions: During conditioning sessions, participants sat at the table (again with an S^D to facilitate discrimination) with three age-appropriate leisure items (the leisure items alternated after each series of sessions). Prior to each series of conditioning sessions (we define a series as the combination of one RC, one NC, and one CT session), an abbreviated preference assessment was conducted in which the experimenter presented the four previously-identified preferred edible items and asked the participant to choose which he/she would like to work for.

The experimenter delivered the selected edible item during the subsequent RC and NC pairing sessions until the next series began.

During response-contingent (RC) pairing sessions, in addition to the leisure items, the participant also had access to a simple operant task, identified using similar interviews and assessments as we described in the preconditioning probes (for Mabelle this was drawing a circle and for Mika and Lexi this was clipping clothespins onto a string). The experimenter initiated a session by instructing the participant to engage in the task. If the participant did not engage within 20 s of the verbal prompt, the experimenter physically guided the participant to engage in one correct response. Following each response (a fixed-ratio 1 schedule), whether independent or physically guided, the experimenter presented the RC card in the participant's view for 5 s, removed the card, and then delivered a small edible item to the participant (Mika and Lexi also received 15 s of attention as part of the reinforcement along with the edible item). If the participant did not respond again within 20 s of reinforcer delivery (for Mabelle immediately after delivery the edible item; for Mika and Lexi 20 s after termination of attention), the experimenter delivered additional physical guidance. Responses that occurred during the delivery of reinforcement did not result in the delivery of an additional reinforcer; rather, the interval reset after the termination of reinforcer delivery. The experimenter did not deliver a verbal prompt after the initial prompt. The session concluded after 10 reinforcer deliveries.

During noncontingent (NC) pairing sessions, the experimenter initiated sessions with an instruction to play with the provided leisure materials and delivered reinforcement on a fixed-time (FT) schedule that we yoked to the RC sessions. That is, we divided the total time of the previous RC session by the number of reinforcer deliveries (10) to calculate the inter-reinforcement interval (IRI) for NC sessions. Reinforcement deliveries were otherwise similar to

those of the RC session in that the experimenter presented the NC card in the participant's line of sight for 5 s, removed the card, and then delivered an edible item, along with 15 s of attention for Mika and Lexi (she delivered the same edible delivered during the associated RC session for that series). Tasks used during the RC sessions were not present in order to avoid any incidental pairing between response completion and reinforcement delivery during NC sessions. These sessions were also terminated following 10 reinforcement deliveries.

Control (CT) sessions were conducted in a similar manner to the NC sessions. The experimenter initiated sessions with an instruction to play with the provided leisure materials (again the academic task was not present) and presented the CT card on the same FT schedule as the NC session in the series. The CT card, however, was presented alone and no edibles or attention were delivered during control sessions. The experimenter presented the CT card for 5 seconds and then removed the card. The purpose of these sessions was to control for any exposure effects that may have occurred simply from being presented the card.

We randomly decided the order of presentation of RC and NC sessions for each series using a coin flip. Control sessions always occurred in the middle of the series in order to lessen the likelihood of satiation. The only constraint of the randomization of series sequences was that each participant experienced RC-CT-NC for their first session of the study. This order was necessary to establish the FT schedule of reinforcer delivery for the CT and NC sessions. Following this session, the most recent RC session was used to calculate the FT schedule for the CT and NC sessions. The experimenter ensured an equal number of sessions of each condition each day. Following every 6 series completed (6 sessions in each condition, which we term a block), the experimenters conducted post-conditioning probes as described above.

Measurement and Interobserver Agreement

We individually defined response completion based upon the idiosyncratically identified tasks for each participant. For drawing a circle (Mabelle’s RC task), response completion was defined as continuous contact of the pen with the paper that resulted in a line crossing over itself with a visible gap in the middle (i.e., the circle did not have to be perfectly round). For clipping the string tasks (Mabelle’s probe task, Mika and Lexi’s RC task), response completion was defined as the opening of the clip passing over half of the string or the clip remaining on the string after the participant removed his/her hand from it (if it was ambiguous how far the clip was on the string). For folding the washcloths (Mika and Lexi’s probe task), response completion was defined as folding the cloth in half twice, in which each fold must have resulted in more than four inches of the cloth being folded on top of the cloth. During PR probes, we collected paper-and-pen data on response completion and reinforcer delivery using pre-coded data sheets. Each sheet included a grid of boxes in rows to denote the number of responses necessary to complete each schedule requirement (i.e., 1 box in row 1, 2 boxes in row 2, etc.). Data collectors scored each response by marking an X in its corresponding box (this also served to indicate to the experimenter when reinforcement should be delivered). From these data, we calculated the total number of responses completed and the “break point” associated with each session (i.e., the largest ratio schedule completed prior to meeting session stop criteria). Data collectors also collected the total session duration for each PR session using a stop watch.

Data collectors scored response completion during RC sessions, reinforcement delivery during RC and NC pairing sessions, and card presentation during all sessions using netbook computers. Data collectors scored responses and reinforcement deliveries, and the data were

analyzed after the session to ascertain the number of responses and reinforcement deliveries in each 10 s interval. The netbook computers recorded the session duration as well.

To obtain interobserver agreement (IOA), two observers simultaneously but independently collected data for 25% of probe and conditioning sessions. We calculated IOA for responding during probe sessions by summing the total number of scored responses for each observer and dividing the smaller number of responses by the larger number and then converting this number into a percentage (the data collection system did not allow for a more point-by-point comparison). For conditioning sessions, we calculated IOA for both responding and reinforcement delivery using a proportional-agreement method. We compared each observer's data on an interval-by-interval basis in which 10 s intervals with exact agreement were scored with a one, and any intervals not in exact agreement were scored as the smaller number divided by the larger number of events. These scores were then summed, divided by the number of intervals for that session, and converted to a percentage.

The average IOA across each participant was above 90% with a range of 68.4% to 100% agreement per session across observers. IOA was collected on 25% of sessions for Mabelle, with an average agreement of 95.4% for CT sessions, 91.3% for NC sessions, 95.6% for response completion for RC sessions and 90.9% for reinforcer delivery for RC sessions. IOA was collected on 32% of sessions for Mika, with an average agreement of 94.8% for CT sessions, 95.2% for NC sessions, 97.9% for response completion for RC sessions, and 95.8% for reinforcer delivery for RC sessions. IOA was collected on 27% of sessions for Lexi, with an average agreement of 97.9% for CT sessions, 95.4% for NC sessions, 94.7% for response completion for RC sessions, and 95.9% for reinforcer delivery for RC sessions.

Results

We present our results in Figures 1 and 2. Pre-conditioning probes for Mabelle met PR break point criteria at a maximum of PR 5 completion and did not increase beyond that point during any post-conditioning probes. Mabelle never completed above a PR 3 schedule during any post-conditioning probes, and her total responding was also undifferentiated among the cards. Mika demonstrated fairly stable responding during pre-conditioning probes and consistently met break point criteria at PR 1 or below. He continued to demonstrate undifferentiated total responding between the three cards during post-conditioning probes and never responded above the highest pre-conditioning break point of PR 1. Lexi engaged in variable but undifferentiated rates of responding during both pre and post-conditioning probes. Lexi's highest completed PR schedule during pre-conditioning probes was PR 2 and responding never exceeded PR 2 schedule completion throughout conditioning.

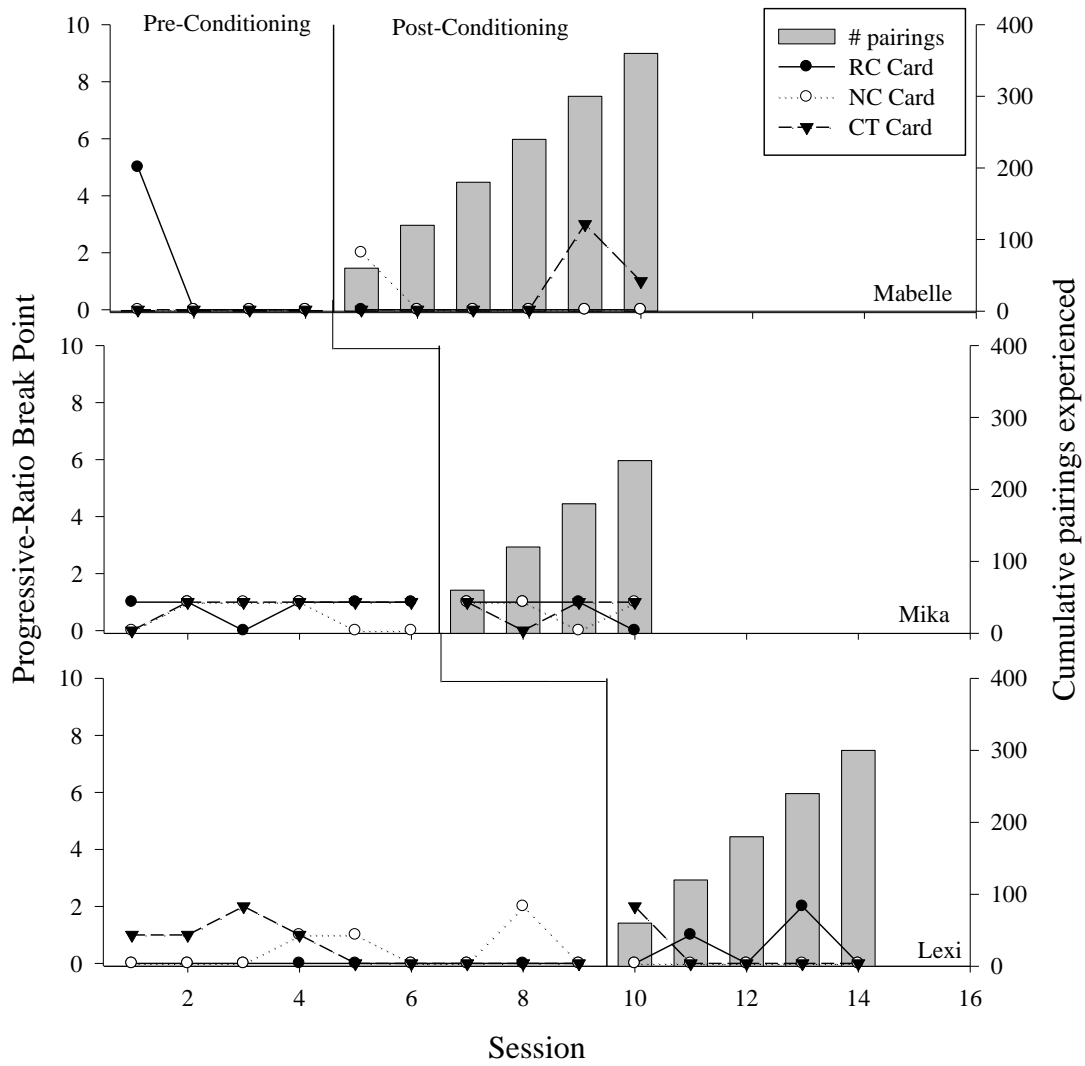


Fig. 1. Pre-conditioning and post-conditioning progressive-ratio break points across sessions for Mabelle, Mika, and Lexi.

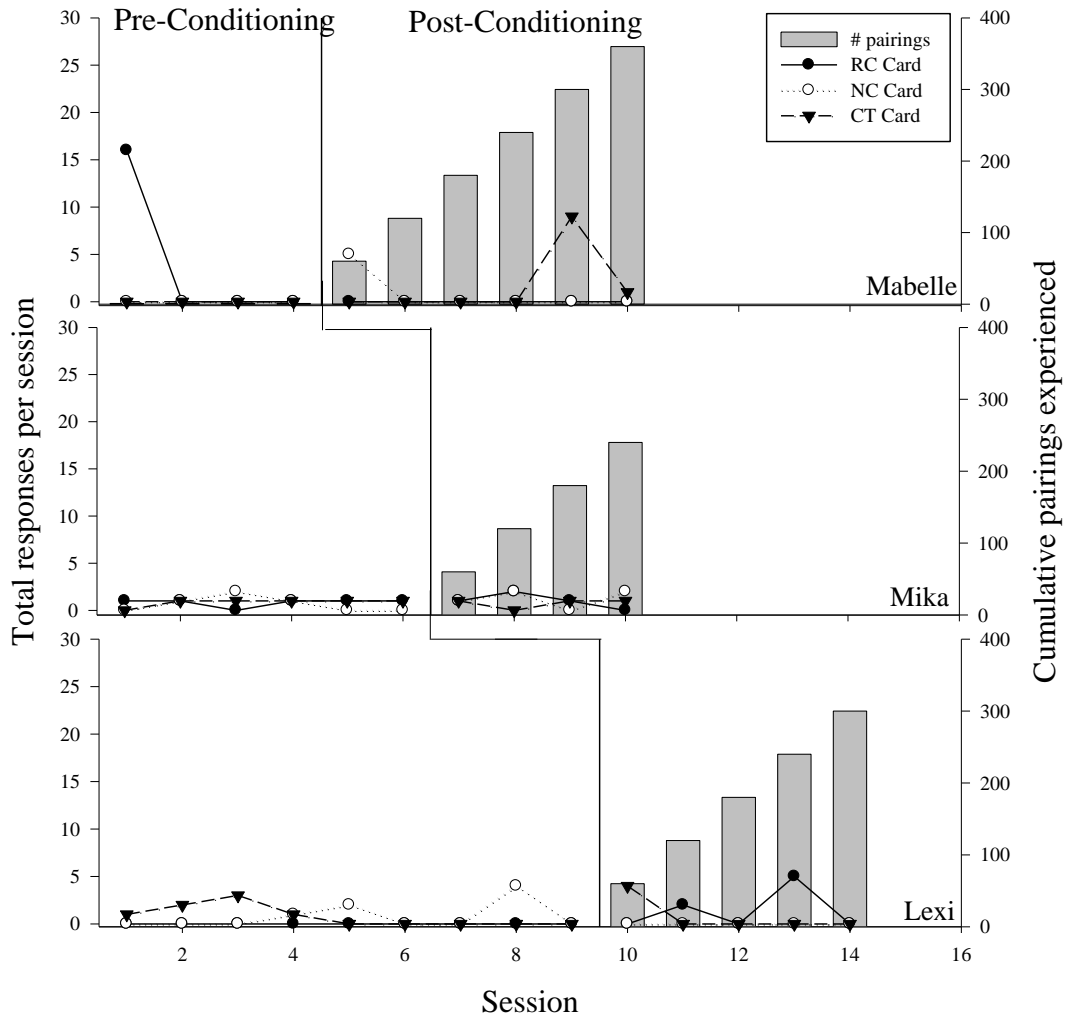


Fig. 2. Pre-conditioning and post-conditioning total responses across probe sessions for Mabelle, Mika, and Lexi.

Mean Session Duration (Pairing Sessions)	Range of Session Duration (Pairing Sessions)	Mean Session Duration (Probe Sessions)	Range of Session Duration (Probe Sessions)
301 s	133 – 500 s	137 s	120 – 485 s

Fig. 3. Mean and range of session duration for all pairing and probe sessions.

Discussion

The results of this study are inconclusive as to any relative or differential efficacy of contingent versus noncontingent pairing in the conditioning of a reinforcer. Interpretation of these results is difficult due to the undifferentiated responding within each participant. This pattern of responding indicates that no conditioning effect occurred for any of the three participants, as responding to the CT card, which was never paired with primary reinforcement, was similar to responding to both the RC and NC cards, which were paired with primary reinforcement.

These results are in contrast to the findings of Hanley, Iwata, Roscoe, Thompson, and Lindberg (2003) in which noncontingent pairing of primary reinforcers with low-preference activities increased engagement in low-preference activities even after primary reinforcers were no longer delivered. They are also in contrast to the findings of Leiman, Myers, and Myers (1961) in which contingent pairing of a primary reinforcer with a neutral stimulus (buzzing sound) resulted in increased responding during conditions in which the buzzing sound was delivered alone following pairing. There are multiple differences between these studies and the current study that may have influenced our results.

First, Leiman, Myers, and Myers (1961) utilized a group design while the current study utilized a single-subject design. This difference in group versus single-subject design means that Leiman, Myers, and Myers' study exposed each participant to only one condition and tested for a conditioning effect across subjects while the current study exposed each participant to all three conditions in an alternating treatments design and tested for an effect within subjects. This difference between exposures to contingencies is potentially important. It is possible that, despite the use of S^D s in the current study, the contingencies were still ambiguous to participants and

that a reversal design in which participants were only exposed to one condition at a time may have yielded different results. In other words, it is possible that the rapid alternations between conditions interfered with the establishment of a conditioning effect and that longer exposures to each condition would have better facilitated conditioning.

Second, the participants in Hanley, Iwata, Roscoe, Thompson, and Lindberg (2003) were adults with developmental disabilities while the current study utilized preschoolers who were typically developing. It is possible that this population difference influenced our results.

However, the participants in Leiman, Myers, and Myers (1961) were typically developing fifth graders, therefore we were not concerned that the population difference between our study and Hanley et al. would be a determining factor in our results and did not seek out a population with developmental disabilities. Additionally, conditioning is considered a basic learning process, and this study was intended to assess a component of conditioning for its efficacy in a basic research design. Such a study is intended to capture basic learning processes that should be consistent across all members of a species, which gave further confidence in evaluating this question with typically-developing individuals.

Third, both studies evaluated the effects of pairing during extended extinction conditions in a pre-post comparison, and the current study utilized brief probes intermixed throughout pairing. While it is unlikely that extending the amount of exposure to extinction from an S^R schedule would have yielded different results, it is possible that the current study's intermittent exposure to extinction during PR probes affected the pairing process. Specifically, our participants experienced sixty pairings with each stimulus which were followed by one session of extinction from S^R , and it is possible that pairing was affected by these somewhat frequent disruptions and that less frequent probes may have yielded different results.

The fourth and potentially the most significant difference between the current study and Leiman, Myers, and Myers (1961) and Hanley, Iwata, Roscoe, Thompson, and Lindberg (2003) regards the tasks used to evaluate the effects of pairing. In both of the previous studies, the task used to measure responding during extinction was the same task that was the instrumental task in pairing. The current study utilized a novel task that had never been present when S^R was delivered, therefore having no reinforcement history or potential of conditioned reinforcing efficacy. This difference may be very significant as it could reflect that in the previous studies either the task also acquired efficacy as a secondary reinforcer or the participant's continued responding functioned more as probes for whether the task would again result in S^R (i.e., responses were solely extinction responses and not maintained by the CS). The current study controlled for the confound of ambiguity between S^R contingencies through the use of separate tasks for probes and pairing sessions, and this difference may have been important in yielding the current results.

Our study also differed from studies that have tested the additive effect of a CS to an S^R schedule to evaluate for a conditioning effect (Kelleher, 1966; Williams, 1994). These studies superimposed the delivery of a CS over an S^R schedule and tested for any increase in responding as a result of the addition of the CS, whereas the current study delivered the CS in isolation from S^R during probes. It is possible that evaluating the effect of a CS superimposed over an S^R schedule may have been more sensitive to any effects pairing had on the CS. We chose not to utilize this design for evaluating the effects of pairing due to concerns that the CS may function as a discriminative stimulus for upcoming S^R and not as a conditioned reinforcer (Fantino, 1977).

Previous studies that evaluated the efficacy of a CS at strengthening a novel response have often continued to deliver the S^R on a separate time schedule during these sessions in an

attempt to stave off the rapid loss of conditioned value that tends to occur when the CS is delivered alone. Those studies also often prevent the S^R from being delivered within a certain time of the CS in order to avoid adventitious reinforcement or continued pairing (Zimmerman, Hanford, & Brown, 1967; Rashotte, Marshall, & O'Connell, 1981). We did not deliver the S^R during our probes but instead utilized brief intermittent probes rather than long exposures to extinction. The rationale behind this design was that brief exposures might not weaken the conditioning effect for the participants to as large of a degree as extended exposures to extinction and would allow for a continued evaluation of the CS's reinforcer strength. Previous studies have typically conducted their evaluations in a pre-post manner utilizing extinction; based on our review of the literature, our study was the first to attempt to evaluate the reinforcing efficacy of a CS using intermittent probes throughout the pairing process. Given that this was a novel manner by which to test for a conditioned reinforcer effect, it is possible that our probe methodology influenced our results, and future research should evaluate whether utilizing brief intermittent probes is a valid method by which to test for reinforcing efficacy of stimuli.

In summary, our study compared contingent and noncontingent pairing for differential efficacy in conditioning a reinforcer. We did not find any differences in responding between stimuli that had been paired with primary reinforcement and a stimulus never paired with primary reinforcement. Our study utilized a novel method for testing a potential conditioned reinforcer by utilizing intermittent PR probes of the ability of the CS to maintain a novel response in isolation rather than utilizing extinction in a pre-post manner or superimposing the CS over an S^R schedule. This difference may have influenced our results and future research should test for the validity of this probe methodology in evaluating conditioned reinforcers.

Appendix: IRB Approval



Institutional Review Board
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ACTION ON PROTOCOL APPROVAL REQUEST

TO: George Noell
Psychology

FROM: Robert C. Mathews
Chair, Institutional Review Board

DATE: November 10, 2011

RE: IRB# 3221

TITLE: A comparison of response-contingent and non-contingent pairing in the conditioning of a reinforcer

New Protocol/Modification/Continuation: New Protocol

Review type: Full Expedited **Review date:** 11/7/2011

Risk Factor: Minimal Uncertain Greater Than Minimal

Approved **Disapproved**

Approval Date: 11/10/2011 **Approval Expiration Date:** 11/9/2012

Re-review frequency: (annual unless otherwise stated)

Number of subjects approved: n/a (secondary data only)

Protocol Matches Scope of Work in Grant proposal: (if applicable)

By: Robert C. Mathews, Chairman 

PRINCIPAL INVESTIGATOR: PLEASE READ THE FOLLOWING –
Continuing approval is **CONDITIONAL** on:

1. Adherence to the approved protocol, familiarity with, and adherence to the ethical standards of the Belmont Report, and LSU's Assurance of Compliance with DHHS regulations for the protection of human subjects*
2. Prior approval of a change in protocol, including revision of the consent documents or an increase in the number of subjects over that approved.
3. Obtaining renewed approval (or submittal of a termination report), prior to the approval expiration date, upon request by the IRB office (irrespective of when the project actually begins); notification of project termination.
4. Retention of documentation of informed consent and study records for at least 3 years after the study ends.
5. Continuing attention to the physical and psychological well-being and informed consent of the individual participants including notification of new information that might affect consent.
6. A prompt report to the IRB of any adverse event affecting a participant potentially arising from the study.
7. Notification of the IRB of a serious compliance failure.
8. **SPECIAL NOTE:**

**All investigators and support staff have access to copies of the Belmont Report, LSU's Assurance with DHHS, DHHS (45 CFR 46) and FDA regulations governing use of human subjects, and other relevant documents in print in this office or on our World Wide Web site at <http://www.lsu.edu/irb>*

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Vita

Sarah Miller graduated with a Bachelor of Science degree in psychology in 2010 from Louisiana State University. She enrolled in Louisiana State University's doctoral program in psychology immediately after graduation. Her research interests are focused on academic and behavioral interventions for children. Sarah is currently completing her third year of graduate schools and intends to complete her doctoral degree with an emphasis on behavioral interventions for children.