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## A comparison of two procedures for conditioning tokens: response-required and no-response-required

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**A Comparison of Two Procedures for Conditioning Tokens:  
Response-required and No-response-required**

**A Thesis Presented**

**by**

**Laura A. Dodds**

The Department of Counseling and Applied Educational Psychology

In partial fulfillment of the requirements

for the degree of

**Master of Science  
in the field of  
Applied Behavior Analysis**

Northeastern University  
Boston, MA

August 2009

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NORTHEASTERN UNIVERSITY

Bouvé College of Health Sciences Graduate School

Thesis Title: A Comparison of Two Procedures for Conditioning Unkens: Response-required and No-response-required

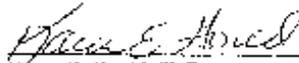
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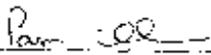
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A Comparison of Two Procedures for Conditioning Tokens:  
Response-required and No-response-required

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A Comparison of Two Procedures for Conditioning Tokens:  
Response-required and No-response-required

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### Abstract

The use of tokens as conditioned reinforcers in applied settings is preferred because tokens can be easily delivered and may be traded-in for a variety of primary reinforcers. The present study compared the effectiveness of two pairing procedures in establishing tokens as conditioned reinforcers: a response-required pairing procedure and a no-response-required pairing procedure. Two individuals participated in this study. A paired-stimulus preference assessment was first conducted. Three reinforcer assessments were then conducted: a reinforcer assessment with immediate delivery of edible, a reinforcer assessment with accumulated edible, and a reinforcer assessment with unconditioned tokens. Token pairing sessions were then conducted and alternated with reinforcer assessments. Results indicate that for one participant both pairing procedures were effective in establishing tokens as conditioned reinforcers. For the second participant, both pairing procedures were eventually effective in conditioning tokens as reinforcers, with the tokens established in the response-required pairing condition maintaining higher response rates.

## A Comparison of Two Procedures for Conditioning Tokens:

### Response-required and No-response-required

Reinforcement is crucial to teaching and maintaining new behaviors and to reducing problem behavior. Therefore, it is important for behavior analysts to find the most effective and efficient reinforcement methods. Often, conditioned reinforcement is the method of choice. In this procedure, a stimulus that has acquired its reinforcing properties because of previous pairings with one or more reinforcers is presented contingent on a specified response (Cooper, Heron, & Heward, 2007).

The benefits of using conditioned reinforcers are numerous. Kazdin and Bootzin (1972) identify eight of these benefits. Conditioned reinforcers“(1) bridge the delay between the target response and back-up reinforcement; (2) permit the reinforcement of a response at any time; (3) may be used to maintain performance over extended periods of time when the back-up reinforcer cannot be parceled out; (4) allow sequences of responses to be reinforced without interruption; (5) maintain their reinforcing properties because of their relative independence of deprivation states; (6) are less subject to satiation effects; (7) provide the same reinforcement for individuals who have different preferences in back-up reinforcers; and (8) may take on greater incentive value than a single primary reinforcer since...the effects resulting from association with each primary reinforcer may summate” (p. 343). Research on conditioned reinforcement has been conducted over several decades including empirical and theoretical studies of how conditioned reinforcers are established and how they can be used in applied settings.

*Establishment of Conditioned Reinforcers*

Williams (1994) describes the conditioning of reinforcers as “an initially neutral event acquiring value because of its relation to primary reinforcement” (p. 261). Williams relates the conditioning of a reinforcer to Pavlovian conditioning. By pairing a neutral stimulus with a primary reinforcer, the previously neutral stimulus may acquire reinforcing properties. Recent applied research has focused on testing the effectiveness of conditioned reinforcers. In order to accomplish this assessment it is necessary to examine conditioned reinforcement effects isolated from primary reinforcement effects (Williams). The earliest research conducted on conditioned reinforcement effectiveness tested resistance to extinction. If a stimulus has become a conditioned reinforcer it should maintain a behavior in the absence of delivery of the primary reinforcer. One problem with this approach is that in the absence of continued pairings of the conditioned reinforcer and primary reinforcer, the conditioned reinforcement effects extinguish. Also, a generalization decrement may form between a conditioned reinforcer condition and an extinction condition. That is, responding may maintain longer when a conditioned reinforcer is delivered because such a condition has similar stimulus properties as a condition in which primary reinforcement is delivered. An extinction condition has less similar stimulus change and therefore stimulus discrimination may account for the extinction of responding. Williams states another method for studying the effects of conditioned reinforcement is the acquisition of a new response using a conditioned reinforcer without delivering the primary reinforcer. More recently, research has shifted to focus on conditioned reinforcement in terms of higher-order schedules of reinforcement, to be discussed below.

Moher, Gould, Hegg, and Mahoney (2008) systematically evaluated the reinforcing effectiveness of tokens with 5 children with autism. A preference assessment was first conducted

to determine highly preferred and less preferred edible stimuli. A reinforcer assessment was then conducted to test the potential reinforcing properties of novel (unconditioned) tokens. During this assessment novel tokens were delivered contingent on hand raising. The results of this reinforcement assessment indicated that the tokens were not a reinforcer for hand raising prior to being paired with edibles. Next, token pairing was conducted in which the delivery of a token was paired with the delivery of an edible. One token was paired with a highly preferred edible while another token was paired with a less preferred edible. During stage one of token pairing the edible was delivered within 0.5s of token delivery, while during stage two the token was delivered and then immediately exchanged for the backup reinforcer. After token pairing, a reinforcer assessment was again conducted. During this second reinforcer assessment, the reinforcing effectiveness of the primary edible was compared with the token reinforcer. That is, the reinforcer assessment alternated between response-contingent FR1 delivery of the highly preferred edible, less preferred edible, token paired with highly preferred edible, and token paired with less preferred edible. Results of this reinforcer assessment showed that the highly preferred edible maintained the highest rates of hand raising, while the less preferred edible maintained low rates of hand raising. Similarly, the token paired with the highly preferred edible maintained higher rates of hand raising than the token paired with the less preferred edible, though the rates of hand raising were not as high as the highly preferred edible on its own. The authors concluded that the tokens had acquired the reinforcing value of the primary reinforcer as a result of the pairing procedure.

Moher et al. (2008) continued their study on conditioned reinforcement by testing the effects of satiation and deprivation on the reinforcing effectiveness of tokens, and the number of different backup reinforcers necessary for a token to become resistant to satiation and

deprivation. Three of the original five children participated in this study. A reinforcer assessment was conducted with primary reinforcers and tokens in which noncontingent access to the backup reinforcer (edible) was in effect prior to the start of each session. Results indicated that satiation with the primary reinforcer decreased responding when both the edible and the token paired with the edible were delivered. A deprivation condition was also assessed in which access to the backup reinforcers was not permitted for 24 hours. Results indicated that edibles and tokens were also sensitive to the effects of deprivation. That is, higher rates of hand raising occurred during the deprivation condition than during the satiation condition. Moher et al. then paired each token with two (2 participants) or three (1 participant) back up reinforcers and conducted reinforcer assessments following satiation with one of the two or three backup reinforcers. Results for these participants indicated that a conditioned reinforcer need only be paired with two or three backup reinforcers to become a generalized conditioned reinforcer and to be insensitive to satiation.

### *Schedule Effects*

Much conditioned reinforcement research has focused on schedules of reinforcement. In part, as mentioned above, it is necessary to study conditioned reinforcers using complex schedules in order to isolate conditioned reinforcement effects from primary reinforcement effects. Conditioned reinforcement has been interpreted in terms of higher-order schedules of reinforcement, most commonly chained schedules. A chained schedule is a schedule of reinforcement “in which the response requirements of two or more basic schedules must be met in a specific sequence before reinforcement is delivered; a discriminative stimulus is correlated with each component of the schedule” (Cooper et al., 2007, p. 691). Gollub (1977) reviewed the schedule effects of conditioned reinforcement. He noted three important factors that control

response rate in chained schedules: the type of component schedules, the number of component schedules, and the requirement in each component. “The response rate of a component is controlled primarily by the separation in time of that component from [primary reinforcement]” (p. 293). When component schedules are all the same type, response rates in the initial component are lowest and the rate of responding increases throughout the chain. Similarly, the number of component schedules that make up a chain effect overall responding, since response rates tend to be lowest in components further away from delivery of primary reinforcement. Lastly, response requirements for each component effect rate of responding. Conditioned reinforcers may function as discriminative stimuli signaling that the delivery of primary reinforcement is approaching.

Bullock and Hackenberg (2006) examined conditioned reinforcement in regard to second order schedules of reinforcement. In their study, Bullock and Hackenberg manipulated the token-production and token-exchange schedules. A token-production schedule refers to the schedule determining the number of responses required to produce a token, while a token-exchange schedule refers to the number of tokens required to produce the opportunity to exchange tokens for back-up reinforcers. Using 4 pigeons, Bullock and Hackenberg varied the token-production ratios between FR 25, FR 50, and FR100, while varying the token-exchange ratios on FR2, FR4, and FR8. Results of this study showed that response rates decreased as the token-production ratio increased. Pre-ratio pausing varied directly with token-production ratios and tended to be longer during higher exchange-production ratios. While the results of this study show that higher token-production ratios and token-exchange ratios result in lower rates of responding in pigeons, more research is needed to evaluate these effects in applied practice.

*Token Economies*

Token economies, which are applied examples of conditioned reinforcement use, are effective in maintaining a wide range of behavior. Additionally, they have numerous other benefits, which Kazdin and Bootzin (1972) review. Token economies may be an ideal system of conditioned reinforcement because tokens can be used to reinforce a variety of behaviors, be traded in for a variety of backup reinforcers, and effectively bridge delays from responding to primary reinforcement. Tangible tokens are more preferable than other generalized conditioned reinforcers because (1) the number of tokens can directly relate to the amount of reinforcement; (2) the subject can be in possession of tokens even when removed from the situation in which he earned tokens; (3) there is no limit to the number of tokens a subject can possess; (4) tokens can be used directly to operate devices for the automatic delivery of reinforcers; (5) tokens can be present during the delay to primary reinforcement; (6) the physical characteristics can be easily standardized; (7) tokens can be made indestructible so as not to deteriorate during the delay to primary reinforcement; and (8) the tokens can be made unique and difficult to counterfeit.

Kazdin and Bootzin (1972) also note several limitations to setting up a token economy. Firstly, staff members must be trained in the techniques of reinforcement procedures, particularly when it is appropriate to deliver tokens. Clinicians must then ensure that staff members are reinforcing desirable behaviors rather than undesirable behaviors. It is also possible that clients may resist the token system. Because reinforcers that were previously freely available may now be only accessible via token trade-in, clients may show “resistance in the form of anger, complaints, disruptive behavior, impulsive acts, rule-breaking, and requests for transfers to other wards or hospitals” (Kazdin & Bootzin, 1972, p. 345). Clients may also find ways of circumventing the contingencies of the token economy. Clinicians must ensure that tokens are

only available through the contingencies that are in place. Though there may be difficulties setting up a token economy, such means of conditioned reinforcement have been effective in increasing desirable behaviors with psychiatric inpatients, the mentally retarded, delinquents, and in classrooms and workshops.

Nelson and Cone (1979) instituted a token economy on a psychiatric ward in a state hospital. Participants were 16 male patients ranging in age from 19 to 61 years old. Thirteen participants were diagnosed as psychotic and three were diagnosed as mentally retarded. Twelve target behaviors (washing face, combing hair, shaving, brushing teeth, dressing neatly, making bed, cleaning bed drawer, exercising, ward work, greeting staff, answering awareness questions, and verbal participation in group discussions) were selected for token reinforcement. Participants earned one to four tokens contingent on the occurrence of the target behaviors. A token store was open for trade-in three times a day for 15 min. Backup reinforcers for which tokens could be traded-in included beverages, edibles, phonograph records, wallets, and toiletries. Occasionally the tokens could be exchanged for off ward trips. During the initial baseline period, the percentage of participants completing the target behaviors was low and variable. When the token economy was introduced to the ward, the percentage of participants engaging in the target behaviors increased substantially. During probe conditions, the token economy remained effective in maintaining completion of target behaviors by participants.

McGinnis, Friman, and Carlyon (1999) investigated the effects of a token system on intrinsic motivation for doing math. Two children served as participants in this study, one a resident of a treatment facility and the other the son of administrators of that facility. A token reward system was implemented for completing math work pages. During 15-min sessions, the participants had a choice of completing math work pages, word unscrambles, or letter coding.

Tokens were only delivered for every three to four pages of math completed. During baseline sessions, time spent working on math was low and variable. The number of math work pages completed was also low, however accuracy was high. When the token system was introduced, the time spent working on the math increased to nearly 100% of session time and the number of pages completed also increased. The accuracy of the math work remained high. The number of tokens earned for pages completed was gradually faded such that completing five pages of math work was required to earn a token. Tokens were traded in after each session for stickers or small toys. Tokens were eventually withdrawn and time spent on math remained high. Throughout the study, a survey was conducted in which the participants were asked to subjectively rate their liking of math. For one participant, math liking remained high and constant. For the other participant, liking of math increased throughout the study. Results of this study suggest that token economies can increase intrinsic motivation for academic tasks rather than undermine such motivation.

Conditioned reinforcers are effective in teaching and maintaining behaviors when they continue to be paired with primary reinforcers. The use of conditioned reinforcement is ideal when there is a delay to primary reinforcement. The effectiveness of conditioned reinforcers to maintain behaviors may be due to being paired with primary reinforcers or signaling changes in components of chained schedules.

Several methods of conditioning neutral stimuli to establish conditioned reinforcers have been researched. Many of these methods include presenting the neutral stimulus then immediately presenting the primary reinforcer. Through this pairing procedure the neutral stimulus may come to function as a discriminative stimulus for the availability of the backup reinforcer. Another method for conditioning a reinforcer is to require a response prior to

presenting the neutral stimulus, and then presenting the backup reinforcer after the neutral stimulus has been traded-in. With this pairing procedure the neutral stimulus may function more clearly as a reinforcer to maintain a response and as a discriminative stimulus signaling the availability of the backup reinforcer. Further, this procedure more closely resembles a typical chaining procedure. The purpose of the current study was to compare the effectiveness of two procedures for establishing conditioned reinforcers: a response-required pairing procedure and a no-response-required procedure.

## Method

### *Participants*

There were two participants in this study. Both were diagnosed with autism and attended a pre-school classroom at The New England Center for Children-Abu Dhabi 5 days a week. Fred was 4-years-old and often engaged in flopping, bolting, aggression, and vocal stereotypy. Behavioral interventions were in place to decrease these behaviors and remained in use throughout the study. Fred earned primary reinforcers during academic work, but had no experience with tokens. Sam was 4-years-old and often engaged in finger picking, motor and vocal stereotypy, environmental destruction, and occasionally aggressive and self-injurious behaviors. Behavioral interventions were in place to reduce these behaviors, and remained in effect throughout the study. Throughout the day Sam earned primary reinforcers. Use of a 1-item token board had previously been established and the token board was used during maintenance trials of previously mastered gross motor skills. That is, the participant imitated a gross motor model, earned a token, and immediately traded-in the token for 30-s access to a video. A laminated animal sticker was conditioned as a token.

*Setting and Materials*

All sessions were conducted in the participants' cubbies at the school. The cubby was where the participant completed all academic work, and consisted of a desk pushed against one wall and a chair for the participant to sit in. Attached to the walls of the cubby were the participants' hourly schedules and notes for teachers running academic programs. These items remained on the cubby wall during all sessions. The desk was cleared of all materials unrelated to the session.

Materials used during the preference assessment were small pieces of different edible items. These edibles were selected for the preference assessment based on casual observation of items the participant consumed. For Fred, these items were Fritos, Doritos, Lays Chips, Skittles, Pringles, M&M cookie, M&Ms, Smarties, Oreos, Kit Kat, Jelly Beans, Super Ring, gummy, sour Skittles, Ritz cracker, and rice cracker. For Sam, these edibles were gummy bears, sugared gummies, mini M&Ms, white chocolate, milk chocolate, Snickers, fluorescent gummy, Skittles, Pez, Kit Kat, Starburst, soft cheese, cheese puff, cracker, Oreo, and pretzel.

Materials used during the reinforcer assessments included tokens and the most preferred edibles. An item was determined to be preferred if it was selected at least 80% of the opportunities it was presented. Two sets of tokens were used. One set consisted of 2.5cm red, paper squares with a gold star, while the other set was 2.5cm black, pipe cleaner rings. Participants had no previous experience with either set of tokens. Materials needed for the target behavior to be completed during the reinforcer assessments included a 7.62cm blue, paper square (Fred and Sam); a 7.62cm pink, paper heart (Sam only); and a 7.62cm yellow, paper star (Sam only).

*Dependent Variables and Measurement*

The dependent variable during the preference assessment was selection. For both participants, selection was defined as the participant placing the edible inside his mouth. Consumption of the edible was not a requirement for selection to be scored; however, each participant typically consumed the edible placed in his mouth. During the assessment in which immediately-delivered edibles were used, the dependent variable was touching a blue square, which was defined as placing an isolated finger on the blue square. The finger had to be removed before a new response was recorded. For Fred, this was also the dependent variable for subsequent reinforcer assessments (i.e. reinforcer assessment with accumulated edibles and tokens). For Sam, the dependent variable during the assessment in which accumulated edibles and tokens were used consisted of a touching a yellow star on the wall, then a pink heart with an isolated finger.

During Sam's preference assessment, the observer recorded selection of the stimulus. A second observer simultaneously, but independently, collected interobserver agreement data. Interobserver agreement scores were calculated by dividing the number of agreements by the total number of agreements plus disagreement and multiplying by 100. IOA was collected for 17% of the preference assessment trials with 100% agreement.

During all reinforcer assessments, response rate (responses per minute) was recorded. For Fred, a second observer recorded responses per minute separately and independently during 20% of sessions. For Sam, a video camera recorded 29% of sessions and the tapes were scored by an independent observer for interobserver agreement. IOA scores were determined by dividing the smaller number of responses recorded by the larger number of responses recorded,

and multiplying by 100. For Fred, IOA scores were 91.5% agreement. For Sam, IOA for all reinforcer assessments was 97% agreement.

### *Procedure*

*Phase 1: Preference assessment.* A paired stimulus preference assessment based on the procedures of Fisher et al. (1992) was first conducted. Each of the 16 stimuli was paired with every other stimulus twice during the preference assessment. Prior to the beginning of the preference assessment, each stimulus was presented to the participants one at a time, and participants were first prompted to touch the stimulus then allowed to consume it. An edible was determined to be preferred if it was selected at least 80% of the occasions it was presented. One preferred edible was selected to be used during subsequent reinforcer assessments and token pairing sessions.

*Phase 2: Reinforcer assessment with immediate edible.* Following the preference assessment, a reinforcer assessment with immediate edibles was conducted. In this phase, primary reinforcement was delivered immediately following a response. The purpose of this assessment was to determine if the preferred edible functioned as a reinforcer. The targeted response for the reinforcer assessment was touching a 7.62cm blue, paper square with an isolated finger. The square was placed on the table arms length from the participant. The preferred edible was immediately delivered on a FR1 schedule. Prior to each session, the experimenter modeled two responses and delivered the consequence programmed for that session. An alternating treatments design, in which an FR1 reinforcement schedule was alternated with extinction, was used. The reinforcer assessment was conducted until differential responding was observed

between extinction and FR1. Sessions were 2-min in length and were conducted 1 to 3 times per day, 5 days a week.

*Phase 3: Reinforcer assessment with accumulated edibles.* Following the reinforcer assessment with immediate delivery of edibles, a reinforcer assessment with accumulated edibles was conducted. The purpose of this assessment was to assess whether responding was maintained when access to reinforcement was delayed. During the reinforcer assessment with accumulated edibles, the preferred edible was delivered into a clear plastic box on a FR1 schedule. Edibles were accumulated in the box during the 2-min sessions. Approximately 1-min after the session ended, the edibles were delivered, one at a time, to the participant. For Fred, the target response remained the same as in the previous phase. Sam's responding during the previous phase occurred at a high rate, making it difficult to accurately deliver edibles on a FR1 schedule. Therefore a more effortful response was required during the reinforcer assessment with accumulated edibles and token assessment conditions. For Sam, the target response for the reinforcer assessment with accumulated edibles was touching a yellow, 7.62cm star with an isolated finger then touching a pink, 7.62cm heart with an isolated finger within 5-s of touching the star. The star was located on the cubby wall behind the participant while the heart was located on the cubby wall to the right of the participant. The star and heart were located more than arms length away from the participant, thus requiring more effort by the participant. Prior to the start of each session, two responses were modeled and the consequence for that session delivered. This phase was conducted until differential responding occurred.

*Phase 4: Reinforcer assessment with unconditioned tokens.* Following the reinforcer assessment with accumulated edibles, a pre-pairing reinforcer assessment with tokens was conducted. The purpose of this assessment was to determine if the novel, unconditioned tokens

maintained responding. The same response used for each participant during the reinforcer assessment with accumulated edibles was used during the reinforcer assessment with unconditioned tokens. The red square tokens and black ring tokens were accumulated in the clear plastic container on a FR1 schedule and sessions alternated with extinction. Approximately 1-min after the sessions ended, the box full of accumulated tokens was removed from the desk without trade-in. Prior to the start of each session, two responses were modeled and the consequence for that session was delivered.

*Phase 5: Token pairing.* In this phase, the unconditioned tokens used in the pre-pairing token reinforcer assessment were paired with the preferred edible previously demonstrated to be a reinforcer. For one set of tokens (red squares), a response was required in order to produce the pairing trial. The response required was hand raising, defined as the participant raising one or both hands in the air with his elbow above his shoulder. This response produced the token on a FR1 schedule. The token was immediately exchanged for the preferred edible. Sessions lasted for 20 pairing trials, or until 4-min elapsed. The second set of tokens (black rings) was paired with the preferred edible through a yoked-pairing control without response requirement. That is, the token was delivered on a fixed time interval based on the mean interresponse time (IRT) of the previous response-required pairing session. The token was first presented, then immediately exchanged for the preferred edible.

*Phase 6: Reinforcer assessment with conditioned tokens.* Following each set of token-pairing sessions (one response-required and one with no response-required), a conditioned reinforcer assessment was conducted to determine if the tokens were successfully conditioned as reinforcers. The same response used for the reinforcer assessment with unconditioned tokens was used in this phase. An alternating treatments design was used to evaluate the conditioned

reinforcing value of the tokens conditioned using the response-required and the no-response-required pairing procedures. Three reinforcer assessment sessions with each type of token were conducted between each set of conditioning sessions. Alternating between the pairing sessions and the conditioned token reinforcer assessments continued until stability in the data paths was reached.

## Results

Results of Phase 1 are presented in Figures 1 and 2 for Fred and Sam respectively. For Fred, results of the paired stimulus preference assessment indicate that Fritos and Doritos were highly preferred edibles. For Sam, results of the paired stimulus preference assessment indicate that gummy bear, sugared gummies, and mini M&Ms were highly preferred edibles. Based on the results of these preference assessments, Doritos and mini M&Ms were selected to be used during the reinforcer assessments with Fred and Sam respectively.

Figure 3 depicts the results of phases 2 through 6 for Fred. During the reinforcer assessment with immediate delivery of the edible (Phase 2) Doritos were immediately delivered on an FR1 schedule contingent on touching the blue square. Rate of responding during FR1 conditions was high (mean=7.5 responses per minute, range=6 to 11.5 responses per minute). When no Doritos were delivered, rate of responding was low and stable (mean=0.83 responses per minute, range=0 to 1.5 responses per minute). Results of the reinforcer assessment with immediate delivery of edible indicate that Doritos functioned as a reinforcer for touching a blue square.

Results of the reinforcer assessment with accumulated edible (Phase 3) are also depicted in Figure 3. When Doritos were accumulated, contingent on touching a blue square on an FR1

schedule, responding was initially low, but steadily increased to a high response rate (mean=5.5 responses per minute, range=0.5 to 20.5 responses per minute). When no consequence was delivered, responding remained low and stable (mean=0.17 responses per minute, range= 0 to 0.5 responses per minute). Results of phase 3 indicate that responding was maintained when consumption of the edible reinforcer was delayed.

During the reinforcer assessment with unconditioned tokens (Phase 4) responding remained low and stable when no consequences were delivered (mean=0.43 responses per minute, range= 0 to 2 responses per minute). When the red square tokens (to be conditioned using the response-required pairing procedure) were accumulated on an FR1 schedule contingent on touching a blue square, responding was low and stable (mean=0.77 responses per minute, range=0 to 5 responses per minute). When black ring tokens (to be conditioned using the no-response-required pairing procedure) were accumulated on an FR1 schedule, responding was variable (mean=1.47 responses per minute, range=0 to 6.5 responses per minute). Results of phase 4 indicate that delivery of unconditioned tokens initially maintained responding, but responding was eventually extinguished.

Phases 5 and 6-token conditioning and token reinforce assessment, respectively- alternated. Following the first pairing sessions (Phase 5) responding in the token reinforcer assessment remained at low levels. Rate of responding began to increase for both sets of tokens following the second pairing set. After the third pairing set, rate of responding decreased to low levels when the tokens conditioned with the response-required pairing procedure were delivered. When the tokens conditioned with a no-response-required pairing procedure were delivered, responding remained at high, variable levels. Following the fourth pairing procedure, responding initially increased and then began to decrease when the response-required tokens were delivered.

When the no-response-required tokens were delivered, responding was extinguished. Overall, mean response rates in this condition were 4.92 responses per minute (range=0 to 15.5 responses per minute) for the tokens conditioned with a response-required, and 7.23 responses per minute (range=0 to 31.5 responses per minute) for the tokens conditioned with no-response-required.

Due to unstable results during the reinforcer assessment with conditioned tokens, a reinforcer assessment with immediate delivery of the edible was conducted to ensure Doritos continued to function as a reinforcer. When Doritos were immediately delivered on a FR1 schedule responding was high and stable (mean=15 responses per minute, range=14 to 17 responses per minute). This suggests Doritos continued to function as a reinforcer.

Following this reinforcer assessment with immediate edible, two token pairing sets (pairings 5 and 6) were conducted, after which the reinforcer assessment with conditioned tokens was repeated. Responding when the response-required tokens were delivered was high with slight variability (mean=28.17 responses per minute, range=23 to 32.5 responses per minute). Responding when the no-response-required tokens were delivered was moderate with variability (mean=17 responses per minute, range=6.5 to 25 responses per minute).

Figure 4 depicts the results of the initial reinforcer assessment with immediate edibles (Phase 2) for Sam. When mini M&Ms were delivered contingent on touching a blue square, rate of responding remained high (mean=9.75 responses per minute, range=0.5 to 14.5 responses per minute). When no mini M&Ms were delivered, rate of responding was low with slight variability (mean=1.2 responses per minute, range=0 to 3 responses per minute). Following session 7, a two week school vacation occurred. Session 8 took place on the first school day after the vacation.

This vacation may account for the low level of responding in session 8. Overall, these results indicate that mini M&Ms functioned as a reinforcer for touching a blue square.

Figure 5 shows the results of the reinforcer assessment with accumulated edibles (Phase 3), the reinforcer assessment with unconditioned tokens (Phase 4), and the reinforcer assessment with conditioned tokens (Phase 6). When mini M&Ms were accumulated on an FR1 schedule, responding remained high and on an increasing trend (mean=12.4 responses per minute, range=9.5 to 16.5 responses per minute). When no consequence was delivered for responding, the rate of responding remained at zero. This suggests that responding was maintained when consumption of the edible rewards was delayed.

When unconditioned tokens were delivered on a FR1 schedule (Phase 4), rate of responding was initially high with slight variability in the data path. Sessions were extended from 2-min to 5-min in an attempt to extinguish responding. During the 5-min sessions, responding remained variable across conditions when either token was delivered contingent on responding. Responding during extinction conditions reached zero during the 5-min sessions, however responding when unconditioned tokens were delivered continued to occur at variable rates. Sessions were extended to 10-min and responding during all conditions was extinguished. Sessions were then shortened to the original 2-min, and rate of responding for all conditions remained at low and stable levels.

A with-in session extinction analysis was conducted for the 5- and 10-min sessions of Phase 4. Results of the extinction analysis during the 5-min sessions are presented in Figure 6. The with-in session extinction analysis depicts the number of responses during each minute of the session, averaged across sessions. Three sessions were analyzed during the unconditioned

response-required conditions, and four sessions were analyzed for both the unconditioned no-response-required token and extinction conditions. Across sessions, there was an average of 13 responses during the first minute of the session when the unconditioned response-required tokens were delivered contingent on responding (range=11 to 15 responses). When the unconditioned no-response-required tokens were delivered, there was an average of 1.75 responses during the first minute across sessions (range= 1 to 3 responses). When there was no consequence for responding, there was an average of 1.5 responses during the first minute across sessions (range= 0 to 6 responses). The extinction analysis illustrates that within the 5-min sessions, responding during the unconditioned response-required token and extinction conditions was extinguished. However, during the unconditioned no-response-required token condition responding remained constant throughout the session.

Results of the within-session extinction analysis during the 10-min sessions are presented in Figure 7. Four sessions were analyzed during both the unconditioned response-required tokens and unconditioned no-response-required tokens conditions. Five sessions were analyzed during the extinction condition. Results of this extinction analysis illustrate that most responding occurred during the first minute of the session and responding extinguished by the end of the 10-min session. When the unconditioned response-required tokens were delivered contingent on responding, there was an average of 0.75 responses during the first minute of the session (range= 0 to 2 responses). During the unconditioned no-response-required token sessions, an average of 2.5 responses occurred during the first minute of the session (range=0 to 10 responses). During extinction sessions, an average of 0.4 responses occurred during the first minute of the session (range=0 to 2 responses). Results of the extinction analysis and reinforcer assessment with

unconditioned tokens indicate that while the unconditioned tokens initially functioned as reinforcers, they did not maintain responding over time.

Figure 5 also depicts the results of the reinforcer assessment with conditioned tokens for Sam. Following the first pairing session for both the response-required and no-response-required tokens, responding immediately increased from the previous condition. When the tokens conditioned using a response-required pairing procedure were delivered contingently, responding occurred at high but variable rates (mean= 9.33 responses per minute, range=5 to 15.5 responses per minute). When the tokens conditioned using the no-response-required pairing procedure were delivered contingently, responding occurred at higher rates than in the previous phase. Response rates continued to be variable (mean=7.75 responses per minute, range=4 to 13 responses per minute). Four token pairing sets were conducted during this phase. Results indicate that both sets of tokens were successfully conditioned as reinforcers. There was no differentiation in the data paths, suggesting that there was no differentiation between the pairing procedures.

### Discussion

The results of this study did not show any consistent differences in the effectiveness of conditioning using response requirement versus no response requirement. Results of the reinforcer assessments with edible reinforcers indicate that Doritos functioned as a reinforcer for Fred, and mini M&Ms functioned as a reinforcer for Sam. For Sam, results of the reinforcer assessment with accumulated edibles indicate that responding was maintained when consumption of the edible reinforcer was delayed. For Fred, responding gradually increased when the edibles were accumulated. This gradual increase in response rate might have been a result of various stimuli in the experimental setting (e.g., the sound or sight of the items being

dropped into the container, etc.) acquiring conditioned reinforcement properties. For both participants, the delivery of unconditioned tokens in Phase 4 initially maintained variable rates of responding; however, responding when unconditioned tokens were delivered gradually extinguished.

For Sam, following the first pairing sessions of both the response-required pairing procedure and no-response-required pairing procedure, responding when the conditioned tokens were delivered immediately increased to rates similar to those observed when edibles were accumulated. Responding remained high and variable as more pairing sessions were conducted. These results suggest that, for Sam, both pairing procedures were equally effective in conditioning tokens as reinforcers.

For Fred, responding remained low following the first pairing sessions of both the response-required pairing procedure and no-response-required pairing procedure. As more pairing sessions were conducted, responding increased with extreme variability. Such responding suggests that there were inconsistent conditioned reinforcer effects with both sets of tokens. When Doritos were again delivered contingent on responding, response rates were high and stable, demonstrating that Doritos continued to function as a reinforcer. When the number of pairing sessions was increased before reinforcer assessment, response rates were high with some variability. This final reinforcer assessment demonstrates that the tokens functioned as conditioned reinforcers. Some differentiation between the data paths was observed, suggesting that the response-required pairing procedure may be more effective in conditioning tokens. However, differentiation only occurred in the final three data points, and it is unknown whether such responding would be maintained across time.

For both participants, responding was initially maintained when unconditioned tokens were delivered. For Sam, responding occurred at high rates; while for Fred responding occurred at low and variable rates. Responding when unconditioned tokens were delivered may have been the result of an extinction burst. Responding during the reinforcer assessment with accumulated tokens in Phase 3 was occurring on a steady, increasing trend during FR1 conditions and not occurring during extinction conditions for both participants. Responding occurred during the first three sessions of extinction in Phase 4 for both participants. This suggests that an extinction burst was occurring. Reinforcing effects of accumulating edibles during Phase 3 may have generalized to accumulating unconditioned tokens during Phase 4, which may account for a longer extinction burst when both sets of unconditioned tokens were delivered.

For Sam, the unconditioned tokens may have initially maintained responding due to his previous history with tokens. Although Sam had minimal experience with a token economy prior to the start of this study, generalization from the previously conditioned tokens to the novel stimuli may have occurred. A 1-item token board had been established using a procedure in which Sam imitated a gross motor response, the token was delivered, and Sam immediately traded that token for primary reinforcers. Sam's token economy was used an average of 2 times per week for approximately 10 trade-ins. Generalization of engaging in a motor response and the presentation of a stimulus may have maintained responding during Phase 4. Such generalization may have also occurred following the first pairing session of both the response-required pairing procedure and no-response-required pairing procedure, thus resulting in the high rate of responding during the conditioned token reinforcer assessment in Phase 6.

A total of 6 pairing sessions was conducted with Fred and a total of 4 pairing sessions was conducted with Sam. For Sam, the tokens were immediately conditioned as reinforcers with

both pairing procedures. There was no differentiation in the data paths for each set of tokens, suggesting both pairing procedures were equally effective in conditioning tokens as reinforcers. For Fred, variable responding occurred following the first four pairing sessions, suggesting that both pairing procedures were inconsistent at conditioning the tokens. Pairing sessions 5 and 6 were conducted without an intervening conditioned token reinforcer assessment in order to analyze the effects of doubling the number of pairing trials for both pairing procedures. Responding following pairing sessions 5 and 6 occurred at high and variable rates. This suggests that following twice as many pairing trials for both the response-required pairing procedure and no-response-required pairing procedure, the tokens began to function as conditioned reinforcers. There is some differentiation between the data paths suggesting that the response-required pairing procedure may have been slightly more effective in conditioning tokens as reinforcers than the no-response-required pairing procedure.

The lack of differentiation between the two pairing procedures with Sam may be the result of generalization of earning tokens. Such responding may also be the result of the token trade-in procedure. Approximately 1-min following the conclusion of the session, the conditioned tokens were traded-in. This consisted of the participant handing over the tokens, one at a time, to the therapist who exchanged the token for primary reinforcement. Such a trade-in was similar to the no-response-required pairing procedure. These trade-ins may have functioned as token pairing sessions, resulting in similar rates of responding when both sets of tokens were delivered.

Directions for future research may include assessing the effects of both sets of pairing procedures without allowing for trade-in of tokens earned following the conditioned token reinforcer assessment. As suggested by Williams (1994), such a study may isolate the

conditioned reinforcement effects from primary reinforcement effects, allowing one to better ascertain if the pairing procedures were successful in conditioning tokens. Future studies may also stagger the pairing sessions of the response-required pairing procedure and no-response-required pairing procedure. For example, one session of the response-required pairing procedure may be conducted, followed by a brief conditioned reinforcer assessment, then the no-response-required pairing procedure may be conducted, followed by a brief conditioned reinforcer assessment. In such a manner, the effects of generalization of the pairing procedures may be analyzed.

The use of token economies is important in applied settings. When tokens are conditioned with only one back-up reinforcer, satiation on the primary reinforcer may quickly occur, rendering the token economy useless. It is therefore important to condition the tokens with several back-up reinforcers. Future research may assess the effectiveness of a response-required pairing procedure and that of a no-response-required pairing procedure on establishing generalized conditioned reinforcers.

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## Figure Captions

*Figure 1:* Percent selection of edible items in a 16-item paired-stimulus preference assessment during Phase 1 with Fred. An edible item was determined to be preferred if it was selected during at least 80% of the occasions presented. Fritos and Doritos were determined to be highly preferred edibles.

*Figure 2:* Percent selection of edible items in a 16-item paired-stimulus preference assessment during Phase 1 with Sam. An edible item was determined to be preferred if it was selected during at least 80% of the occasions presented. Gummy Bears, sugared gummies, and mini M&Ms were determined to be highly preferred edibles.

*Figure 3:* Responses per minute during the reinforcer assessments with immediate edible, accumulated edibles, unconditioned tokens, and conditioned tokens with Fred (Phases 2 through 6).

*Figure 4:* Responses per minute during the reinforcer assessment with immediate edible (Phase 2) with Sam. After session 7, a two week vacation occurred. Session 8 took place on the first day of school after the vacation.

*Figure 5:* Responses per minute during the reinforcer assessments with accumulated edibles, unconditioned tokens, and conditioned tokens (Phases 2 through 6) with Sam.

*Figure 6:* Within session extinction analysis for 5-minute sessions of the reinforcer assessment with unconditioned tokens. The average number of responses made per minute across sessions is depicted. Three sessions were analyzed during the unconditioned response-required token

condition, while 4 sessions were analyzed during both the unconditioned no-response-required condition and extinction condition. This illustrates that responding decreased within the session.

*Figure 7:* Within session extinction analysis for 10-minute sessions of the reinforcer assessment with unconditioned tokens. The average number of responses made per minute across sessions is depicted. Four sessions were analyzed during both the unconditioned response-required token and unconditioned no-response-required token conditions, while five sessions were analyzed during the extinction condition. This illustrates that responding was extinguished within the session.

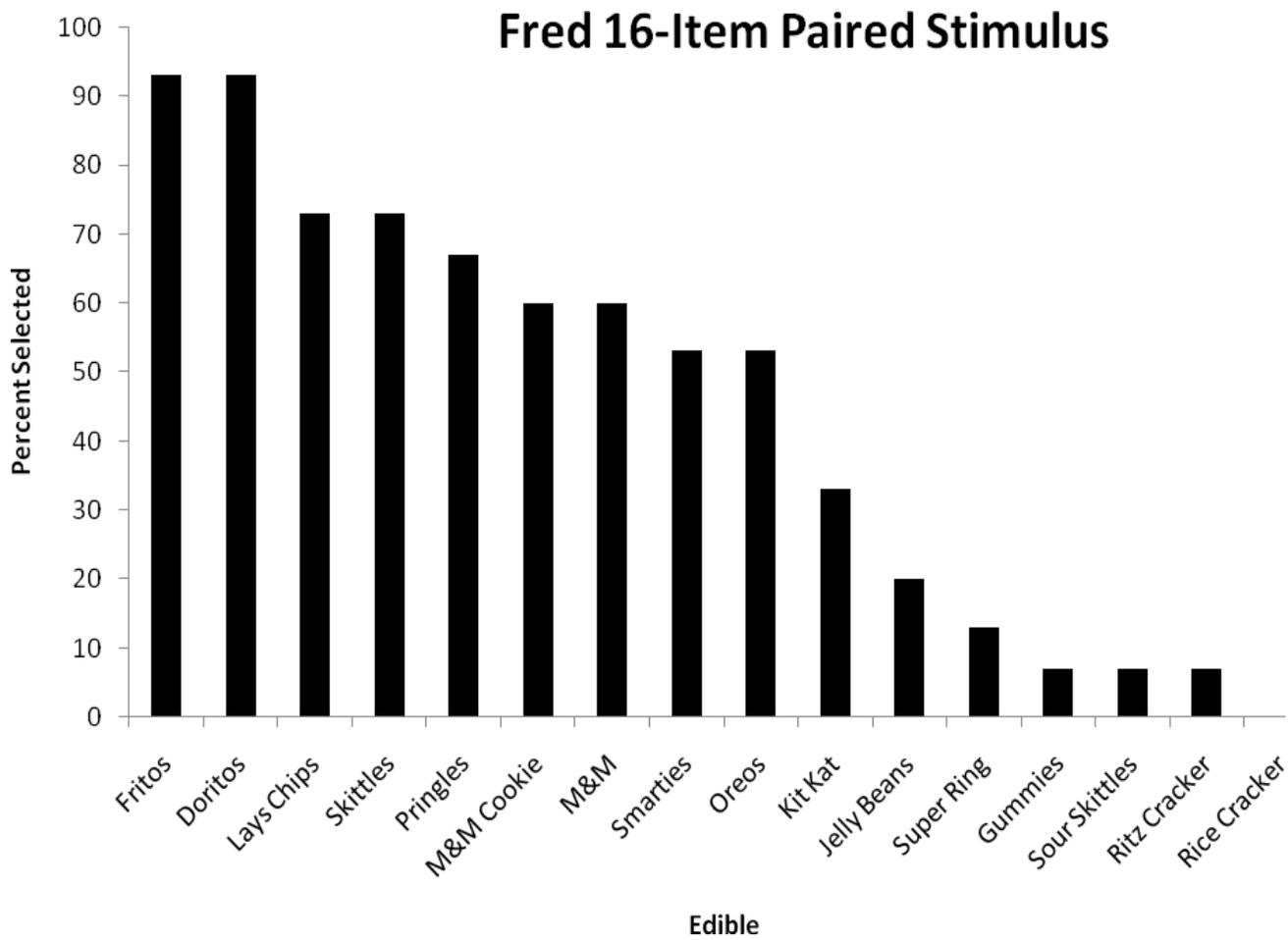


Figure 1

### Sam16-item Paired Stimulus

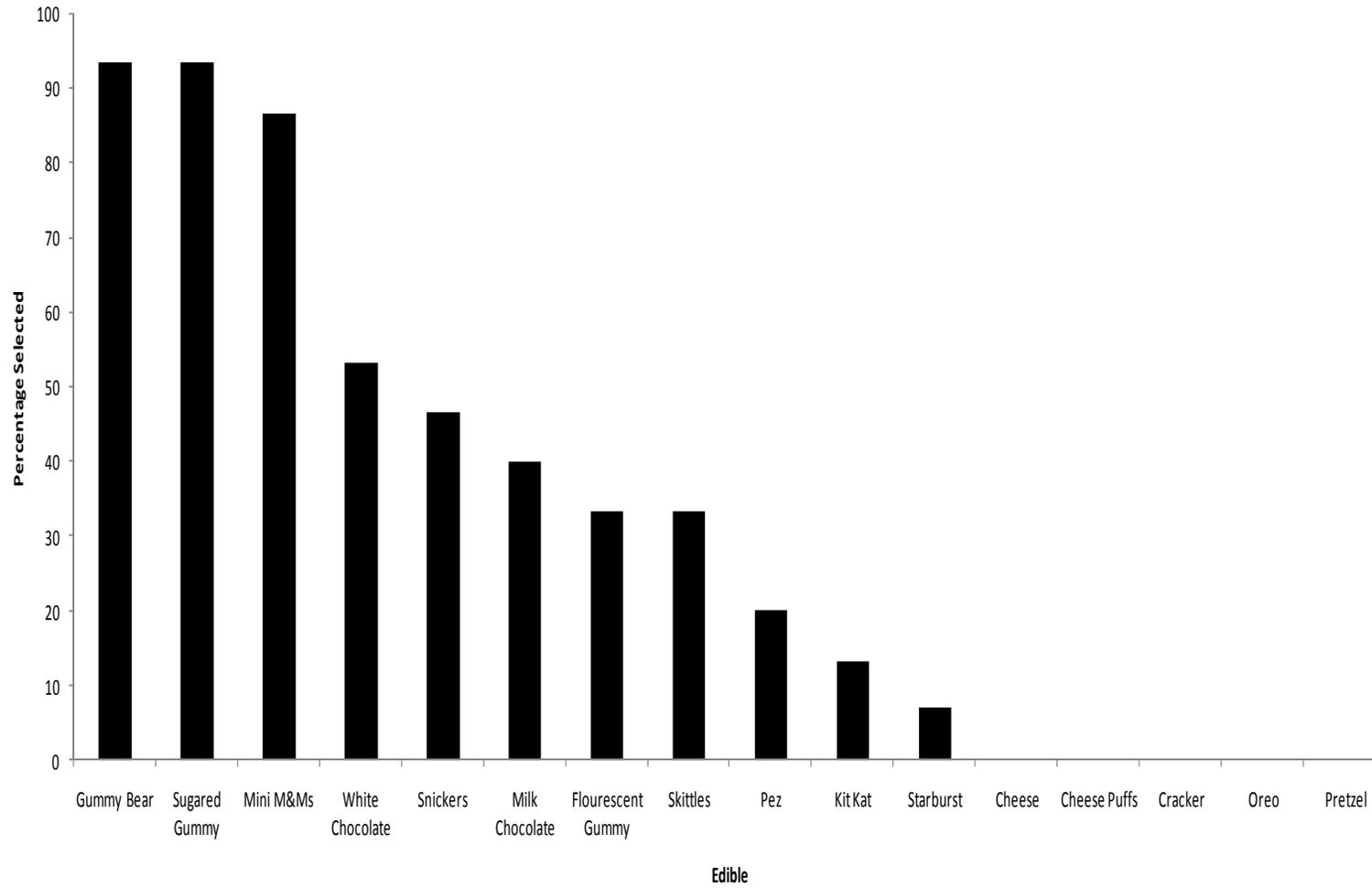


Figure 2

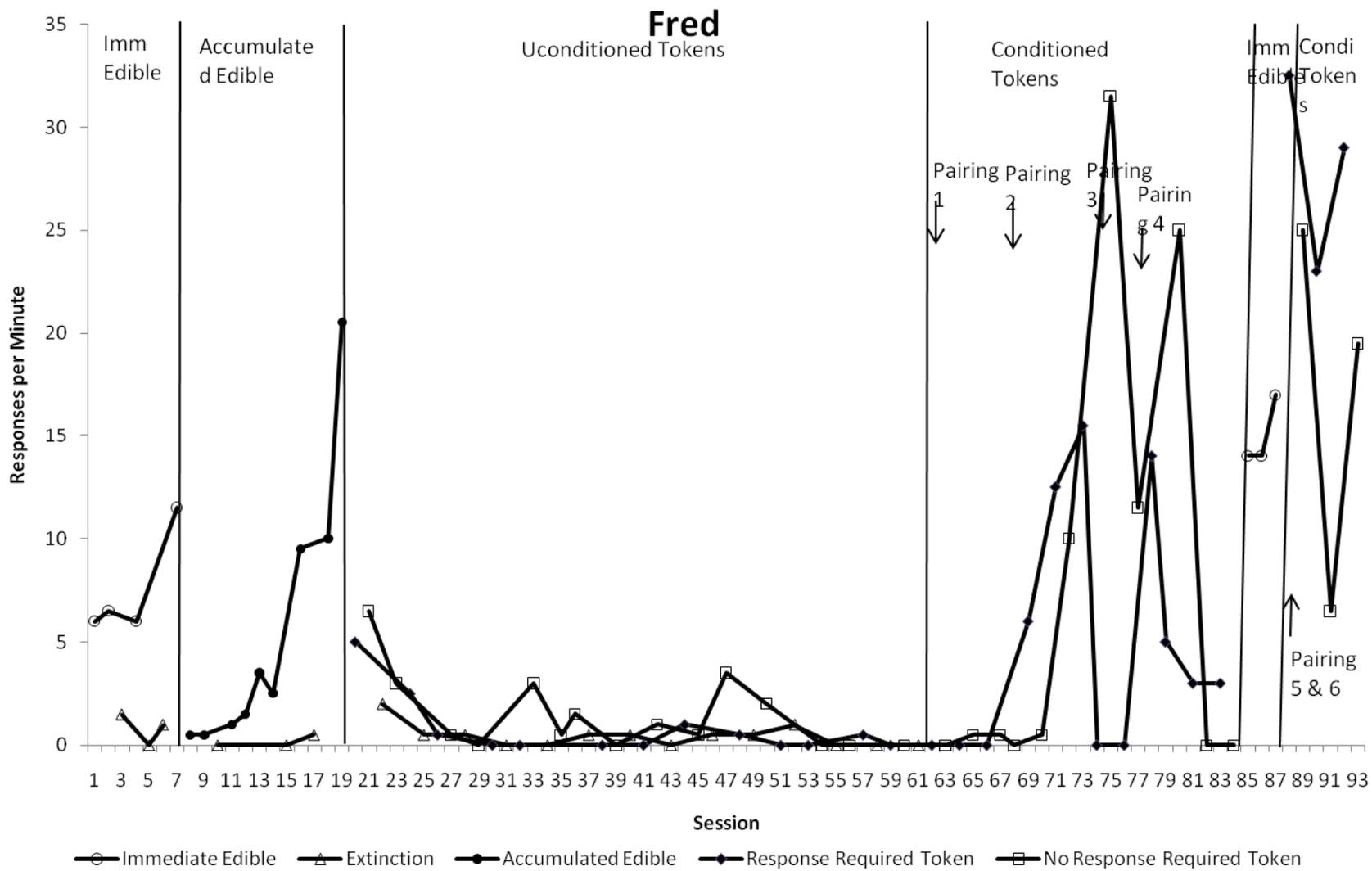


Figure 3

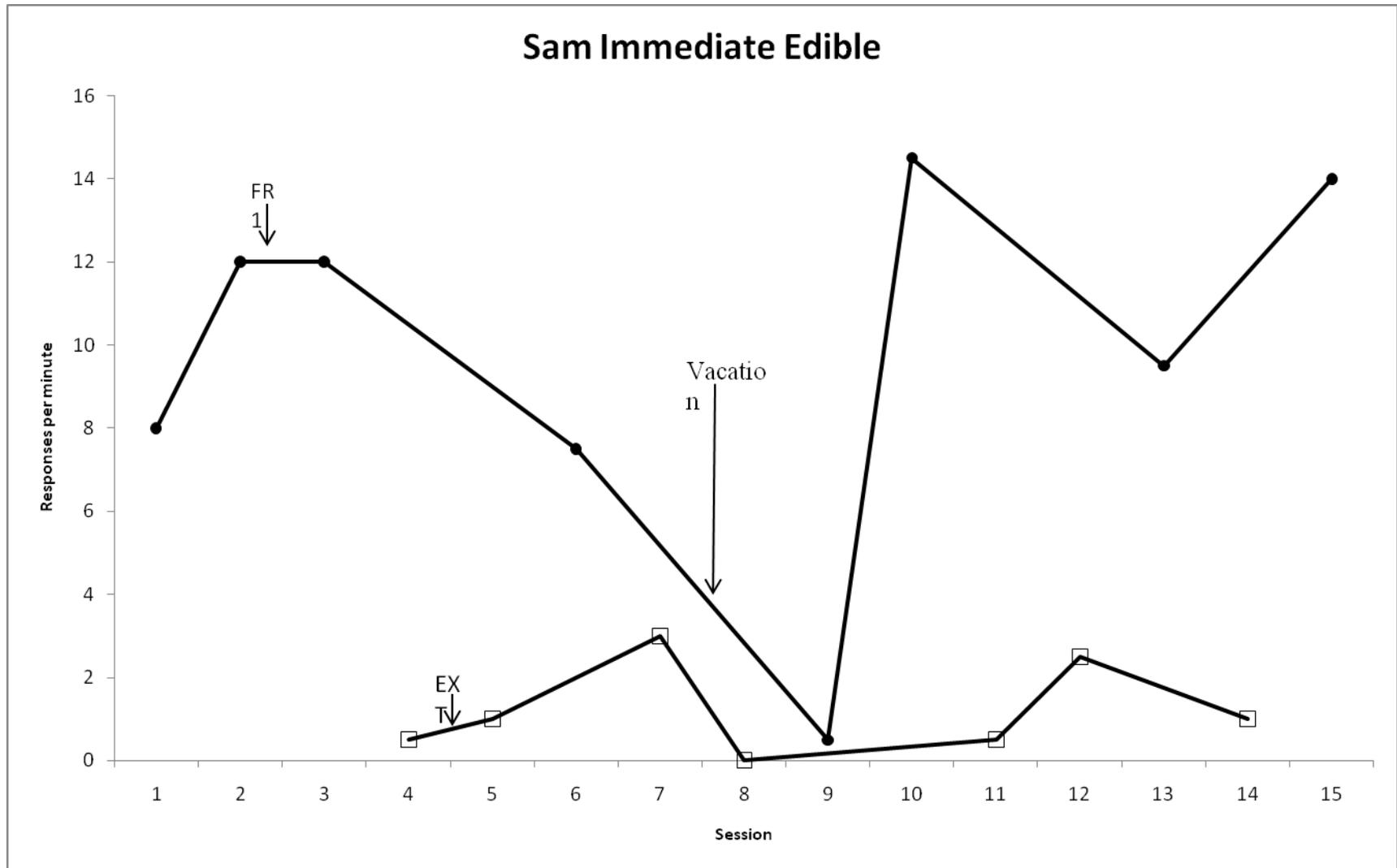


Figure 4

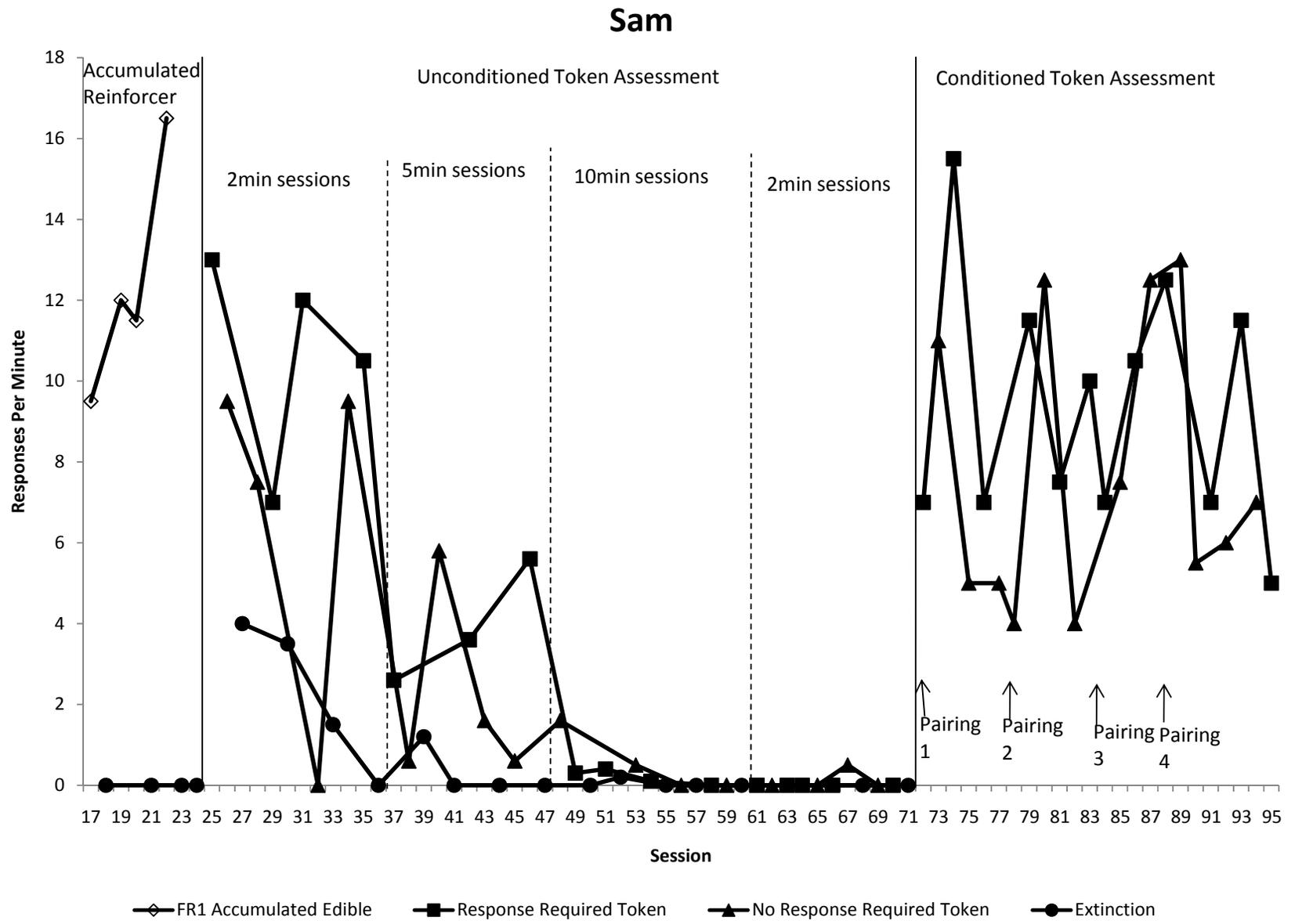


Figure 5

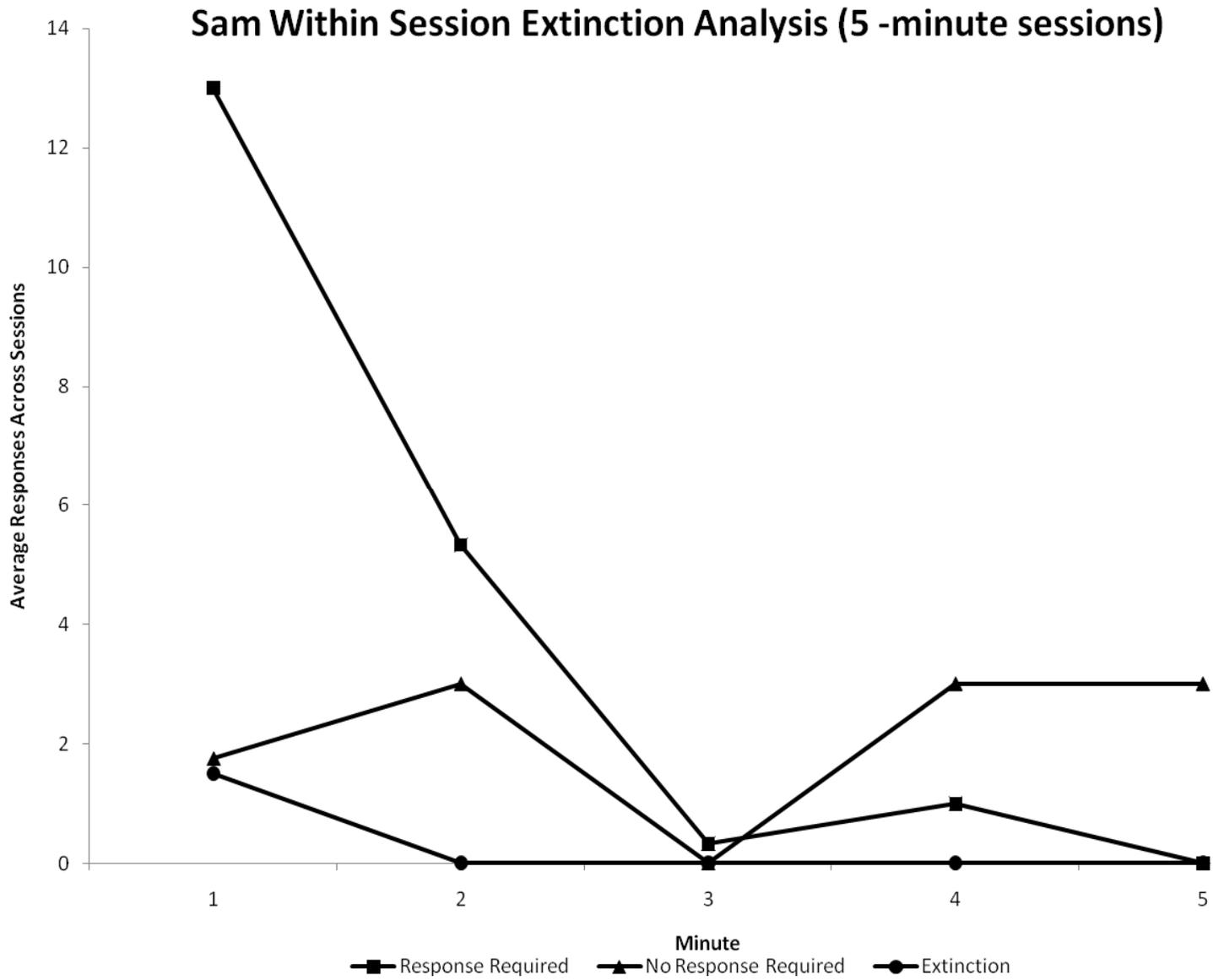


Figure 6

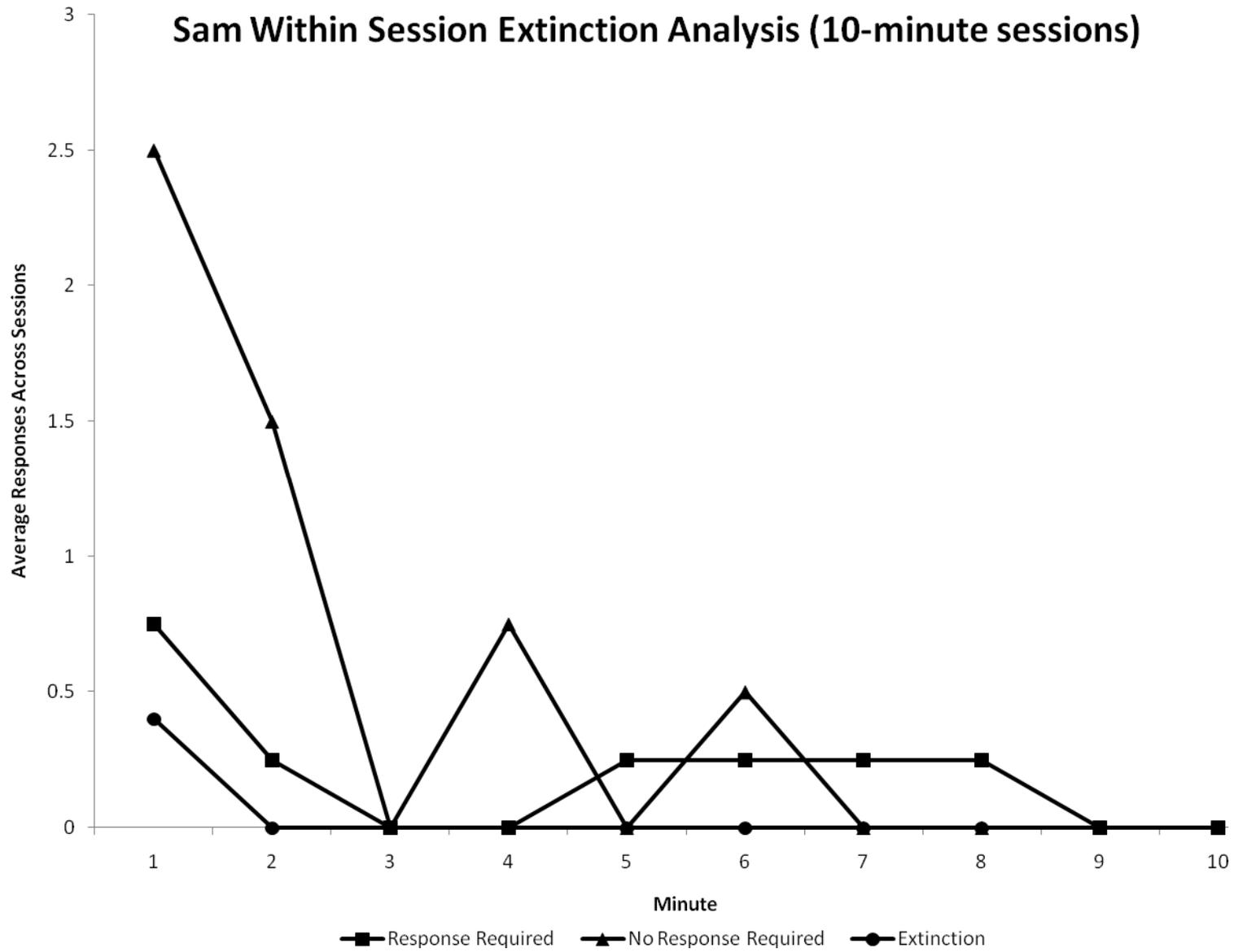


Figure 7