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Behavioral Sensitivity to Progressively Thinning Reinforcement Schedules in a Token Economy

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Abstract

Tokens are commonly used in educational settings to reinforce behavior without interrupting the response. There are two ways to increase the amount of work a person will do prior to receiving a reinforcer: either by increasing the work required to earn a token, or by increasing the number of tokens needed to redeem for a reinforcer. However, there is no literature supporting which of the two is more effective. The purpose of the current study is to extend the literature by thinning schedules of reinforcement within a token economy at two points, token earning and token exchange, and to compare the point at which the participants stop responding. The participants were asked to string various amounts of beads on a plastic lace in order to receive a token that can later be exchanged for a reward. The amount of time with the reward depended on how many tokens he or she received. While the preference for the thinning method was idiosyncratic, tokens increased the levels of responding. Overall, both methods are viable options to thin a schedule of reinforcement while maintaining high levels of responding in preschool aged participants.

Keywords: token economy; preschoolers; progressive ratio schedule; schedule thinning

Table of Contents

List of Tables

Table Page

List of Figures

Figure Page

Chapter I: Overview

Introduction

Schedules of reinforcement evoke different patterns of responding. One particular schedule, a progressive ratio (PR) schedule, has been used in basic operant research to assess the relative strength of reinforcers. PR schedules require that an organism produce an increasing number of responses to obtain reinforcement. The ratio requirement usually increases arithmetically within a session, meaning that once a ratio requirement is completed and reinforcement is delivered, the next ratio requirement for reinforcement increases (Baron & Derenne, 2000; Hodos, 1961; Roane, Lerman, & Vorndran, 2001).

Another important aspect of behavior that PR schedules reveal is the point at which the organism stops responding for the reinforcer. Stafford and Branch (1998) found that as the ratio requirement in a PR schedule increased, the duration of the post-reinforcement pause increased. In addition, they found that the points at which responding ceased increased as the magnitude of the step-size increased. Ferster and Skinner (1957) originally termed this phenomenon "ratio strain," indicating that when the magnitude of the ratio, either fixed or progressive, increased too drastically, the pause in responding essentially terminated behavior altogether. In a PR schedule this is termed the "breakpoint" and is defined as the highest ratio value completed on the PR schedule, signifying the stopping point for the organism (Hodos, 1961).

Covarrubias and Aparicio (2008) studied rats pressing a lever to compare step sizes in PR schedules (PR1, in which each completed step resulted in increasing the next response requirement by one response, and PR3, in which each completed step resulted in increasing the next response requirement by three responses) and the relative potency of two reinforcers (food and saccharin pellets). Their results indicated that the rats' breakpoint was sensitive to both

variables, with the rats emitting more overall responses in the PR3 than the PR1 schedule, and emitting more responses for saccharin pellets than for food pellets. The authors hypothesized that the greater value of the saccharin pellets evoked continued responding in the rats, even at higher ratio requirements. This study shows that the magnitude of each step within a PR schedule as well as what the reinforcer is affects the overall rate of responding and the measured breakpoint.

Covarrubias and Aparicio's (2008) results have been replicated with human subjects. Tiger, Toussant, and Roath (2010) demonstrated that breakpoints will increase when participants are given the choice of more preferred reinforcers. Dixon and Falcomata (2004) compared different schedules to delayed reinforcement with a participant with acquired brain injury. When given the choice to work towards a small immediate reinforcer, a large fixed-delay reinforcer, and a large progressive-delay reinforcer, the participant chose the progressive-delay schedule of reinforcement 90% of the time. The participant continued to prefer the progressive delay even when its duration surpassed the large fixed delay, further supporting that PR schedules can produce more overall responding than static schedules. In addition, this study shows that the participant was able to wait for reinforcement even when the progressive schedule was longer than the fixed schedule. Overall, this study shows that a person is able to maintain and increase their responding through delayed reinforcement.

Another area of research influenced by PR schedules is behavioral economics. Behavioral economics examines operant behavior through a progressive relationship between price and consumption of the reinforcer. PR schedules can be looked at economically through the cost of the reinforcer: as the response requirement for reinforcement increases, the cost of the reinforcer in terms of response effort also increases. Stated simply, the cost of the reward increases as consumption increases (Reed et al., 2009; Roane, Lerman, & Vorndran, 2001). The breakpoint

value in the PR schedule signifies that the amount of work that the next reinforcer requires does not outweigh the reward being received in that ratio value (Madden, Smethells, Ewan, & Hursh, 2007).

PR schedules have been used to assess the response effort produced by an organism. For example, Romani, McCoy, Wacker, and Padilla-Dalmau (2014) assessed four participants' choice of instruction for varying levels of task difficulty while progressively increasing the amount of work needing to be done. The researchers found that three out of four participants completed eight times the amount of work when the preferred instruction (i.e., visual) was used compared to the amount of work completed for their lowest-preferred instruction (i.e., vocal). This suggests that an organism will produce more effortful responses to have access to preferred stimuli than they will produce for less preferred consequences.

Roane et al. (2001) used a behavior economics approach to determine a new method for identifying a reinforcer for four participants with developmental disabilities. When analyzing reinforcer efficacy through behavior economics, the reinforcers that are the most preferred should produce a higher level of responding as the price and consumption of the reinforcer increases. To measure the potency of the reinforcer, the researchers measured work-rate functions to determine which reinforcer would produce the most responding throughout the PR schedule. Roane and colleagues found that the participants would respond (work) more for reinforcers that were highly preferred compared to not as salient reinforcers. Overall Roane et al. provided data on a new method for evaluating the salience of the reinforcer through the use of a PR schedule.

Another way in which the breakpoint value is important in behavior economics is that it can determine a cost-effective treatment intervention with the most benefits for the client and

staff. The maximum PR value (i.e., the breakpoint) shows how much the client will work prior to contacting reinforcement, thus signaling to the staff when it is most appropriate to deliver a reinforcer to prevent ratio strain. Empirically identifying this breakpoint allows programs to be written in a manner that will maximize the magnitude of responding while minimizing the time spent delivering and consuming reinforcement (Reed, Niileksela, & Kaplan, 2013).

PR schedules can be applied in the context of a token economy as well as to primary or secondary reinforcers. Tan and Hackenberg (2015) demonstrated that when pigeons were given the choice between colored tokens, each of which was associated with a specific backup reinforcer, the pigeons allocated responding to the schedule associated with the tokens exchangeable for food reinforcers. These results extended those of Covarrubias and Aparicio (2008), namely that higher breakpoints would be seen for more preferred reinforcers, even in the context of a token economy.

Russell, Ingvarsson, Haggar, and Jessel (2018) used a PR schedule to evaluate if leisure items, tokens, and edibles serve as generalized conditioned reinforcers in a token economy for three participants diagnosed with autism and developmental delays. While the results showed that providing reinforcement increased the rate of behavior from baseline for all the participants, providing tokens produced even higher breakpoints for two of the participants. In addition, edible reinforcers were detrimental to the rate of responding when the participants already had access to food. This provides support that tokens are less susceptible to satiation, function as more consistent reinforcers, and produce higher breakpoints than edibles or other primary reinforcers.

Applying a PR schedule in a token economy is a useful method of thinning the schedule of reinforcement. Tarbox, Ghezzi, and Wilson (2006) analyzed different parameters of a token

economy. First they manipulated the cost of the backup reinforcer by increasing the number of tokens required to exchange for the backup reinforcer. They also looked at delaying the time to receive the backup reinforcer to 190 s. They successfully thinned the schedule of reinforcement through the use of tokens. This is important for situations in which access to primary reinforcers is limited: as the token becomes a generalized reinforcer, it allows for increased delays to the backup reinforcer while still maintaining behavior. However, research has not definitively shown the best approach for thinning the tokens for the reinforcement in order to still maintain the responding behavior.

DeLeon et al. (2014) examined methods of thinning reinforcement in a token economy by comparing two conditions of either a distributed or accumulated schedule. In the distributed schedule participants received reinforcers after the completion of each response, while in the accumulated condition participants waited to contact reinforcement until multiple responses were complete. However, with the accumulated condition, the reinforcer value accumulated over the course of task completion. Overall, this study concluded that the participants preferred to accumulate their reinforcement so that they had more time with their reinforcer at one time. However, since only some participants experienced token reinforcement, the researchers suggested examining the effects of distributed and accumulated reinforcement across token schedules.

There are two common methods to progressively thin schedules of reinforcement within a token economy. One method increases the number of responses required to earn a token or the reward (Fiske et al., 2015; Reed et al., 2009), altering the response effort required for the reinforcer. This method of schedule thinning increases the delay to conditioned reinforcement while maintaining the temporal relation between conditioned (i.e., token) and backup

reinforcement. The second method increases the number of tokens required to trade for a backup reinforcer (Tarbox et at., 2006). This method employs more frequent token delivery and relies on the conditioned value of the token to bridge the delay to exchange for the backup reinforcer. Both methods are commonly employed in behavior analytic practice and have empirical support, and both have been successful at thinning the schedule of reinforcement; however, there is no literature supporting which of the two is more effective.

The purpose of the present study was to extend the literature on thinning schedules of reinforcement within a token economy. PR schedules were used to thin the reinforcement schedule at two points within the token economy—token earning and token exchange—to compare breakpoints across conditions. Both conditions included the accumulated-reinforcement delivery method from DeLeon et al. (2014).

Chapter II: General Method

Participants, Setting, and Materials

Participants were preschoolers attending an on-campus child care center at a Midwestern university. After permission to conduct the study was obtained from the center director and the lead teacher and information was given to parents, 11 sets of parents initially gave consent for their children to participate. Of those, three participants were dismissed due to scheduling conflicts and one met the criteria for being excused from the study (see Experimental Design for dismissal criteria). The remaining seven participants progressed in the study. Their ages ranged from 3 years, 10 months to 5 years, 0 months (*M* age= 4 years, 6.86 months).

The study took place in an office allocated to the child care center, which contained a desk with chairs for the participant, researcher, and research assistant. The participant sat adjacent to the researcher at the desk, and the research assistant sat in an unobtrusive location behind the participant. Sessions occurred in the mornings during either free-play or unstructured learning periods, up to 30 minutes per session, three days a week. This time was chosen so it would not interfere with any educational lessons plans.

The materials used for this study consisted of large-hole beads, plastic lace with one end knotted, a computer displaying a Microsoft PowerPoint® file of token boards and animated tokens, a bowl, small cups, two timers, and various activity reinforcers. The token boards for the conditions were rows of squares that and each new row was separated from the previous one to signal a new PR step. The token board for the increasing response requirement (IRR) consisted of four single rows of one pink square. A pink circle “token” appeared with a pink check mark when the response was completed. The token board for the increasing token exchange (ITE) condition consisted of horizontal rows of yellow squares. The quantity of squares per each row

depended on the PR step. When a response was completed a yellow circle “token” appeared. Once the row of tokens was filled a yellow check mark appeared. In both conditions, the check mark signaled that the token could be exchanged at the end of the session (see Appendix C). The beads were portioned out in small paper cups prior to conducting the session and placed in a medium-sized bowl for the participant to string during each of the PR steps. Extra beads and knotted lace were available if needed.

Response Definition and Data Collection

An arbitrary task of stringing beads was used for all participants. This response was selected so that the participants could practice using their fine motor skills through an activity of making a craft. One response was defined as three beads successfully put on the string. Data were collected on the total number of responses emitted, the number of tokens earned, the number and magnitude of PR steps completed, and the total backup reinforcement earned. The cup, plastic lace, and animated tokens used for each phase were the same color, which differed across the three phases to enhance discriminability of baseline and the two token conditions.

Data were graphed as a cumulative number of PR steps that the participant attempted per session. The definition of breakpoint was defined similarly to the one used in Fiske et al. (2015); however, it was only applied to the last successfully completed PR step before moving to the next phase. The comparison of which condition had the highest breakpoint allowed for the identification of the most efficient schedule-thinning condition that maximized responding with minimal reinforcement.

Experimental Design

A counterbalanced ABCAX design was used, in which phase A was baseline and phases B and C were the different schedule-thinning conditions. Phase X was a replication of the

reinforcement condition with the highest breakpoint (when directly comparing B and C). Initial treatment order was counterbalanced across participants (i.e., ABC and ACB).

The PR schedule was a modified arithmetic schedule (refer to Table 1 for the complete PR schedule). In the increasing response requirement (IRR) condition, the number of beads required to earn a token progressively increased, while the number of tokens required for exchange stayed the same. In the increasing token exchange (ITE) condition, the number of tokens required to trade for a backup reinforcer progressively increased, while the number of beads required to earn a token was held constant. The criteria for a session to end for the conditions were similar to those used in DeLeon et al. (2014): a session was terminated after 5 minutes of access to working on the PR steps or after the completion of 4 PR steps, whichever came first. Baseline sessions ended after 5 minutes of access to working on the PR steps. If the participant was actively responding when the 5 minutes elapsed, they were allowed to complete the PR step. Following a session in which all attempted PR steps were completed, the participant began the next session at the last successfully completed PR step. For example, if the last successfully completed step was PR6, then the next session began with a re-presentation of PR6 before continuing with the PR schedule.

Sessions were terminated if the participant stated or indicated that they were all done or if they had no engagement with the task for 30 s (Fiske et al., 2015). Following sessions in which the final attempted PR step was not completed, the next session began at the same PR step at which the prior session was terminated. This was done to control for termination due to possible satiation or fatigue in the prior session. If the participant failed to complete the same PR step in two consecutive sessions, that step constituted the breakpoint and the participant moved to the next phase of the study in the subsequent session.

Research assistant training. Prior to commencement of the study, the primary researcher trained three research assistants in study procedures. In-person training was completed using behavioral skills training – consisting of instructions, modeling, rehearsal, and feedback – for session setup, session implementation, data collection, and completing task list. A training task was considered mastered following three consecutive implementations with 100% integrity, and all three tasks were mastered prior to collecting data.

IOA and procedural integrity. The research assistant collected interobserver agreement (IOA) and procedural integrity data in 100% of sessions for all participants. Each successfully completed PR step was scored as an agreement or a disagreement between the two observers. Procedural integrity was calculated as either correctly implementing each of the components of the task list including implementing each of the PR steps, not implementing components according to task list, or not applicable. The agreements for both IOA and procedural integrity were totaled and then divided by the sum of agreements and disagreements. Lastly, that value was then multiplied by 100 to get a percentage. Both IOA and procedural integrity were 100% for the entirety of the study.

Procedure

Prior to beginning sessions for the day, the researcher and research assistant identified what condition the participant was in so that they could prepare the materials for that session accordingly. This included portioning out the beads according to the PR steps to be presented, preparing the data sheets (i.e., filling out the condition and participant number) that were going to be used, setting the time to 5 min, and placing one lace next to the bowl for the participant to use. Also, an extra lace and bag of spare beads were prepared. For each session, the researcher approached the participant by saying, “Hi (name) want to do a special activity with me?” or a

similar phrase. If the child declined to go with the researcher, session was not run for that participant that day. When the participant got to the office, he or she sat down, the task instructions were presented, then the timers began and the participant was given access to the beading material. Throughout the sessions the researcher provided praise statements such as, "Good job" or "You're doing a great job" as the participant progressed through the PR steps. When the session was completed due to either the participant completing 4 PR steps, 5 min elapsed, or the participant ended the session, the researcher stated, "Great job today. Thank you for being my helper." If the participant timed out during the session, the researcher stated, "That's all the time we have for today. Thank you for being my helper." At the end of the last session in the study, the participants were able to take home the beaded lace that they made. The researcher placed the beaded lace in a plastic bag labeled with the participant's name in his or her cubby.

Baseline. This phase was similar to the baseline conducted by DeLeon et al. (2014). Black colored lace and cups were used for this condition. The quantity of beads in the black cups progressively increased according to the PR schedule. The initial instruction was, "You can put the beads on the string if you want to, and you can tell me when you want to be all done." The beads were placed in the bowl located in front of the participant, and the session timer was started. A second timer was used to measure continuous duration of no task engagement. If the participant reached 30 s of consecutive non-engagement with the task, the researcher stopped both timers and terminated the session by saying, "That's all the time we have for today. Thank you for being my helper." There was no reinforcement beyond periodic verbal praise in this condition.

Increasing response requirement (IRR). In the IRR condition, pink colored cups, tokens, token boards, and string were used. This condition progressively increased the number of responses needed in order to earn one token. This condition differed from baseline in that the computer was present on the desk with the PowerPoint® slide facing the participant. At the start of each IRR session the participant chose what reinforcer he or she wanted to work towards. After the reinforcer was chosen, the researcher presented the initial instruction, "You can put the beads on the string. When you put all the beads that are in the bowl on the string then you will get a token and a check mark. When we are all done, you can trade each token for 30 s with the _____. You can also tell me when you want to be all done." IRR sessions proceeded in the same fashion as baseline sessions. As soon as a response was completed (i.e., all the beads that were in the bowl were strung) the researcher pressed the space bar on the computer, causing a token to appear on the animated token board. The participant was then given the next cup of beads representing the next response requirement according to the PR schedule. When the participant completed four PR steps or when 5 min elapsed, the researcher removed the bowl and the beaded lace and stated, "Great job! You earned (x) tokens, so you can trade them for (x) s or min to play with the _____."

Increasing token exchange (ITE). In the ITE condition, yellow colored cups, tokens, token boards, and string were used. This condition progressively increased the number of tokens needed to exchange for 30 s with the activity reinforcer. This condition differed from IRR in that each response completed earned a token. The researcher presented the initial instruction, "You can put the beads on the string. When you put the beads that are in the bowl on the string then you will earn tokens. Once each row is filled with tokens then you will receive a check mark. When we are all done, you can trade each finished row for 30 s with the _____. You can also

tell me when you want to be all done." ITE sessions proceeded in the same fashion as IRR. As soon as a response was completed (i.e. three beads strung) the researcher pressed the space bar on the computer, causing a token to appear on the animated token board. At the end of the session the researcher stated, "Great job! You completed (x) rows of tokens, so you can trade them for (x) s or min to play with the _____."

Increasing token exchange–3 beads (ITE'). This condition was the same as ITE; however, the presentation of the beads differed. In this condition each yellow cup was portioned out with three beads (i.e., one response) in each cup. The quantity of cups was dependent on the four PR steps that the participant had access to in that session. For example, PR 6 would need six cups with three beads in each cup. The cups were stacked on top of each other so that the presentation of the cups did not influence the magnitude of the PR step. As the third bead was placed on the string, a token appeared on the token board to reinforce the completed response. At the same time the next cup of three beads was placed in the bowl to allow the participant to have continued access to the PR step.

Chapter III: Results

The results are reported according the sequence in which the participants completed the study. Phase A was baseline, phase B was IRR, and Phase C was either ITE or ITE'. Filled data points indicate sessions in which the participant successfully completed the terminal PR step, and open data points indicate sessions in which the participant finished session with a PR step in progress (i.e., either verbally stopped the session or timed out). Refer to Table 2 for the participants' individual ages and breakpoints per each phase. In baseline, participants had an average breakpoint of 6.71 responses (i.e., 20.13 beads; range = 3-10 responses).

Figures 1 through 4 display the results for Sally, Matt, Vicky, and Ali, respectively. For Sally, a higher breakpoint was achieved in ITE' (PR 16) compared to IRR (PR 12) and baseline (PR 6). When replicated, her baseline breakpoint was PR 8 and the ITE' condition achieved a breakpoint of PR 4. For Matt, a higher breakpoint was achieved in IRR (PR 8) compared to ITE (PR 3) and baseline (PR 6). For Vicky, a higher breakpoint was achieved for IRR (PR12) compared ITE (PR 8) and baseline (PR 10). For Ali, a higher breakpoint was achieved for IRR (PR12) compared to baseline (PR 6) ITE (PR4). Ali was persistently responding at PR 12 but could not surpass that PR step because of the duration of the session, so a modification was made starting in session 18. At this point, the final completed PR step from the prior session was not re-presented to begin the next session; rather, the next PR step (PR 16) in the sequence was presented to see if she could complete it given the complete session time.

Figures 5 through 7 display the results for George, Lucy, and Lisa, respectively. For George, a higher breakpoint was achieved in the IRR condition (PR 10) compared to ITE (PR 8) and baseline (PR 8). For Lucy, her breakpoint for baseline was PR 3 compared to the breakpoint of PR 4 for both the ITE' and IRR conditions. However, in the ITE' she was unable to complete

PR 6 when in the IRR condition she was unable to complete PR 4 when it was rerun. For Lisa, her breakpoint for baseline was PR 8 compared to the breakpoint of PR 12 for ITE' and IRR conditions. However, she had more persistent responding at the terminal level for condition ITE' indicating a preference for this schedule-thinning condition.

Chapter IV: Discussion

The current study evaluated two common schedule-thinning methods used in a token economy that are reported in the literature by comparing the breakpoints. The IRR condition increased the number of responses required to receive a token, whereas the ITE/ITE' condition manipulated the value of the token by increasing the number of tokens to be exchanged for the reinforcer. The results indicate that while preschool-aged participants are able to increase their levels of responding through token delivery, the preference for the schedule-thinning method is idiosyncratic. We were able to thin the schedule of reinforcement to a greater degree in the IRR condition than in the ITE condition for four participants. Only one participant (Sally) had a higher breakpoint in ITE than in IRR, but two additional participants (Lucy and Lisa) showed greater persistence with the task at their terminal thinning stage in the ITE condition than in IRR.

The results of this study provide valuable information that extends the current literature in numerous ways. First, preference for a method of schedule thinning is idiosyncratic and should be tailored to the individual learner. A trend in the data indicated that ITE' was preferable to IRR, but IRR was preferable to ITE. For the participants who preferred the IRR condition (Matt, Vicky, Ali, and George), it lowers teacher's response effort. For the preschoolers that preferred the ITE/ITE' condition (Sally, Lisa, and Lucy), it extends the use of conditioned reinforcers. For all preschoolers, it increases persistence (i.e., momentum) and decreases time spent engaging with backup reinforcers during the school day.

While this does not provide conclusive results as to which schedule-thinning condition is the most effective, it does add to the body of literature supporting both methods as viable options to thin a schedule of reinforcement while maintaining high levels of responding. Second, these results showed that both methods of token delivery not only increased responding compared to

each participants' baseline levels, but they maintained high levels of responding at his or her terminal level for longer periods prior to reaching a breakpoint. The data shows that the participants were persistently able to emit their maximum number of responses for minimal reinforcement.

Another important aspect of this study is that it extends the literature on token economies to a younger age group, namely preschoolers. In the only other known study to use tokens with this age group, Filcheck, McNeil, Greco, and Bernard (2004) used a classwide token economy called the Level System in a preschool class to decrease inappropriate behavior. In the Level System, the preschoolers were given behavior-specific praise and received shapes to move up the levels contingent on appropriate behavior. While the token economy slightly decreased inappropriate behavior, additional treatment elements such as Child-Directed Interaction and Parent–Child Interaction, were needed to further decrease the levels of responding. These two treatment elements required that the teacher and parents use more behavior specific praise along with more positive statements while decreasing critical statements. In addition, parents and teachers were taught how to implement a timeout correctly. Tokens alone were not sufficient to maintain appropriate levels of behavior. While tokens were able to decrease inappropriate behavior, they were not sufficient to maintain appropriate levels of behavior. The current study was to increase adaptive responding while Filcheck et al. (2004) was trying to decrease responding (i.e., inappropriate behavior). Implementing a differential reinforcement of alternative behavior is much easier than a differential reinforcement of other behaviors. With that being said, perhaps preschoolers can only respond to tokens when a specific response topography is being directly reinforced compared to reinforcing a broad category of appropriate behavior. This idea will need to be further studied.

In the current study, patterns of responding appeared to differ at least partially as a function of age. The younger preschoolers ages 3 y 10 mon to 4 y 5 mon (George, Matt, and Lucy) had lower responding levels across all conditions as compared to the older preschoolers ages 4 y 11 mon to 5 y 0 mon (Sally, Ali, Vicky, and Lisa). Regardless of their age, all participants were able to increase their responding from their original baseline levels. However, the difference in responding levels provides valuable information in increasing the preschoolers' school readiness skills, as well as at what age to begin using token economies. Based on the lower responding that the younger participants emitted through the delivery of tokens, they might be too young to respond to a token economy. However, the older preschoolers, that will be in kindergarten the next school year, were able to drastically increase their levels of responding when tokens were provided. By establishing tokens as conditioned reinforcers for children while they are still in preschool, educators may be able to enhance school readiness and decrease the amount of time elementary school teachers spend directly reinforcing behavior or training classroom token systems, thereby increasing the available instructional time in elementary grades.

It was also notable that, despite participants having different overall levels of responding in the token-delivery conditions, all were able to tact aspects of the conditions. After the initial session of learning about the contingency of the particular condition that they were in, the participants were able to tact the requirement of the contingency. Also, they tacted the differences between the conditions (i.e., color of string, cups, tokens, and token boards) when moving through the phases of the study, often even before the new contingencies were explained by the researcher. In addition, participants tacted the differences in magnitude of the PR steps by identifying that the number of beads increased, the differences in quantity of tokens delivered

and the presentation of the beads in the ITE/ITE' conditions, and the differences in the reinforcement value (i.e., more check marks or completed rows of tokens received meant more time with the reinforcer). These accurate verbal descriptions of the conditions indicate a high degree of experimental control, as well as the fact that the participants were responding to the salient and functional variables of the study (i.e., that the contingencies of reinforcement changed, not just the color of the string). In addition, it shows that preschool-aged participants are able to understand and identify key qualities of the schedule-thinning conditions, increasing the likelihood that any demonstrated preference for one thinning condition over the other can be attributed to the functional characteristics of that particular condition.

Another way in which this study showed experimental control is that for a breakpoint to be identified, the terminal response requirement needed to be "failed" (i.e., not completed) in two consecutive sessions. This was done to control for satiation and fatigue. All participants had numerous sessions in which a PR step was unable to be completed; yet when re-re-presented in the next session the participant completed it successfully. For example, after the completion of the first PR step presented to the participant in a session, they terminated the session in the second PR step. When that PR step was rerun the next session it was successfully completed. While the criteria for this study controlled for these factors, other published studies on breakpoints could possibly be misinterpreted due to factors of fatigue or satiation.

While not a central focus of the current study, it should be noted that the results contradict the over-justification effect (OJE). The OJE posits that a person will lose motivation (i.e., respond less) to complete a task that they previously completed when a reinforcement contingency has been implemented and then removed (Deci,1971; Lepper, Greene, & Nisbett, 1973). In the current study, participants showed similar or slightly elevated levels of responding

in the return-to-baseline condition (see Figure 1 for Sally; in progress for other participants) following exposure to both reinforcement contingencies. This shows that removing the reward contingency was not detrimental to the original levels of responding and that reinforcement does not inherently decrease the natural or so-called "intrinsic" motivation for task completion.

Results of the current study should be interpreted cautiously, especially as they point to a mechanism of effect. Specifically, the researcher could have shaped longer periods of waiting for reinforcement for the preschoolers. In both of the conditions, the preschoolers had to wait until the end of the session to exchange their tokens for their reinforcer. An advantage is that shaping longer durations of waiting is itself a useful skill for preschool-aged children. However, the fact that PR schedules can be viewed as shaping somewhat confound the results, making it unclear as to whether what this study did constituted shaping the skill of waiting or identifying an already existing breakpoint.

The overall time the study took to be completed indicated that fatigue may have been a factor in the number of responses completed. For example, when Sally replicated the ITE' condition, she terminated responding at a lower breakpoint than she previously achieved. Fatigue, as well as satiation or habituation to the backup reinforcers, may have contributed to this lack of replication. Another possibility is that Sally's history of reinforcement – or in this case, delay to reinforcement – with the associated stimuli (i.e., colored lace, cups, and tokens) evoked less overall responding once the delay to reinforcement increased. Future research could explore removing salient discriminative stimuli for long delays to reinforcement to prevent them from becoming conditioned aversive stimuli.

The possibility of sequence effects is a limitation of the current study. The participants were exposed to both conditions in consecutive phases without a baseline phase between them.

By having a baseline phase between conditions, it could have a more direct comparison of the two conditions. However, when the participants were brought back to baseline there were no carryover effects, providing support that the results would not have been altered. Another limitation was that the participants were asked to participate during their free period. While this was chosen so that the participants did not miss educational group times, it did pose as a challenge for some due to not wanting to leave highly reinforcing toys and friends. In order to minimize the averseness of this transition, the primary researcher prompted the participant to ask a staff to save the toy or recruited the participant when not actively engaged with others. An additional limitation was that the timer for the overall session time could have signaled to the participant that the session was over, even in instances when they would have had the opportunity to complete the PR step that was in progress. To prevent this from occurring, the primary researcher attempted to silence the beeping noise before it occurred.

Future research should continue to evaluate the youngest age at which it is useful to implement a token economy. By doing so, preschool curriculum plans can be developed to increase school-readiness skills. In addition, future research should look into methods of rapidly identifying learners' preferences for thinning schedules of reinforcement. With that knowledge valuable time can be spent maximizing responding with minimal reinforcement.

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Appendix A: Tables

Table 1

PR Schedule of Increasing Number of Beads or Tokens to Exchange

PR Step	IRR # Of Beads	ITE/ ITE' # Of Tokens
PR 1	3	1
PR 2	6	2
PR 3	9	3
PR 4	12	4
PR 6	18	6
PR 8	24	8
PR 10	30	10
PR 12	36	12
PR 16	48	16
PR 20	60	20
PR 24	72	24
PR 28	84	28
PR 34	102	34
PR 40	120	40
PR 46	138	46
PR 52	156	52
PR 62	186	62
PR 72	216	72
PR 82	246	82
PR 92	276	92

Table 2

*Age and breakpoints for the participant*s

Participant	**Age (year, months)**	**BL Breakpoint**	**IRR Breakpoint**	**ITE/ ITE' Breakpoint**
Sally	4 y, 11 mon	PR 6	PR 12	PR 16
Matt	4 y, 5 mon	PR 6	PR 8	PR 3
Vicky	4 y, 11 mon	PR 10	PR 12	PR 8
Ali	5 y, 0 mon	PR 6	PR 12	PR 4
George	4 y, 0 mon	PR 8	PR 10	PR 8
Lucy	3 y, 10 mon	PR 3	PR 4	PR 4
Lisa	4 y, 11 mon	PR 8	PR 12	PR 12

Appendix B: Figures

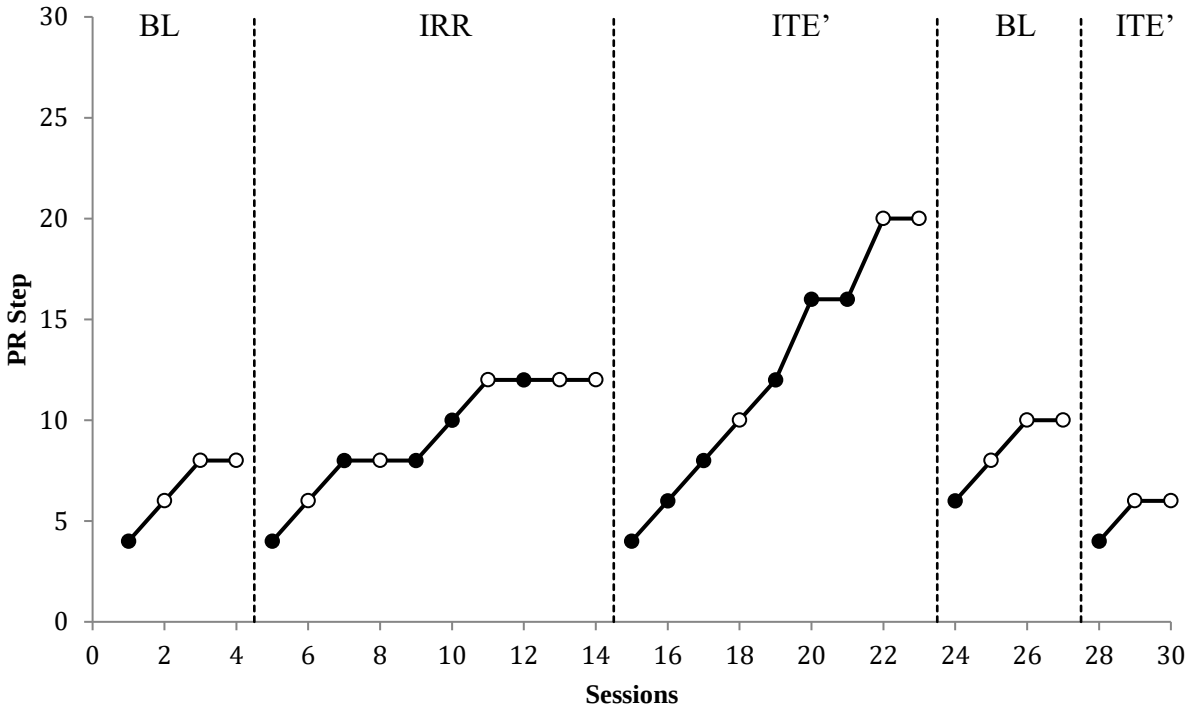


Figure 1. Data for Sally. Data were graphed as cumulative completion of the PR steps per phase. Black data points indicated that the participant was able to complete the PR step. White data points indicated that the participant had access to the PR step but was unable to complete it.

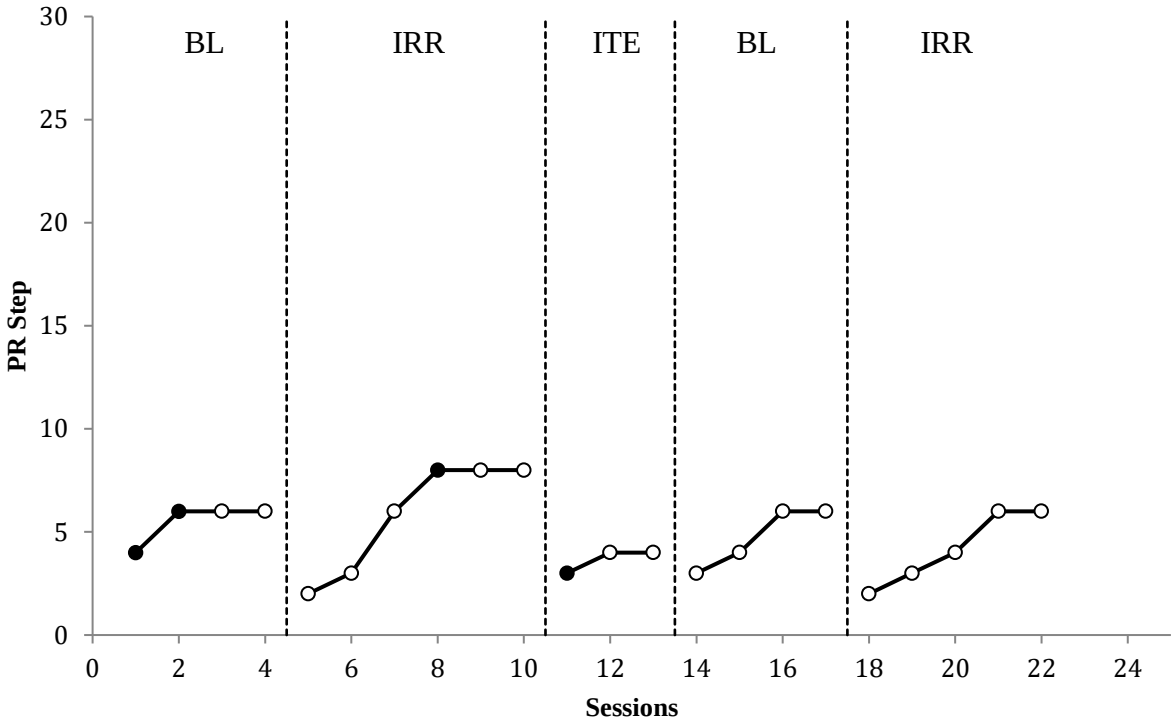


Figure 2. Data for Matt.

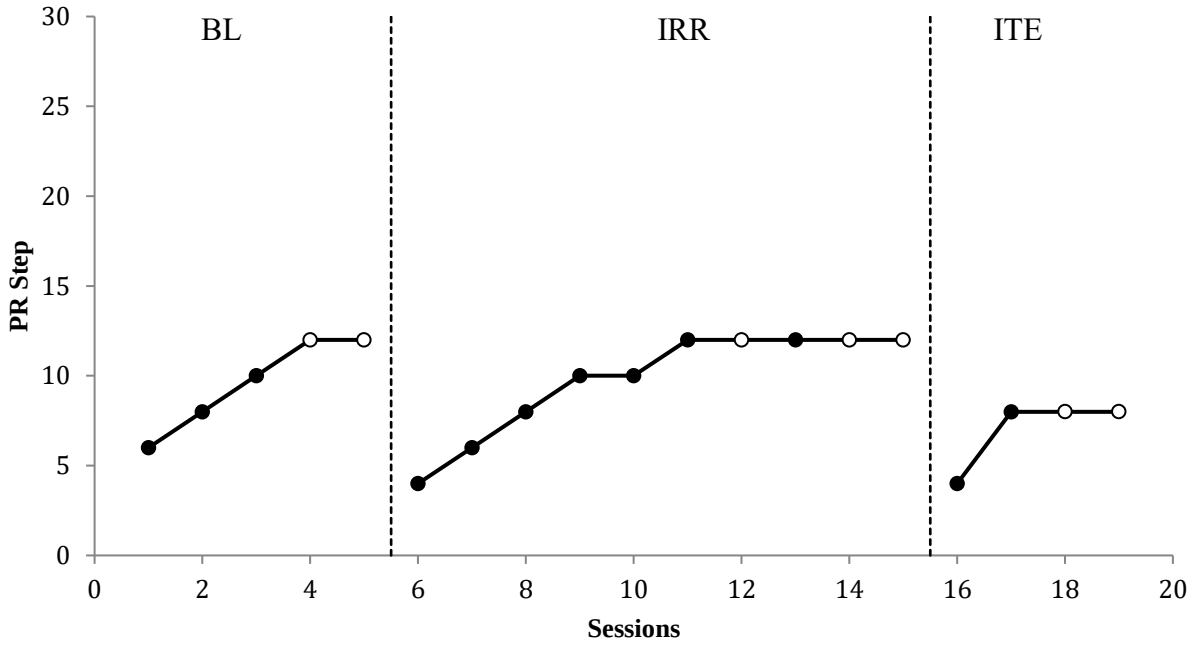


Figure 3. Data for Vicky.

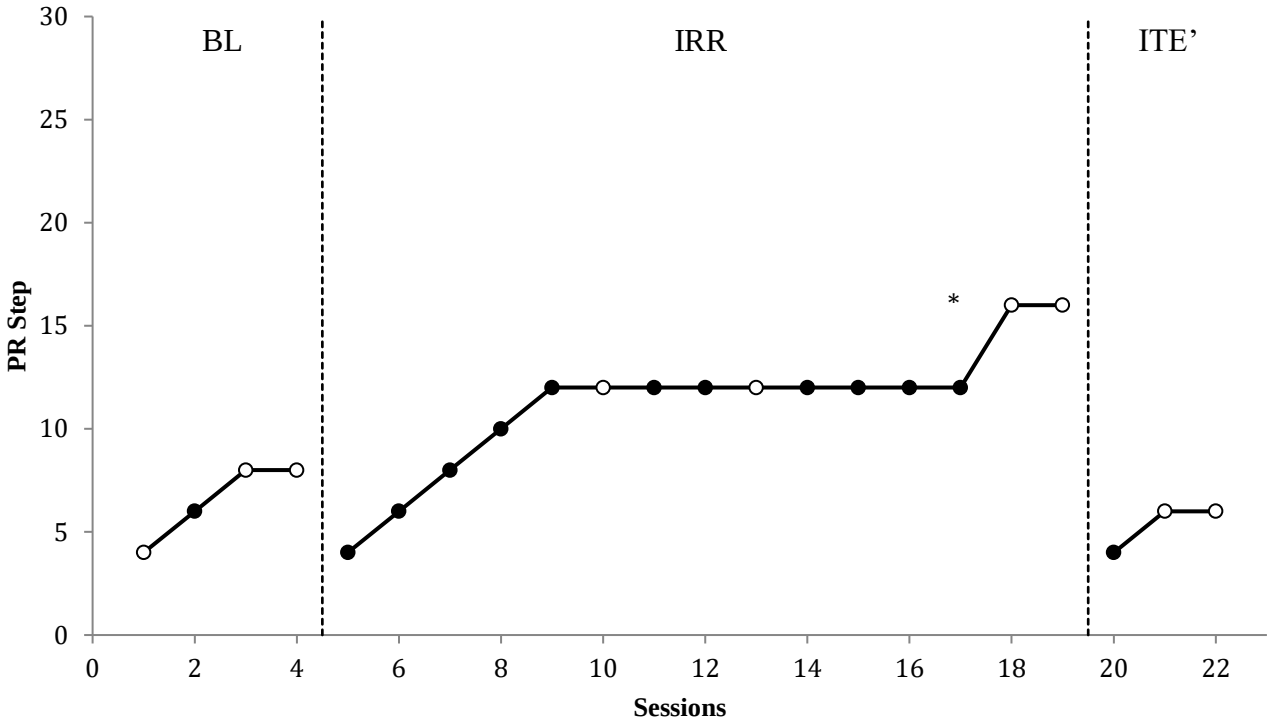


Figure 4. Data for Ali.

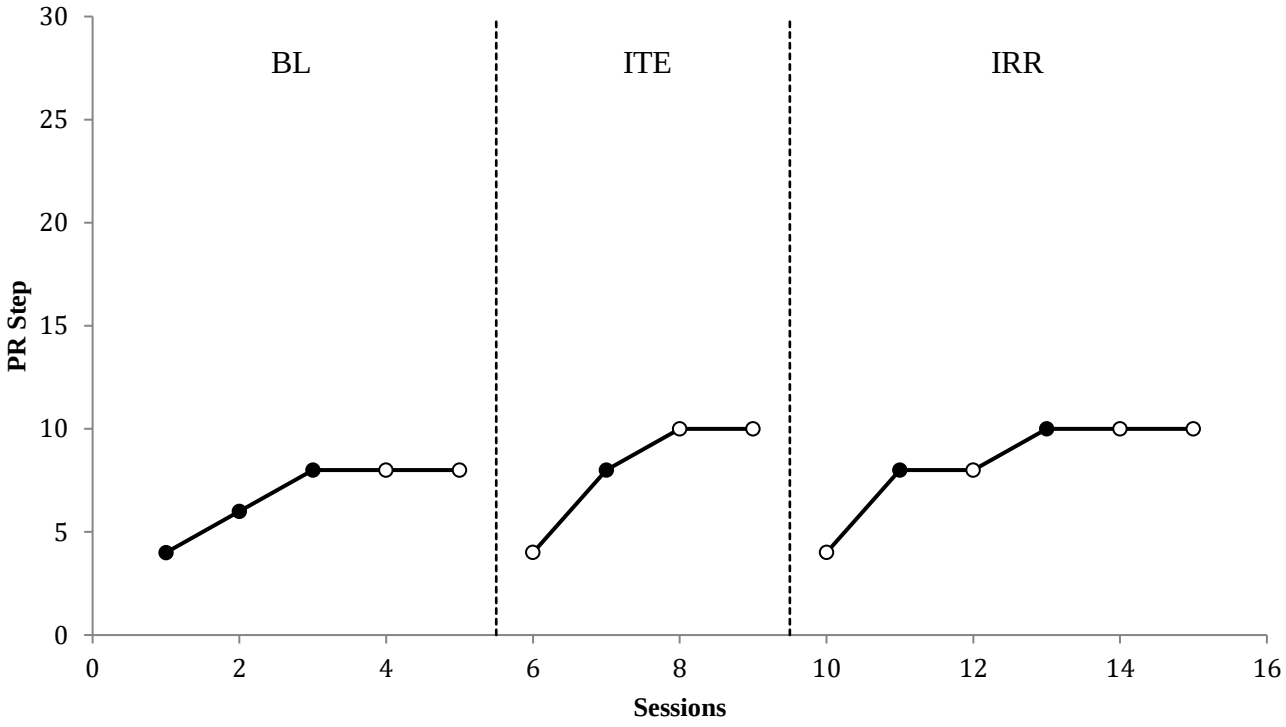


Figure 5. Data for George.

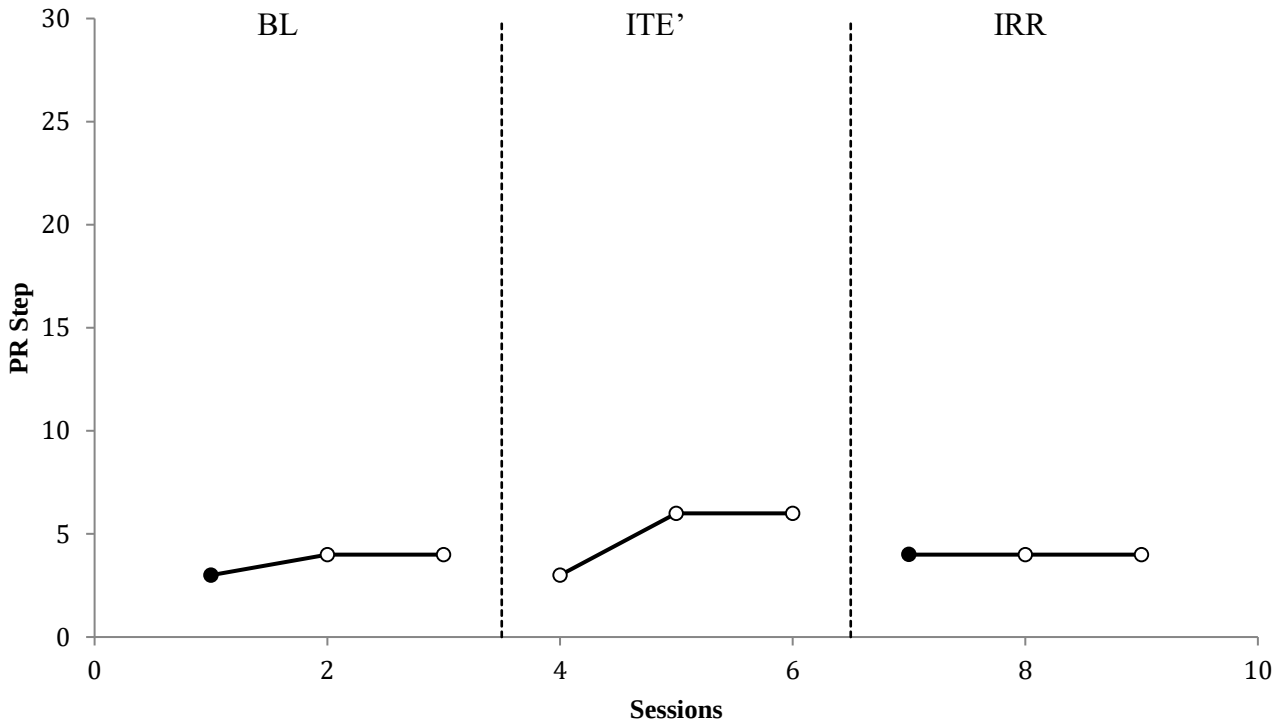


Figure 6. Data for Lucy.

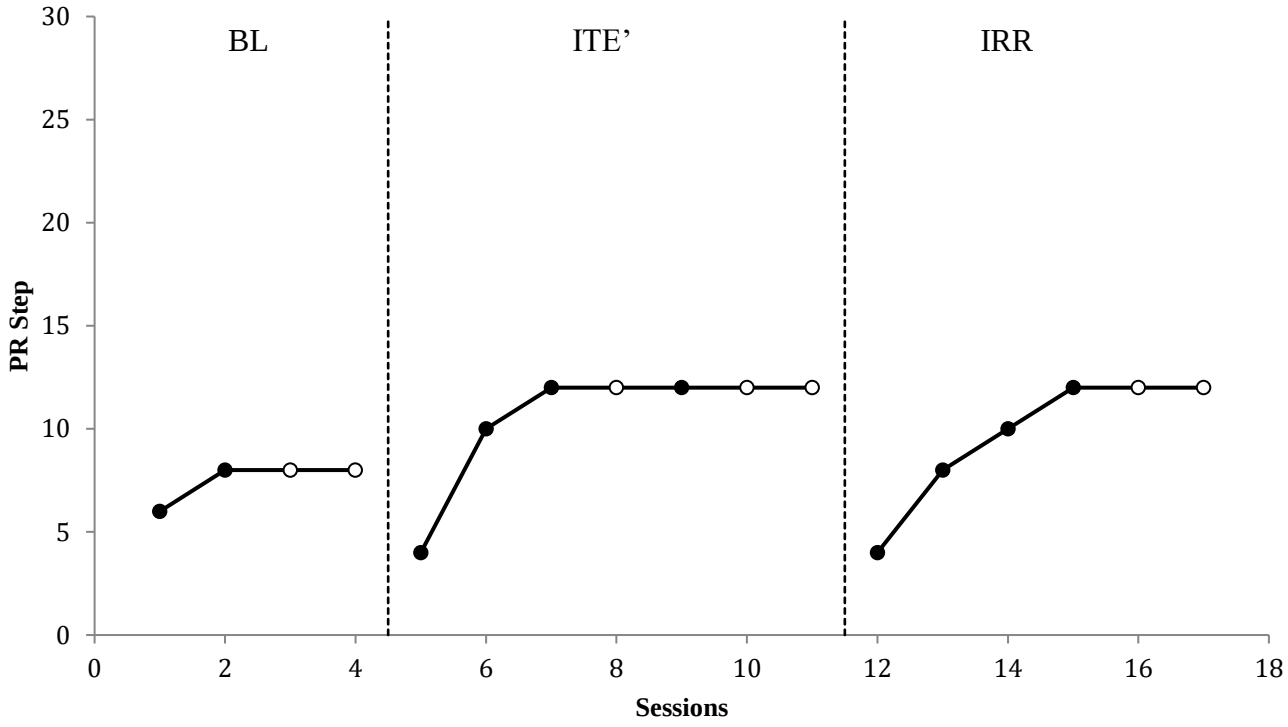
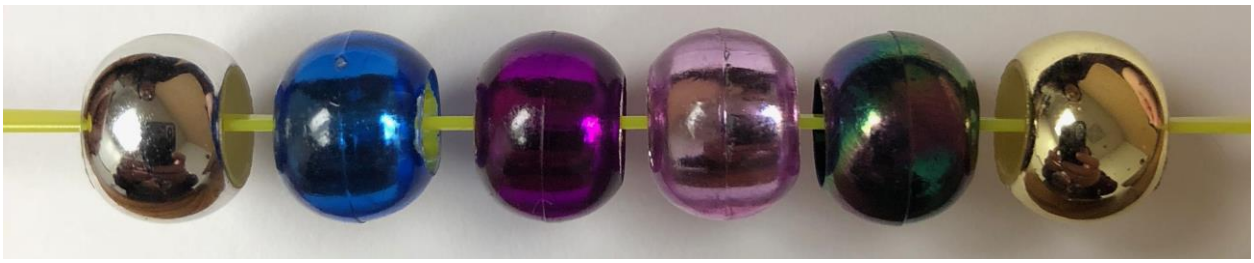


Figure 7. Data for Lisa.

Appendix C: Materials



Beads strung on plastic lace

Task List

	1. Take out supplies that are needed for condition
	2. Get the sheet to track the participants and check where the particular participant is at in the phases
	3. Prepare the string, beads, cups, token boards, games, stopwatches
	4. Greet and ask the participant to do the task
	5. Have the participant pick out the toy that they want to work for
	6. Read the instructions to the participants
	7. Once the participant has access to the task begin timer
	8. Fill bowl with beads accordingly a. When the last bead is being strung fill the bowl up with the next cup of beads (if necessary)
	9. Place tokens as earned a. IRR i. After the last bead is placed on the lace b. ITE i. For every 3 beads placed on the lace
	10. When the timer goes off praise the participant
	11. Count the number of tokens out loud
	12. Tell the participant how much time they have with the toy
	13. Fill out data sheets with the a. PR steps completed b. Number of responses c. Total number of beads on the string d. Number of tokens earned
	14. Thank them for their participation
	15. Take the participant back to class

Put a check mark if complete, “X” if missed, N/A if not needed

Baseline: Data sheet

Baseline Participant # Date:

Circle the last PR step successfully completed before session ended.

Why session ended: 4 PR steps completed 5 minutes elapsed Participant ended session

PR Step	**# Of Beads**	**PR Step Completed**
PR 1	3	
PR 2	6	
PR 3	9	
PR 4	12	
PR 6	18	
PR 8	24	
PR 10	30	
PR 12	36	
PR 16	48	
PR 20	60	
PR 24	72	
PR 28	84	
PR 34	102	
PR 40	120	
PR 46	138	
PR 52	156	
PR 62	186	
PR 72	216	
PR 82	246	
PR 92	276	
Total number of response: Total number of beads:		

Data sheet for IRR and ITE/ITE'

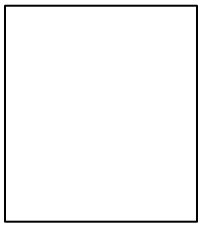
Condition: Participant # Date:

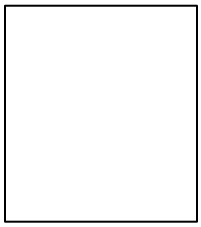
Circle the last PR step successfully completed before session ended.

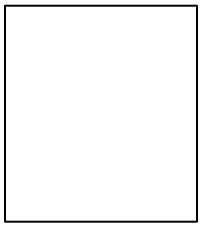
Why session ended: 4 PR steps completed 5 minutes elapsed Participant ended session

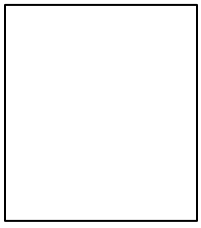
PR Step	**# Of Beads**	**PR Step Completed**	**Check mark Received**
PR 1	3		
PR 2	6		
PR 3	9		
PR 4	12		
PR 6	18		
PR 8	24		
PR 10	30		
PR 12	36		
PR 16	48		
PR 20	60		
PR 24	72		
PR 28	84		
PR 34	102		
PR 40	120		
PR 46	138		
PR 52	156		
PR 62	186		
PR 72	216		
PR 82	246		
PR 92	276		
Total number of response: Total number of beads:		# Check marks received: Total amount of reinforcement:	

IRR: Token board with check mark

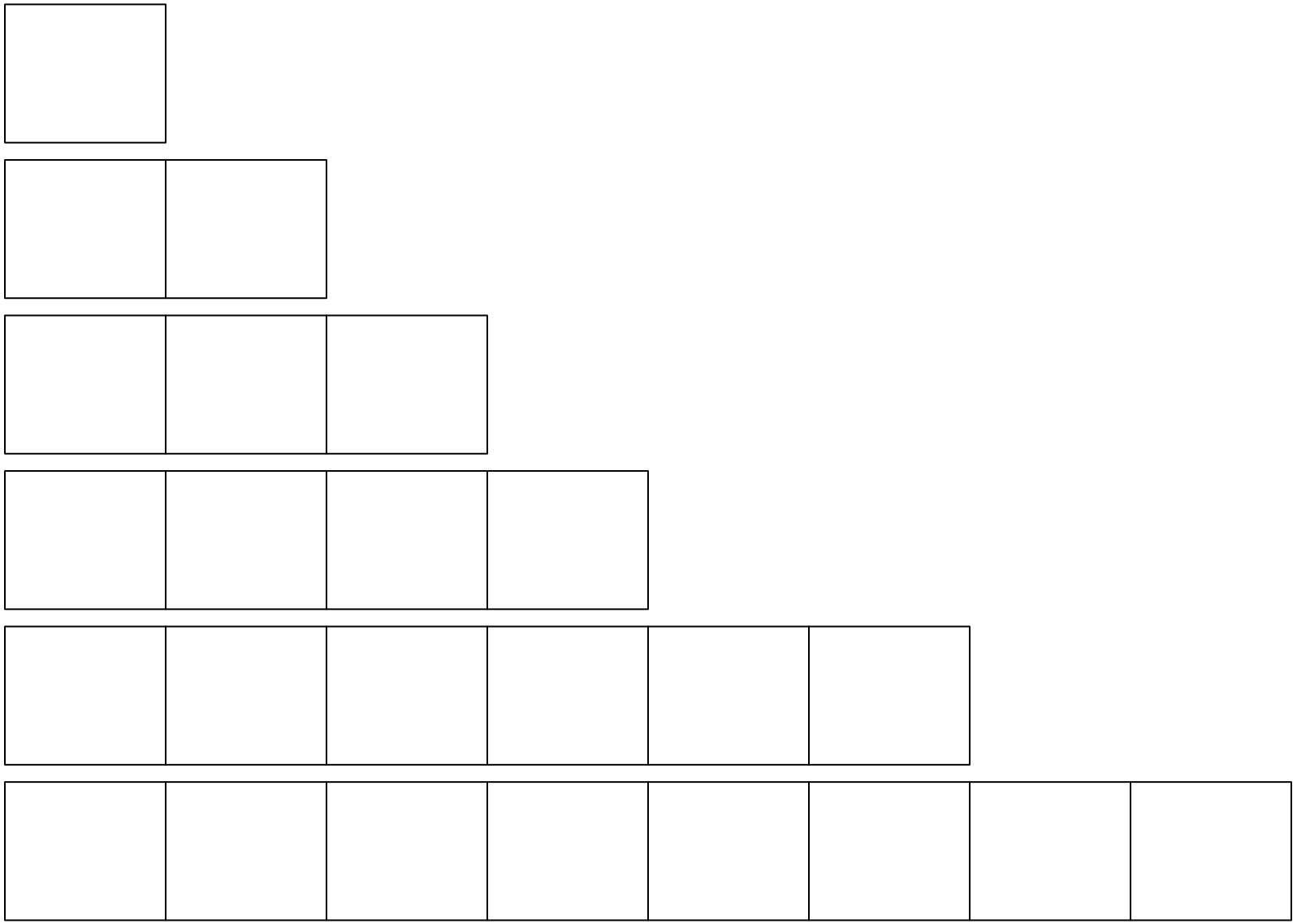


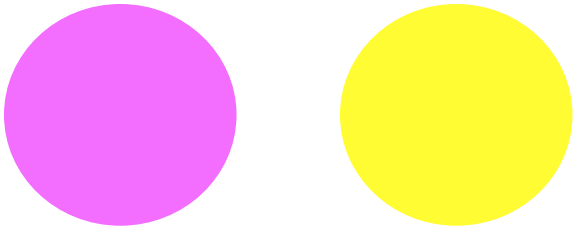






ITE/ITE’: token board with check mark





Tokens were animated circles that appeared in the squares through Microsoft PowerPoint®.

Appendix D: Institutional Review Board Approval

ST. CLOUD STATE UNIVERSITY
EDUCATION FOR LIFE.

Institutional Review Board (IRB)

720 4th Avenue South AS 210, St. Cloud, MN 56301-4498

Name: Jaclyn McGrath

Email: jmcgrath@stcloudstate.edu

IRB PROTOCOL DETERMINATION: Expedited Review-1

Project Title: Behavioral Sensitivity to Progressively Thinning Reinforcement Schedules in a Token Economy

Advisor Michele Traub

The Institutional Review Board has reviewed your protocol to conduct research involving human subjects. Your project has been: **APPROVED**

Please note the following important information concerning IRB projects:

- The principal investigator assumes the responsibilities for the protection of participants in this project. Any adverse events must be reported to the IRB as soon as possible (ex. research related injuries, harmful outcomes, significant withdrawal of subject population, etc.).

- For expedited or full board review, the principal investigator must submit a Continuing Review/Final Report form in advance of the expiration date indicated on this letter to report conclusion of the research or request an extension.

-Exempt review only requires the submission of a Continuing Review/Final Report form in advance of the expiration date indicated in this letter if an extension of time is needed.

- Approved consent forms display the official IRB stamp which documents approval and expiration dates. If a renewal is requested and approved, new consent forms will be officially stamped and reflect the new approval and expiration dates.

- The principal investigator must seek approval for any changes to the study (ex. research design, consent process, survey/interview instruments, funding source, etc.). The IRB reserves the right to review the research at any time.

If we can be of further assistance, feel free to contact the IRB at 320-308-4932 or email ResearchNow@stcloudstate.edu and please reference the SCSU IRB number when corresponding.

IRB Chair:

Dr. Benjamin Witts
Associate Professor- Applied Behavior Analysis
Department of Community Psychology,Counseling, and Family Therapy

IRB Institutional Official:

Dr. Latha Ramakrishnan
Interim Associate Provost for Research
Dean of Graduate Studies

OFFICE USE ONLY

SCSU IRB# 1635 - 2232	**Type:** Expedited Review-1	**Today's Date:** 12/27/2017
1st Year Approval Date: 12/27/2017	**2nd Year Approval Date:**	**3rd Year Approval Date:**
1st Year Expiration Date: 12/26/2018	**2nd Year Expiration Date:**	**3rd Year Expiration Date:**