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A Comparison of Simultaneous and Delayed Conditioning of Visual Stimuli in Children with Autism Spectrum Disorder

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by

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Abstract

Title: A Comparison of Simultaneous and Delayed Conditioning of Visual Stimuli in Children with Autism Spectrum Disorder

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Individuals with autism spectrum disorder and related disabilities often do not respond to social reinforcers, such as praise, in a manner that is consistent with typically developing peers. Conditioning procedures are commonly used to establish new reinforcers with this population; however, there are few published studies examining conditioning procedures with this population. This study compared the effectiveness of simultaneous and delayed conditioning to establish conditioned reinforcers in three children with Autism Spectrum Disorder. The conditioning procedures involved pairing a neutral stimulus (a picture card) with an unconditioned reinforcer using a response-stimulus conditioning procedure. Conditioning trials occurred following simple responses, such as a motor response or sorting task. In the simultaneous conditioning condition, a card was presented simultaneously with the delivery of an edible. In the delayed conditioning condition, a card was presented, followed by the delivery of an edible, and then the removal of the card. We evaluated the effectiveness of the two conditioning procedures by measuring levels of responding when the simple response was consequated with only the card during probe sessions after every 250 pairing trials and after pairing trials had been discontinued. Neither the simultaneous nor the delayed conditioning procedure was effective to condition the card as a reinforcer, counter to our expectations based on results of basic literature with laboratory animals. Thus, further research is needed to examine methods to reliably condition stimuli to control behavior.

Table of Contents

List of Figures

List of Tables

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A Comparison of Simultaneous and Delayed Conditioning of Visual Stimuli in Children with Autism Spectrum Disorder

One common criticism of applied behavior analysis when teaching skills to individuals with Autism Spectrum Disorder (ASD) and related disabilities is the use of frequent edible and tangible reinforcers. The reason for the use of edibles is that children with ASD often do not acquire skills with naturally occurring contingencies alone. Specifically, social contingencies, such as praise, used in typical learning environments often do not reinforce behavior in individuals with ASD (Lovaas, 2003). Instead, edible and other tangible reinforcers are delivered frequently following desired behavior. This reliance on frequent edible reinforcer deliveries is not practical for a typical learning environment, as it is effortful for teachers and parents to continuously provide preferred items following desired behavior. Therefore, it is necessary to establish a wider range of items that function as reinforcers to allow individuals receiving behavior-analytic services to learn in a less restrictive learning environment.

Unfortunately, little is known about the most effective way to establish stimuli as reinforcers. In texts describing programs for teaching children with ASD (e.g., Leaf & McEachin, 1999; Lovass, 2003; Sunberg & Partington, 1998), the authors recommend using pairing (i.e., conditioning) procedures. However, the authors do not provide insight into what might comprise optimal conditioning methods from empirical studies. Behavior analysts working with individuals with ASD and in other applied settings use procedures similar to those shown to be effective in basic research with laboratory animals, but there are few published studies examining these procedures in individuals with ASD. Therefore, there is a need for direct comparisons of procedural variations to establish a technology for conditioning reinforcers. The current study examines one procedural variation of conditioning procedures, examining the temporal contiguity between the neutral stimulus (to be established as a conditioned reinforcer) and the reinforcer.

Conditioning procedures can be split into two categories, classical (respondent) and operant. Classical conditioning is the process by which a conditioned stimulus elicits a reflex through repeated pairings with an unconditioned stimulus (Domjan, 2005). The study of classical conditioning began with the examination of elicited reflexes – Pavlov (1927) summarized much of his work on the processes of classical conditioning. The findings of his work have led to numerous studies on the circumstances necessary for classical conditioning to

occur (Lattal, 2013). Most relevant to this study is the temporal arrangement of the conditioned stimulus and unconditioned stimulus. Two of the most common variations of conditioning, or pairing, procedures in terms of temporal contiguity are simultaneous and delayed conditioning. In simultaneous conditioning, the presentation of the conditioned stimulus (CS) occurs *at the same time* as the unconditioned stimulus (US). In delayed conditioning, also known as forward or sequential conditioning, the presentation of the CS *precedes* the presentation of the US. Specifically, the US is either presented at the end of the CS interval or immediately before the end of the CS interval. Some other procedural variations examined within the research on conditioning include, but are not limited to, the duration of the CS and US intervals, the overlap between the CS and US, extension of the US beyond the termination of the CS, the number or pairing trials, and the inter-trial interval (Lattal, 2013).

Lattal (2013) summarizes the findings of research on these procedural variations. Specifically, delayed conditioning generally is demonstrated to be the most effective. While the CS must precede the US, Lattal also states that the delay between the onset of the CS and the onset of the US must not be too long. The optimal CS and US durations, amount of overlap between the two, and the inter-trial intervals depend greatly on the response examined. For examples, eye-blink conditioning occurs on the scale of seconds while taste aversion learning occurs on

the scale of hours. In general, the CS should reliably predict the occurrence of the US. Classical conditioning has been demonstrated across many species and many different responses, leading many to believe that conditioning is an adaptive trait that assists the organism in interacting with its environment (Domjan, 2005). Thus, the to-be-conditioned stimulus must be predictive in nature; it must tell the organism about impending events. Assuming the stimulus must be predictive in nature, a forward relationship between the CS and the US is necessary.

Numerous studies examining classical conditioning with laboratory animals have demonstrated the efficacy of delayed conditioning procedures to establish conditioned stimuli to elicit reflexes. One example, Fanselow (1990), examined freezing in rats following placement in a chamber, in which the rats had experienced shock. Rats were placed in an observation chamber and received a shock 1, 3, 9, 27, or 81 seconds after placement in the cage. All groups of rats were removed from the chamber 30-seconds after shock delivery. The following day, rats were returned to the observation chamber. In general, the greater delay to the shock following placement in the chamber, the greater the freezing response when the rat was returned to the observation chamber. Additionally, in a separate experiment Fanselow (1990) reported little to no freezing with a 0-second delay to shock (simultaneous conditioning). These results suggest that delayed conditioning was more effective compared to simultaneous conditioning to establish the

chamber as a conditioned stimulus. When rats received shock on a 0-second delay, placement into the chamber was not predictive of shock delivery. Thus, these results are consistent with the view that to-be-conditioned stimuli must be predictive of impending events.

In contrast to classical conditioning, in which a neutral stimulus becomes a conditioned elicitor of behavior, operant conditioning trials result in a previously neutral stimulus becoming a conditioned reinforcer or punisher. Skinner (1938) describes a procedure that resulted in conditioned reinforcement. Rats were exposed to a clicking sound and were given food. Later the animals were not fed but the click was used to train a lever pressing response. The lever pressing increased although it only produced the conditioned stimulus, the clicking sound. Unlike classical conditioning in which the conditioned stimulus elicited a reflex through repeated pairings with the unconditioned stimulus, in this example following repeated pairings with the reinforcer (i.e., food) the conditioned stimulus (i.e., the clicking sound) came to increase a response (i.e., the lever press) when delivered contingently upon that response. As with classical conditioning, there are many variations within research on operant conditioning. Most relevant to the current study is the temporal arrangement of the conditioned stimulus and the reinforcer. Delayed conditioning is commonly used in basic research with

laboratory animals and has been show to effectively condition stimuli as reinforcers (e.g., Bersh, 1951; Kruzich, Congleton, & See, 2001; Stein, 1958).

Based on the findings in the basic literature reviewed above, delayed conditioning should be effective to establish stimuli as reinforcers. While several published studies have demonstrated procedures to establish praise and other social stimuli as conditioned reinforcers (e.g., Chadwick & Day, 1971; Drennen, Gallman, & Sausser, 1969; Miller & Drennen, 1970; Stahl, Thomson, Leitenberg, & Hasazi, 1974), few applied studies directly assess the effectiveness of procedures to condition reinforcers in individuals with ASD. Additionally, many published studies examining conditioned reinforcers have limitations that limit the ability to draw conclusions about the effectiveness of the procedures. First, the use of group design precludes comparisons between treatments for individuals. Second, failure to assess the reinforcing value of the social stimuli (to-be-conditioned) prior to implementing conditioning procedures, limits the ability to conclude that the social stimuli did not reinforce responding prior to conditioning. Last, a lack of experimental control (e.g., lack of baseline measures) limits the ability to conclude that increases in responding following conditioning procedures were due to the procedures and not some other variable.

Based on the limitations noted in previous research, Dozier, Iwata, Thomason-Sasi, Worsdell, & Wilson (2012) sought to examine procedures to

establish social stimuli as reinforcers while mitigating the limitations discussed above. Specifically, they examined the effectiveness of two procedures to condition praise as a reinforcer in adults with intellectual disabilities (e.g., ASD, Down syndrome). This study provides a framework for studying conditioned reinforcement as it is one of few studies that demonstrates effectiveness of conditioning procedures by including tests of the conditioned stimuli before and after pairing procedures.

In Study 1 of Dozier et al. (2012), the authors examined a pairing procedure, presenting a neutral stimulus with an edible item (stimulus-stimulus pairing). They delivered one of 10 praise statements immediately followed by an edible reinforcer (delayed pairing) every 15 s during 10-min sessions (40 pairing trials per sessions). They conducted test sessions following every 200 pairing trials. In test sessions, they delivered the praise statements following a response to examine if praise in the absence of the edible reinforcer increased response rates. When compared to baseline (no programed consequence) and praise-only sessions conducted prior to pairing, the rate of responding increased for one of the four participants. The results indicated that the stimulus-stimulus pairing procedure did not condition praise as a reinforcer for most participants.

In Study 2, Dozier et al. (2012) examined a pairing procedure, presenting a neutral stimulus with an edible reinforcer following a simple response (response-

stimulus pairing). A different set of participants were included in study two. Two changes were arranged in this study. Recall, the first study used delayed pairing on a time-based schedule. In Study 2, an edible reinforcer and one of 10 praise statements were delivered simultaneously following a response to a simple task. To test whether the praise statement functioned as a conditioned reinforcer, the authors then delivered only praise following the response used in pairing sessions. They found that the rate of responding increased for four of the eight participants relative to previous baseline and praise-only sessions. Praise also increased rates of responding, relative to baseline levels, for two additional tasks not used in pairing sessions. The results suggest the response-stimulus pairing procedure may be effective in establishing praise as a conditioned reinforcer in some but not all cases.

Although the results of the Dozier et al. (2012) study contributed to the dearth of applied literature evaluating procedures to establish conditioned reinforcers in individuals with ASD and related disorders, there are some limitations that should be noted. First, the authors did not use the same participants across studies, which limits our ability to compare the effectiveness of the procedures directly for any single individual. Additionally, procedural differences across studies make it difficult to determine what variable was responsible for the outcomes. Specifically, the authors implemented delayed pairing when evaluating the stimulus-stimulus pairing procedure, but used simultaneous pairing within the

response-stimulus pairing procedure. Furthermore, the number of pairing trials varied across participants and across studies.

Given the procedural variations within the Dozier et al. (2012) study and across other applied studies, it is difficult to determine the optimal method for establishing stimuli as conditioned reinforcers with individuals with ASD and related disorders. Establishing conditioned reinforcers within this population is important as these individuals commonly have restricted interests and often do not respond to social reinforcers alone. Currently the applied literature with this population does not systematically evaluate procedural variations to provide clinicians with a technology to condition reinforcers. The basic literature with laboratory animals indicates that delayed conditioning procedures are effective within both classical and operant conditioning. It is unknown whether the results of the basic literature translate to this population. To our knowledge there has not been research published that compares delayed conditioning with other temporal arrangements (e.g., simultaneous conditioning) within the ASD population. Although Dozier et al. (2012) evaluated conditioning procedures within a similar population, conclusionS about the effectiveness of the temporal arrangement of stimuli cannot be drawn due to procedural and participant differences between studies. Thus, the purpose of the current study is to compare the effectiveness of

simultaneous and delayed pairing procedures to establish a neutral stimulus as a conditioned reinforcer in children with ASD.

Procedures used were similar to those used in study 2 of Dozier et al. (2012), with a few key differences. First, the current study evaluated the effects of simultaneous pairing and delayed pairing within each participant, to directly compare the effectiveness of the procedures within each individual. Additionally, all other procedures remained the same across the two pairing procedures. Further, responses varied across different session types, to control for effects of reinforcement deliveries on response persistence. Specifically, responding during sessions with praise only could be attributed to effects of reinforcers delivered during previous pairing sessions if using the same response. Thus, four responses were chosen for each participant. One response was used during simultaneous pairing sessions and a second response for probe sessions (i.e., praise alone) conducted to assess the reinforcing value of the conditioned stimulus presented during simultaneous pairing sessions. A third response was used during delayed pairing sessions and a fourth response was used for probe sessions with the conditioned stimulus presented during delayed pairing sessions. Lastly, pictures were used as conditioned stimuli, rather than praise statements. The purpose of this was to control for effects of previous exposure to the to-be-conditioned stimuli, as individuals are likely exposed to various praise statements during everyday

interactions with caregivers. Based on the results of Dozier et al. (2012), response-stimulus conditioning should be effective to condition neutral stimuli (i.e., pictures) as conditioned stimuli. Further, based on the results of the basic literature with non-human animals, delayed conditioning should establish conditioned reinforcers more effectively than simultaneous conditioning.

Method

Participants and Setting

Three children diagnosed with ASD participated in the study. Gaby, an eight-year-old female, attended a local private school and received clinic-based behavioral intervention services. Connor was a four-year-old male who received clinic-based behavioral intervention services. Morgan was a three-year-old male who received clinic-based behavioral intervention services. Participants were included if they did not engage in problematic or stereotypic behavior that may have competed with the target response, engaged in simple responses when edibles were delivered following the response, and engaged in a variety of responses in the absence of prompts or instructions. All sessions were conducted in a 3 m x 3 m treatment room located at a behaviorally based treatment center for children with ASD.

Materials

Materials present during the session included any materials necessary to complete the task, materials for data collection, edible items, a picture card (to-be-conditioned stimulus), and a table and chairs. Tasks were chosen that the child could independently engage in without instructions or prompt, containing at least 10 pieces (e.g., shape sorter, inset puzzle, stringing beads). Picture cards were laminated, 8 in by 6 in, and contained an image (e.g., inkblot, a division symbol, horizontal lines) with a white background. The therapist wore an apron containing a bag of the top three preferred edible items identified within the preference assessment (see below) cut into small pieces, approximately .25 inches in diameter. The therapist sat at the table and the task materials were placed on the table.

Pre-Experimental Assessment Procedures

Preference assessment. A paired-stimulus preference assessment (Fisher, Piazza, Bowman, Hagopian, Owens, & Slevin, 1992) was conducted to identify preferred edible items, as research has indicated that relative preference may indicate how likely an item is to function as a reinforcer. Eight items were assessed during the paired-stimulus preference assessment. Two items were presented at a time and the participant was instructed to "*pick one*". All of the items were presented with each of the other items two times, in a random order. Percentage consumption was calculated by dividing the number of times each item was

consumed by the total number of times the item was presented. The resulting percentage was used to rank items by their relative preference. The three items with the highest percentage consumption were later assessed in a reinforcer assessment.

Reinforcer assessment. A reinforcer assessment was used to ensure items identified in the preference assessment would reinforce responding when delivered contingent upon a response. Stimuli tested in the reinforcer assessment included the top three preferred edibles identified in the preference assessment and three picture cards to be used as potential neutral stimuli. The frequency of responding to a free-operant task was recorded during 1-min sessions. The reinforcer assessment was conducted using a reversal design with embedded multielement design (Taylor-Santa, Sidener, Carr, & Reeve, 2014). The assessment was implemented in three phases. In the first and third phase, responding did not result in programmed consequences. These phases served as a comparison for the second phase. In the second phase, following each response one of the six stimuli (i.e., three edible item, three picture cards) was delivered. The order of the six stimuli delivered across sessions was randomized within each series of six sessions. At the beginning of each session the child was given a rule specifying the contingency for the current phase (e.g., “You can sort but you won’t get anything”). For Gaby, pre-exposure trials were added in the second phase following low levels of responding across all sessions in which the therapist only provided a rule specifying the contingency, to

ensure exposure to the contingencies. In these sessions the therapist provided a rule, prompted the response five times, providing the specified consequence after each response, and then counted down to the start of the session. For Connor and Morgan, three pre-exposure trials were conducted across all phases.

Edibles were used as reinforcers during pairing sessions if they produced high rates of responding when presented contingent upon behavior, relative to baseline. Picture cards to be used as neutral stimuli (to-be-conditioned stimuli) were selected if they produced levels of responding at or lower than baseline levels. This ensured that the picture cards did not function as reinforcers before being used in the delayed or simultaneous conditioning procedures. Two cards were selected for use in the remainder of the study for each participant. One card was used in simultaneous-pairing procedures and one card was used in delayed-pairing procedures.

Response assessment. A response assessment was used to identify responses that the individual could perform but would not do so in the absence of response-contingent reinforcers. Responses tested were those that the individual could independently perform, as identified by caregivers. Sessions were conducted similar to the procedures described in Holth, Vandbakk, Finstad, Grønnerud, & Sørensen (2009). In each session, one task identified by caregivers was present on a table. At the beginning of each session, the therapist prompted the individual to

engage in the response and provided a rule, “You can do X but nothing will happen.” Session duration was 2-min and no programmed consequences were delivered following each response. If responding did not occur for 30 s, the session was terminated prior to 2 min. Tasks selected were those for which the learner emitted at least one response but fewer than 20 responses in 2 min. This ensured that the individual was able to engage in the response but did not do so in the absence of reinforcement. Four tasks were selected, one for each of the conditions described below. To hold response effort constant, each task chosen was similar in fine motor ability necessary to complete the task and took approximately the same duration to complete.

Experimental Procedures

Each pairing procedure (i.e., simultaneous and delayed pairing) was evaluated successively with each participant. Figure 1 outlines the order of pre-experimental and experimental conditions. The order of simultaneous and delayed pairing was counterbalanced across participants. Responses used were the four responses identified within the response assessment. Two responses were used for each type of pairing procedure, for a total of four responses: one response for simultaneous pairing sessions, on response for simultaneous probe sessions, one response for delayed pairing sessions, and one response for delayed probe sessions. Two neutral stimuli (one for each type of pairing procedure) and three edible items

to be used in pairing trials were chosen in the reinforcer assessment. The therapist wore an apron containing the edible items across all conditions.

Simultaneous Pairing

The therapist started each session by providing a rule specifying the contingencies (e.g., "If you sort the blocks, I will show you this (picture card) and give you food"). The therapist then counted down to the start of the session. Immediately after each response, the therapist delivered a pairing trial. In each pairing trial, the therapist delivered one of three edible items (rotated randomly) and one of the pictures cards (held the same through all simultaneous pairings) simultaneously. The therapist held the picture card approximately 2 ft from the participant's face for 4 s while presenting the edible item in an open palm below the picture. If the participant did not accept the edible, it was removed after 4 s. If the participant did not accept three consecutive edibles, the session was terminated. Pairing sessions were terminated after 25 responses or after 2 min of no responding.

Delayed Pairing

The therapist started each session by providing a rule specifying the contingencies (e.g., "If you sort the blocks, I will show you this (picture card) and give you food"). The therapist then counted down to the start of the session. Immediately after each response, the therapist delivered a pairing trial. In each

pairing trial, the therapist delivered one of three edible items (rotated randomly) and one of the pictures cards (held the same through all delayed pairings) following a delay. The therapist held the picture card approximately 2 ft from the participant's face for 4 s, presenting the edible item 2 s later in an open palm below the picture. If the participant did not accept the edible, it was removed after 4 s. If the participant did not accept three consecutive edibles, the session was terminated. Pairing sessions were terminated after 25 responses or after 2 min of no responding.

Probe Sessions

Probe sessions were conducted to assess changes in the frequency of responding when only the picture card was delivered after each response. We conducted probe sessions before pairing (pre-pairing probe), after every 250 pairing trials (probes) and after the 1000 pairing trials (post-pairing probe). We included pre-pairing probes to ensure that the picture card did not already function as a reinforcer for the task. Additionally, levels of responding in the pre-pairing probes were used as a comparison for evaluating the reinforcing value of the picture card in subsequent probe sessions. Pre-pairing probes were conducted until responding was stable. Probes were also conducted after every 250 pairing trials to assess the number of trials needed to establish the neutral stimuli as conditioned reinforcers. After 1000 pairing trials, post-pairing probe sessions were conducted until the

response returned to baseline levels. The purpose of this phase was to assess the ability of the picture cards to function as a reinforcer across time due to the previous pairing procedures.

At the beginning of each session, the therapist provided a rule specifying the contingencies (e.g., "If you sort the blocks, I will do show you this (picture card)"). The therapist then counted down to the start of the session. Following each response, the therapist presented the picture card 2 ft from the participant's face for 4 s. Edible items were not presented during these trials, but remained present in the therapist's apron. All baseline and probe sessions were 5 min.

Response Measurement, Interobserver Agreement, and Treatment Integrity

The primary dependent variable for this study is the rate of responding (task completion) during the pre- and post-pairing probes. We collected data on the frequency of task completion during 1-min intervals in each session. Task completion was defined individually for each participant and varied depending on the task. For the reinforcer assessment a card touch response was used for Gaby and Morgan. The operational definition for the card touch response included any portion of the hand coming into contact with the card. Two hands were recorded as two responses. For Connor, an object permanence box was used in the reinforcer assessment. The operational definition for the object permanence box included placing a ball in the opening in the top of the box. Table 2 contains response

definitions for the response assessment and responses used within pairing sessions and probe sessions. Session duration was recorded using a timer. The therapist started the timer at the end of the rule and stopped the timer after the specified number of responses or total duration for that session was reached. All measures were recorded on a session datasheet. Across all conditions, we calculated the rate of responding by dividing the total number of responses (i.e., completed tasks) by the session time. A second independent observer collected data during at least 30% of sessions. Mean count per interval was calculated by dividing the smaller number of responses by the larger number of responses within each interval, averaging the resulting ratios, and multiplying by 100.

For the reinforcer assessment, interobserver agreement was evaluated for 46.9% of sessions with Gaby (mean = 98.81%; range, 72.7%– 100%), 57.1% of sessions with Connor (mean = 99.6% ; range, 88.89 - 100%), and 42.1% of sessions with Morgan (mean = 92.73; range, 0-100%)[1]. For the response assessment, interobserver agreement was evaluated for all session with all participants. The mean interobserver agreement was 99.34% (range, 94.74 - 100%) for Gaby, 92.71 (range, 65.38 - 100%) for Connor, and 95.83 (range, 86.67 – 100%) for Morgan.

For delayed pairing, interobserver agreement was evaluated for 34.48% of sessions for Gaby (mean = 98.67%; range, 89.29 - 100%), 46.77% of sessions for Connor (mean = 98.93%; range, 88.89 – 100%), and 45.76% of session for Morgan

(mean = 97.77%; range ,87.5 – 100%). For simultaneous pairing, interobserver agreement was evaluated for 46.3% of sessions for Gaby (mean = 99.52%; range, 96 – 100%), 44.12% of sessions for Connor (mean = 96.39%; range, 70-100%), and 38.98% of sessions for Morgan (mean = 98.08% range, 80 – 100%).

A second independent observer also collected data on procedural integrity, to ensure therapists delivered the correct consequence following each response. Procedural integrity for was calculated for each session by dividing the total number of correctly implemented consequences by the total number of responses and multiplying by 100 to yield a percentage score. Procedural integrity for probe sessions was recorded for 50% of probe sessions (mean = 100%). Procedural integrity for pairing sessions was recorded for 41.36% of pairing sessions (mean = 99.82%; range, 82.14 – 100%).

Results

Figure 1 shows results of the paired-stimulus preference assessment for Gaby. The bar graph depicts percentage of opportunities with consumption for each item. Based on these data, we choose Doritos®, Laffy Taffy®, and Cheez-ITs® to test in the reinforcer assessment, as those items were consumed most frequently. Figure 2 shows results of the pair-stimulus preference assessment for Connor. Based on the results, we choose to test GoldFish®, cheese crackers, and pretzels in the reinforcer assessment. Figure 3 shows results of the paired-stimulus preference

assessment for Morgan. Based on the results, we choose to test GoldFish®, Cheetos®, and mini chocolate chips in the reinforcer assessment.

Figure 4 shows results of the reinforcer assessment conducted with Gaby. In baseline, the graph reflects low response rates across sessions when no programmed consequences were delivered. Low response rates suggest participants will not engage in the task in the absence of reinforcers. The next phase depicts contingent presentation of edible items and picture cards. Response rates remained low in all sessions, indicating that either the edible items did not function as reinforcers for that response, or Gaby did not discriminate among the contingencies provided across each session. In the third phase, we implemented pre-exposure trials prior to each session to aid in discrimination of the contingencies. Response rates increased greatly in edible sessions but also increased to a lesser degree in picture card sessions. This indicated that the edible items functioned as reinforcers. Recall, we anticipated no increase in response rates in picture card sessions. We hypothesized that the increase in response rates in picture card sessions could be attributed to effects of edible sessions interspersed with picture card sessions. Specifically, effects of edible sessions could impact response rates in subsequent picture-card sessions. To test this, edible sessions were discontinued and picture-card sessions were conducted in a multielement design in the next phase. Response rates decreased to near baseline levels in this phase, indicating that the picture cards

did not function as reinforcers. The final phase depicts baseline sessions, in which response rates remained low. Low response rates in the final baseline sessions suggest that increases in responding in previous sessions can be attributed to the consequences provided in those sessions and not another extraneous variable.

Figure 5 shows results of the reinforcer assessment conducted with Connor. In baseline, response rates were variable across sessions. We hypothesized that variability in responding may have been due to the individuals history with intermittent schedules of reinforcement and prompted compliance while seated during typical early intervention sessions. Given this history, we removed the individual's chair from the room. Response rates decreased to zero in this phase. Low response rates suggest the participant will not engage in the task in the absence of reinforcers. The next phase depicts contingent presentation of edible items and picture cards. Response rates increased during edible sessions and remained low during sessions with the picture card. This indicates that edibles functioned as reinforcers and picture cards did not function as reinforcers. The final phase depicts baseline sessions, in which response rates remained low. Low response rates in the final baseline sessions suggest that increases in responding in previous sessions can be attributed to the consequences provided in those sessions and not another extraneous variable.

Figure 6 shows results of the reinforcer assessment conducted with Morgan. In baseline, the graph reflects low response rates across sessions when no programmed consequences were delivered. Low response rates suggest that the participant will not engage in the task in the absence of reinforcers. The next phase depicts contingent presentation of edible items and picture cards. The rate of responding increased greatly in edible sessions but also increased to a lesser degree in picture card sessions. Recall, we anticipated no increase in responding in picture card sessions. We hypothesized that the increase in responding could be attributed to carryover effects. Specifically, effects of edible sessions could impact response rates in subsequent tangible sessions. To test this, we conducted picture card sessions in a multielement design in the next phase. Response rates in this phase were variable but overall response rates remained well below responding in edible sessions of the previous phase. The final phase depicts baseline sessions, in which response rates remained low. Low response rates in the final baseline sessions suggest that increases in responding in previous sessions can be attributed to the consequences provided in those sessions and not another extraneous variable.

Figure 7 depicts simultaneous and delayed probe sessions conducted with Gaby. The fourth simultaneous probe session with Gaby depicts an error, in which the therapist presented the task used in pairing sessions rather than the response used in probe sessions. The fifth session depicts a probe session conducted using

the correct response with no additional pairing sessions conducted between session four and five. Response rates in probe sessions and post-pairing probe sessions did not increase relative to pre-pairing probes for either type of pairing procedure. This suggests that neither procedure established the picture card as a conditioned reinforcer. If the procedures were effective, we would expect increases in response rates in probe sessions and post-pairing probes sessions relative to pre-pairing probes.

Figures 8 and 9 depict simultaneous and delayed probe sessions conducted with Connor and Morgan, respectively. For simultaneous pairing with Connor, response rates increased slightly in the first probe relative to the last four sessions of pre-pairing probes. Response rates remained low across the remaining probe sessions and post-pairing probe sessions. Overall, these low rates suggest that simultaneous pairing was not effective to establish the picture card as a conditioned reinforcer. For simultaneous pairing with Morgan, response rates increased slightly in the first probe relative to the last three sessions of pre-pairing probes. Overall, this suggests that simultaneous pairing was not effective to establish the picture card as a conditioned reinforcer. For delayed pairing with Connor and Morgan, response rates did not increase in probe sessions or post-pairing probes sessions relative to pre-pairing probe sessions, suggesting that delayed pairing also did not establish the picture card as a conditioned reinforcer.

Discussion

We compared simultaneous and delayed conditioning procedures to establish a picture card as a conditioned reinforcer in three children with ASD. We used a response-stimulus pairing procedure by pairing a card with an edible item following a simple response. In simultaneous pairing sessions, the picture card and the edible reinforcer were delivered at the same time. In delayed pairing sessions, the picture card was delivered and the edible reinforcer was delivered 2 s later. To evaluate the effectiveness of these procedures, we conducted probe sessions before pairing and after every 250 pairing trials. Finally, we conducted probes sessions after 1000 pairing trials until responding decreased to initial probe response rates.

Response rates generally did not increase following delayed or simultaneous pairing trials relative to probe sessions conducted before pairing. Thus, neither method was effective in establishing picture cards as a conditioned reinforcers. In two participants, the response rate increased transiently in the probe session following the first 250 simultaneous pairing trials. However, during subsequent probe sessions, response rates were near pre-pairing probe session rates. The increase in response rates in the first probe session is consistent with the conditioning of the picture card as a reinforcer but other explanations exist.

An alternative explanation for the increase in response rates in the first probe session following simultaneous pairing trials is spontaneous recovery.

Spontaneous recovery is a phenomenon demonstrated in basic literature with laboratory animals, in which an extinguished response returns after a passage of time alone (Brooks & Bouton, 1993). Within our procedures, there was a delay between the baseline probe sessions and subsequent probe sessions, while pairing sessions were conducted. It is possible the increase in response rates in the first probe session can be attributed to the time lapse between baseline probes and the first probe session.

Based on the conditioning literature with laboratory animals, we expected delayed conditioning to establish conditioned reinforcers more effectively than simultaneous pairing. However, we did not observe effects convincingly in support of the card being established as a conditioned reinforcer. There are a few possible explanations for our results that relate to the predictiveness of the to-be-conditioned stimulus and other stimuli present, such as the therapist's hand presented when delivering edibles: overshadowing, blocking, and relative validity. I will discuss each of these in relation to predictiveness of the conditioned stimuli. Recall, conditioned stimuli should be predictive in nature, in that they inform the organism about upcoming environmental events (Domjan, 2005).

Overshadowing occurs when two stimuli presented together during pairing with the unconditioned stimulus results in conditioning of one of the stimuli but not the other – the difference is conditioning is due to the greater salience of one

stimulus (Mackintosh, 1976). In the current study, the presence of the therapist's hand moving toward the child to deliver the food may have overshadowed the presence of the picture card. It is possible that the presentation of the therapist's hand was more salient than the picture card and was established as a conditioned reinforcer. Thus in probe sessions, when the therapist did not place her hand below the picture card, the individual did not continue to engage in the response.

Another phenomenon potentially accounting for the lack of control by the card is a phenomenon called blocking. When a conditioned stimulus is presented in compound with a stimulus that has not yet been conditioned, the presentation of the stimulus that has already been conditioned inhibits the conditioning of the other stimulus (Kamin, 1969). In the current study, it is possible that the presence of the therapist hand reaching toward the child with palm upward, may have already been established as a conditioned reinforcer. Specifically, delivery of edible items in the child's daily life could signal the availability of food. Thus, the presentation of the therapist's hand may have blocked conditioning of the picture card. With the overshadowing and blocking explanations, the picture card was a redundant stimulus that did not predict impending environmental events.

Another phenomenon related to the conditioning of stimuli presented in compound is called the relative validity effect (Wagner, Logan, & Haberlandt, 1968). When two stimuli are presented in compound, the stimulus more highly

correlated with the unconditioned stimulus results in greater learning. Specifically, the therapist's out-reached hand was perfectly predictive of the delivery of the unconditioned reinforcer in the children's daily life and thus exerted more control over the response than presentation of the card, which only occurred during experimental sessions.

The literature with laboratory animals suggests that delayed conditioning should be effective to establish conditioned reinforcers (Lattal, 2013). Further, Dozier et al. (2012) demonstrated the effectiveness using a response-stimulus pairing procedure with simultaneous conditioning to establish praise as a conditioned reinforcer for free-operant responses. Nevertheless, this approach was effective in only 4 out of 8 participants. Dozier and colleagues also examined a delayed conditioning procedure, in which they arranged pairing trials on a time-based schedule independent of responding. Unlike simultaneous conditioning, delayed conditioning was completely ineffective in establishing praise as a reinforcer. We failed to replicate the effects demonstrated by half of the participants in the Dozier et al. study when using simultaneous, response-stimulus pairing. Our findings were more consistent with Dozier et al.'s delay conditioning outcomes; however, Dozier et al. confounded simultaneous versus delayed pairing with stimulus-stimulus versus response-stimulus pairing. Therefore, Dozier et al.

provides limited guidance for understanding how these procedures effectively condition stimuli.

This failure to replicate Dozier et al. (2012) even the limited effectiveness across participants demonstrated by could be due to procedural variations across the studies. First, in the current study, a picture card was used instead of praise. It is possible that the auditory stimulus was more salient to the participants (i.e., it was not overshadowed) or already paired with primary reinforcers under natural conditions (it was not blocked). Future studies might attempt to condition a novel, pre-recorded auditory stimulus as a conditioned reinforcer. Unlike praise, using a pre-recorded auditory stimulus would allow researchers to better control for exposure to the stimulus outside of research sessions to control for blocking. Additionally, we used a different response in probe sessions than the one used in pairing sessions. Thus, the individual may have discriminated that engaging in the response during probe sessions would not produce the unconditioned reinforcer.

The current study used a response-stimulus conditioning procedure and failed to condition a previously neutral stimulus as a conditioned reinforcer. Thus, future studies may examine alternative methods to condition stimuli. Taylor-Santa et al. (2014) examined a discrimination training procedure to establish conditioned reinforcers in children with ASD. Each child was trained to engage in a response in the presence of an image on a digital picture frame (S^D) and not in the presence of a

different image (S-delta). The effectiveness of the procedures was assessed in test sessions conducted before (pre-test) and after (post-test) discrimination training. In test sessions, an image was delivered following each response to a free operant task. In post-tests, responding increased with response-contingent delivery of the S^D (relative to pre-test) but not with response-contingent delivery of the S-delta. Results indicate that the discrimination procedure established the S^D as a conditioned reinforcer. The pattern of responding observed in the post-test was demonstrated across multiple stimuli and across all participants. Future research may further evaluate the discrimination training procedure to condition reinforcers and should attempt to replicate the results of Taylor-Santa et al. (2014).

Due to the dearth of published research in this area, many of the procedural variation were determined based on the results of a few studies. For example, based on the results of Dozier et al. (2012) we choose to conduct 1,000 pairing trials per each conditioning procedure. However, 1,000 pairing trials may have not been sufficient to establish the picture cards as conditioned reinforcers with this population. Future studies should examine the effects of conducting additional pairing trials. However, it is important to note that the use of additional pairing trials would be time consuming and may limit the clinical usefulness of the procedures. Additionally, published research in operant conditioning with individuals with ASD often do not report the duration of the delay used between

the conditioned stimulus and the unconditioned stimulus. Recall, research examining respondent conditioning with non-human animals has demonstrated that the optimal delay between the onset of the conditioned stimulus and the onset of the unconditioned stimulus varies depending on the response examined (Lattal, 2013). Thus, the delay chosen in the current study may have not been optimal for conditioning to occur. Future studies may examine the effectiveness of longer or shorter delays to condition reinforcers.

In summary, the current study failed to condition a previously neutral stimulus to reinforce behavior. Procedures similar to those in this study are commonly utilized in application of behavior analysis in individuals with ASD (Leaf & McEachin, 1999; Lovaas, 2003; Sunberg & Partington, 1998). However, the effectiveness of these procedures in conditioning reinforcers has rarely been demonstrated empirically within this population. Thus, further investigation of these processes and procedures to better inform practice is vital. Future studies should attempt to more closely replicate previous studies using methods shown to reliably demonstrate conditioned reinforcement (Dozier et al., 2012; Taylor-Santa et al., 2014). Following reliable demonstrations of conditioned-reinforcing effects, evaluations of procedural variations should follow.

References

Bersh, P.J. (1951). The influence of two variables upon the establishment of a secondary reinforcer for operant responses. *Journal of Experimental Psychology, 41(1),* 62-73.

Brooks, D. C., & Bouton, M. E. (1993). A retrieval cue for extinction attenuates spontaneous recovery. *Journal of Experimental Psychology, 19*(1), 77.

Chadwick, B. A., & Day, R. C. (1971). Systematic reinforcement: academic performance of underachieving students. *Journal of Applied Behavior Analysis*, *4*(4), 311–319.

Domjan, M. (2005). Pavlovian conditioning: a functional perspective. *Annual. Review of Psychology*, *56*, 179-206.

Dozier, C. L., Iwata, B. A., Thomason-Sassi, J., Worsdell, A. S., & Wilson, D. M. (2012). A comparison of two pairing procedures to establish praise as a reinforcer. *Journal of Applied Behavior Analysis, 45*, 721-735.

Drennen, W., Gallman, W., & Sausser, G. (1969). Verbal operant conditioning of hospitalized psychiatric patients. *Journal of Abnormal Psychology, 74*(4), 454-458.

Fanselow, M. S. (1990). Factors governing one-trial contextual conditioning *Animal Learning and Behavior, 18*, 264–270.

Fisher, W., Piazza, C. C., Bowman, L. G., Hagopian, L. P., Owens, J. C., & Slevin, I. (1992). A comparison of two approaches for identifying reinforcers for persons with severe and profound disabilities. *Journal of Applied Behavior Analysis, 25*, 491-498.

Holth, P., Vandbakk, M., Finstad, J., Grønnerud, E. M., & Sørensen, J. M. A. (2009). An operant analysis of joint attention and the establishment of conditioned social reinforcers. *European Journal of Behavior Analysis, 10*, 143-158.

Kamin LJ. 1969. Predictability, surprise, atten- tion, and conditioning. In *Punishment and Aversive Behavior*, ed. BA Campbell, RM Church, pp. 279–96. New York: Appleton- Century-Crofts.

Kelleher, R.T. (1966). Chaining and conditioned reinforcement. In W.K. Honig (ED.), *Operant behavior: Areas of research and application* (pp. 160-212). New York: Appleton-Century-Crofts.

Kruzich, P.J., Congleton, K.M., & See, R.E. (2001). Conditioned reinstatement of drug-seeking behavior with a discrete compound stimulus classically conditioned with intravenous cocaine. *Behavioral Neuroscience*, *115 (5)*, 1086-1092.

Lattal, K.A. (2013). Pavlovian conditioning. In G. J. Madden, W. V. Dube, T.D.

Leaf, R., & McEachin, J. (1999). *A work in progress: Behavior management strategies and a curriculum for intensive behavioral treatment of autism*. Drl Books.

Lovaas, O. I. (2003). *Teaching Individuals With Developmental Delays: Basic Intervention Techniques*. PRO-ED, Inc., 8700 Shoal Creek Blvd., Austin, TX 78757-6897.

Mackintosh, N. J. (1976). Overshadowing and stimulus intensity. *Animal learning & behavior*, *4*(2), 186-192.

Miller, P. M., & Drennen, W. T. (1970). Establishment of social reinforcement as an effective modifier of verbal behavior in chronic psychiatric patients. *Journal of Abnormal Psychology, 76*(3), 392-395.

Pavlov, I.P. (1927). *Conditioned Reflexes*. London: Oxford University Press.

Skinner, B.F. (1938). *The behavior of organisms.* New York: Appleton-Century-Crofts.

Stahl, J. R., Thomson, L. E., Leitenberg, H., & Hasazi, J. E. (1974). Establishment of praise as a conditioned reinforcer in socially unresponsive psychiatric patients. *Journal of Abnormal Psychology, 83*(5), 488-496.

Stein, L. (1958). Secondary reinforcement established with subcortical stimulation. *Science, 127*, 466-467.

Sundberg, M. L., & Partington, J. W. (1998). Teaching language to children with autism and other developmental disabilities. *Pleasant Hill, CA: Behavior Analysts*.

Taylor-Santa, C., Sidener, T.M., Carr, J.E., and Reeve, K.F. (2014). A discrimination training procedure to establish conditioned reinforcers for children with autism. *Behavioral Interventions* 29.2 (2014): 157-176.

Wagner, A. R., Logan, F. A., & Haberlandt, K. (1968). Stimulus selection in animal discrimination learning. *Journal of experimental psychology*, *76*(2p1), 171.

Appendix

Table 1. Order of pre-experimental and experimental conditions

Pre-Experimental Procedures	
Paired-stimulus preference assessment (Fisher et al., 1992)	
Reinforcer Assessment (Taylor-Santana et al., 2014)	
Response Assessment (Holth et al., 2009)	
Pairing Procedure 1	
Probe Session (Response 1)	Conducted minimum three sessions prior to pairing, one session after each 250 pairing trials, and minimum three sessions after 1000 pairing trials
Pairing Session (Response 2)	Conducted 1000 pairing trials, 25 per session
Pairing Procedure 2	
Probe Session (Response 3)	Conducted minimum three sessions prior to pairing, one session after each 250 pairing trials, and minimum three sessions after 1000 pairing trials
Pairing Session (Response 4)	Conducted 1000 pairing trials, 25 per session

Table 2. Results of response assessment *Response selected for Simultaneous Probes **Response selected for Simultaneous Pairing *** Response selected for Delayed Probes **** Response selected for Delayed Pairing

Gaby		
Task	**Response Definition**	**Frequency**
Depositing Coin**	Placing a wooden coin in a slotted hole in a box.	6
Depositing Peg***	Placing a wooden peg in a round whole in a box.	5
Sorting Bears****	Placing a bear of one of three different colors in one of three cups of the corresponding color.	3
Stringing Beads	Placing a string through the whole of a bead and pulling the bead to the end of the string.	18
Object Permanence Box*	Placing a ball in the top of the object permanence box.	1
Connecting Links	Connecting two links together.	0
Sorting Silverware	Placing a fork, spoon, or knife in with the matching utensil in a silverware tray.	0
Depositing Block	Placing one block in a bucket.	0

Connor		
Task	**Response Definition**	**Frequency**
Depositing Peg*	Placing a wooden peg in a round whole in a box.	3
Depositing Coin***	Placing a wooden coin in a slotted hole in a box.	3
Depositing Block	Placing one block in a bucket.	0
Sorting Bears	Placing a bear of one of three different colors in one of three cups of the corresponding color.	26
Sorting Duplo Blocks**	Placing a bear of one of two different colors in one of two bins of the corresponding color	11
Sorting Tiles****	Placing a tile of one of three different colors in one of three cups of the corresponding color.	20

Morgan		
Task	**Response Definition**	**Frequency**
Depositing Coin***	Placing a wooden coin in a slotted hole in a box.	8
Depositing Peg*	Placing a wooden peg in a round whole in a box.	1
Sorting Duplo Blocks****	Placing a bear of one of two different colors in one of two bins of the corresponding color	9
Depositing Block	Placing one block in a bucket.	0
Depositing Vehicles	Placing a one of three vehicles (i.e., plane, train, or car) into a cup.	0
Sorting Tiles**	Placing a tile of one of three different colors in one of three cups of the corresponding color.	24
Depositing Letters	Placing foam letters into a bin.	13
Sorting Links	Placing a link of one of three different colors on a plate with the link of the corresponding color.	1

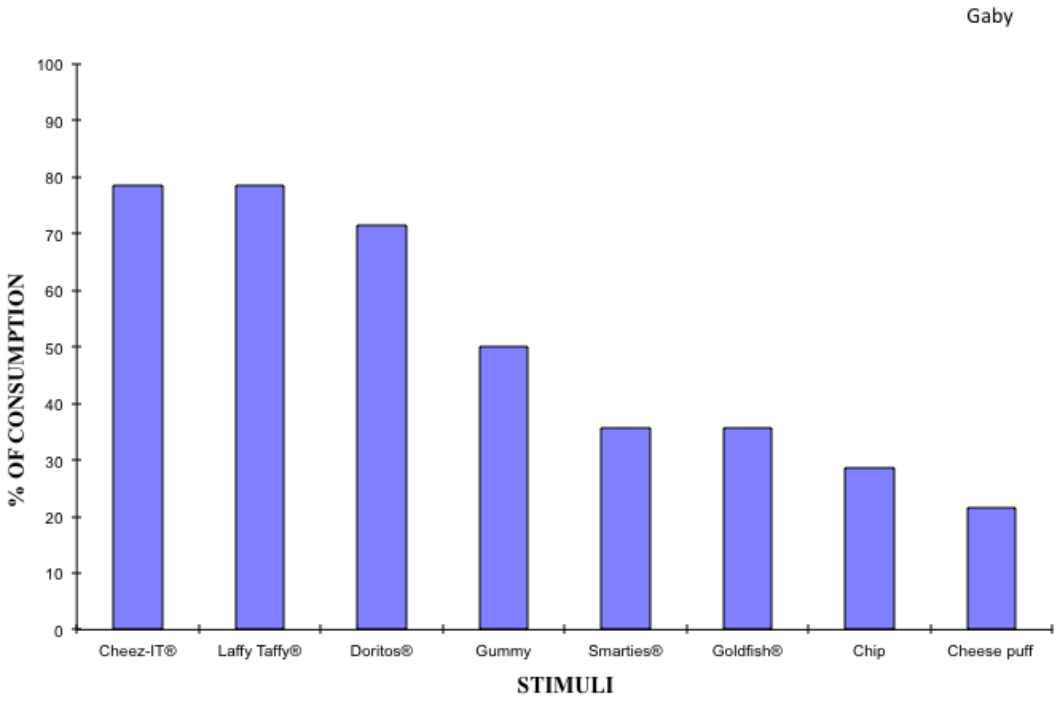

Figure 1. Results of paired choice preference assessment for Gaby

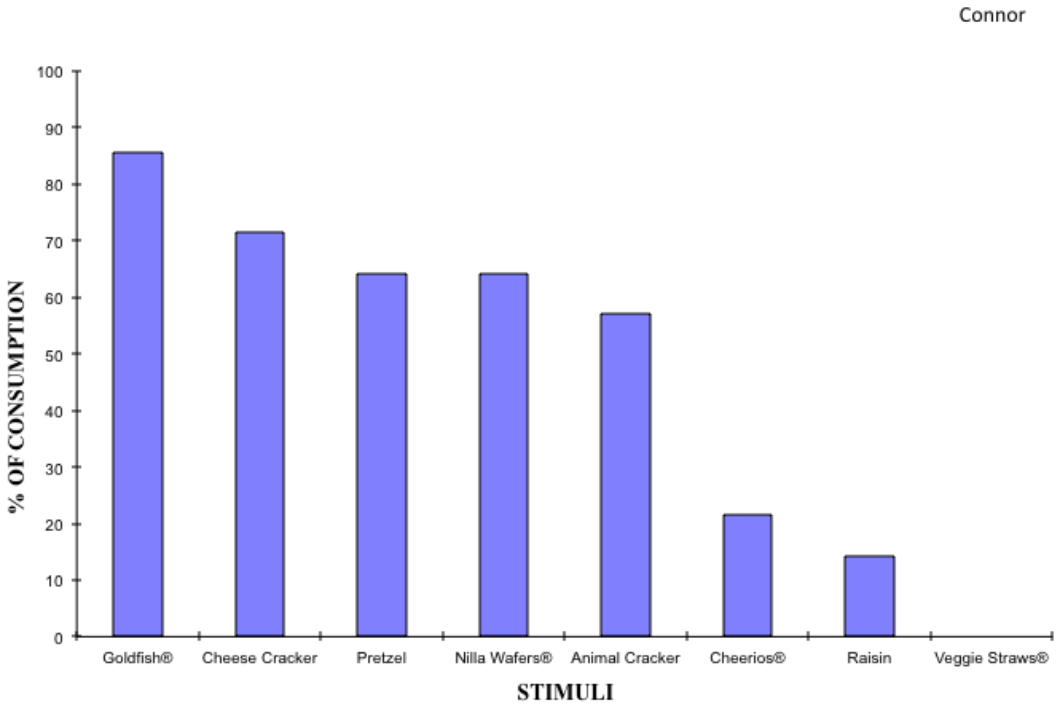

Figure 2. Results of paired choice preference assessment for Connor

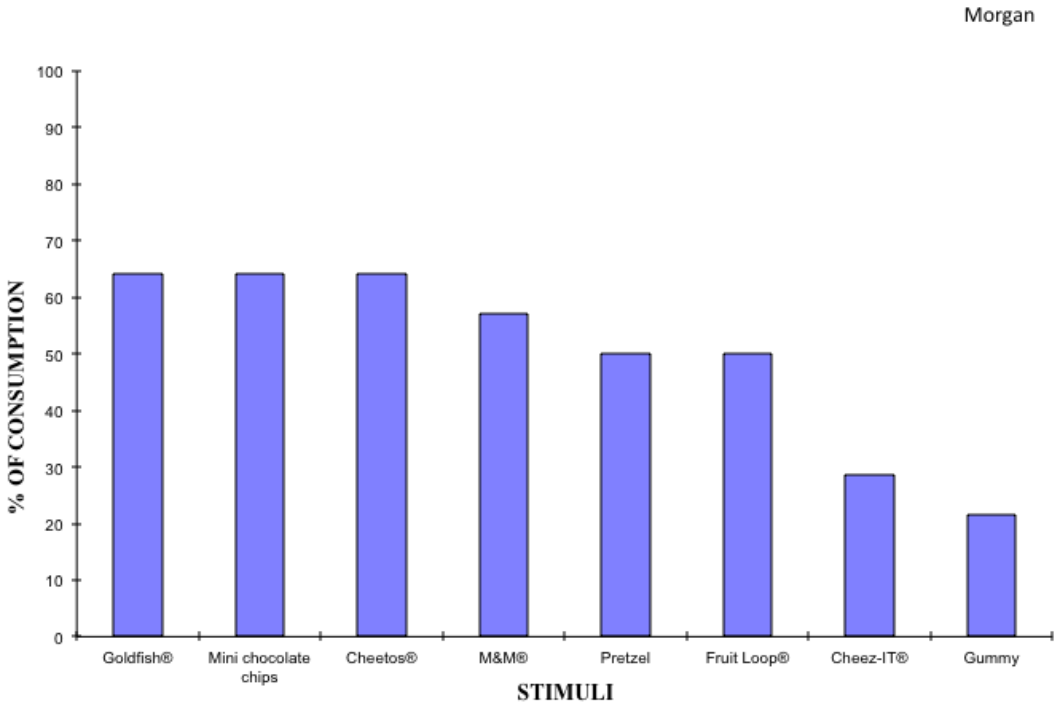

Figure 3. Results of paired choice preference assessment for Morgan

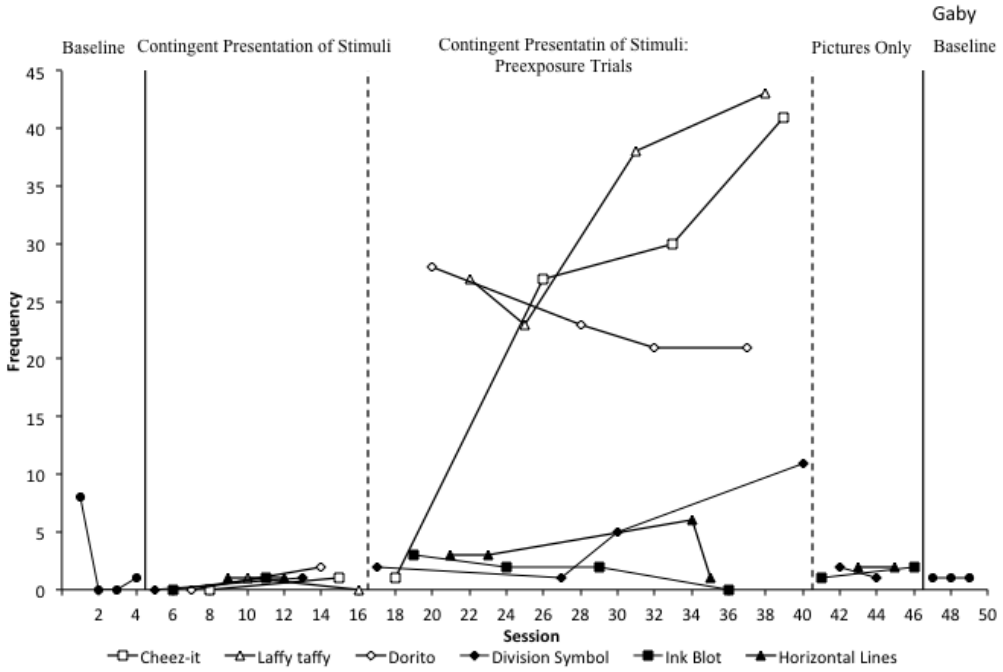

Figure 4. Response frequency in reinforcer assessment for Gaby

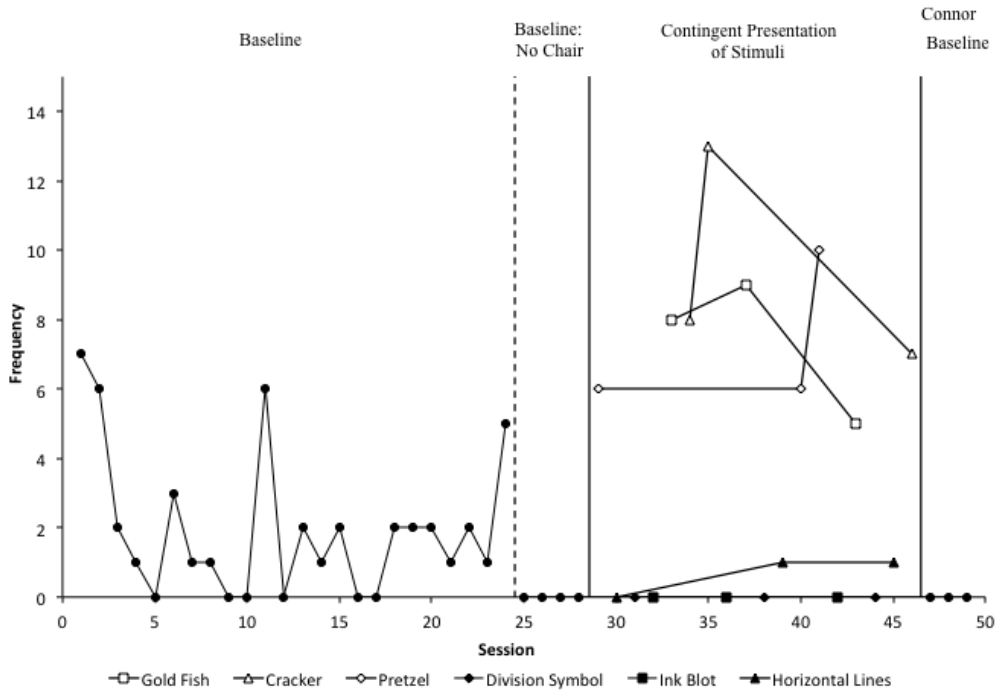

Figure 5. Response frequency in reinforcer assessment for Connor

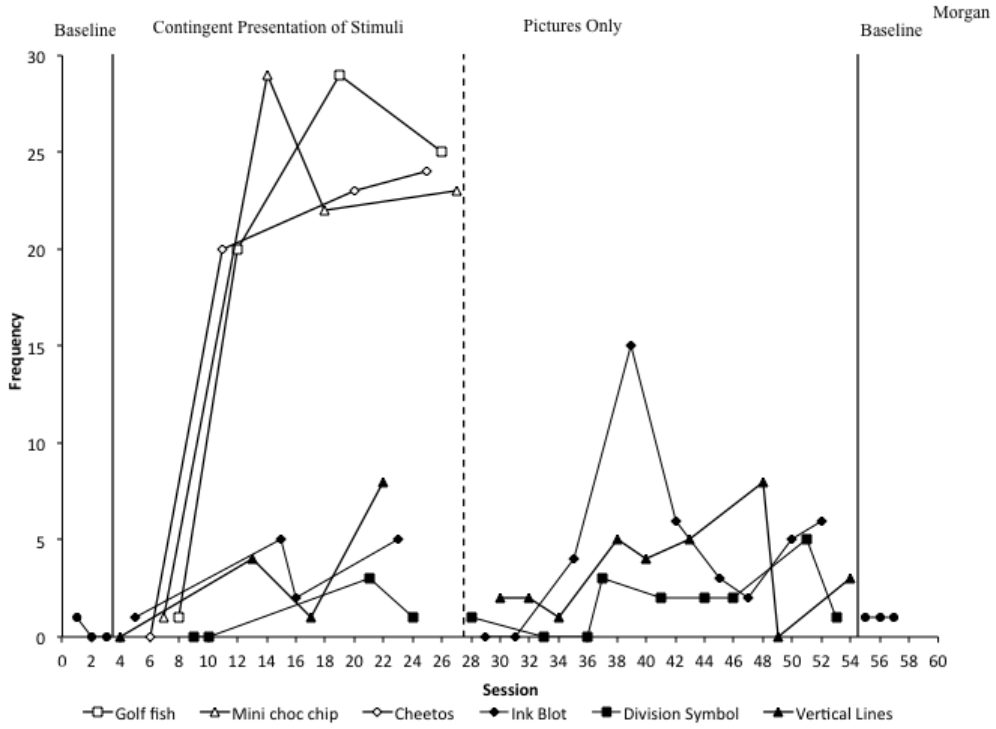

Figure 6. Response frequency in reinforcer assessment for Morgan

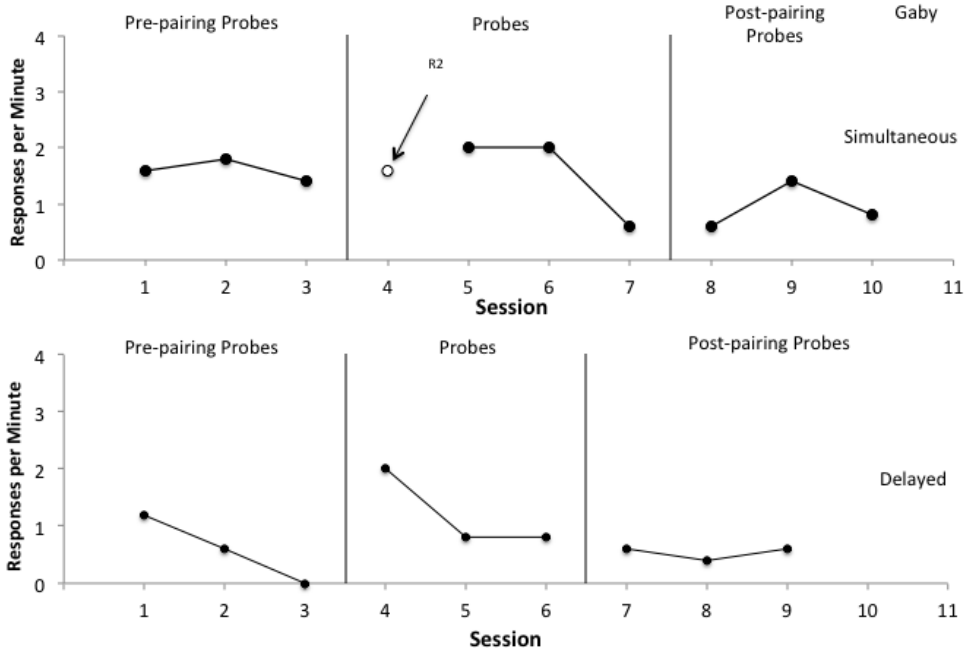

Figure 7. Rate of responding of simultaneous pairing response (top panel) and delayed pairing response (bottom panel) during probe sessions for Gaby

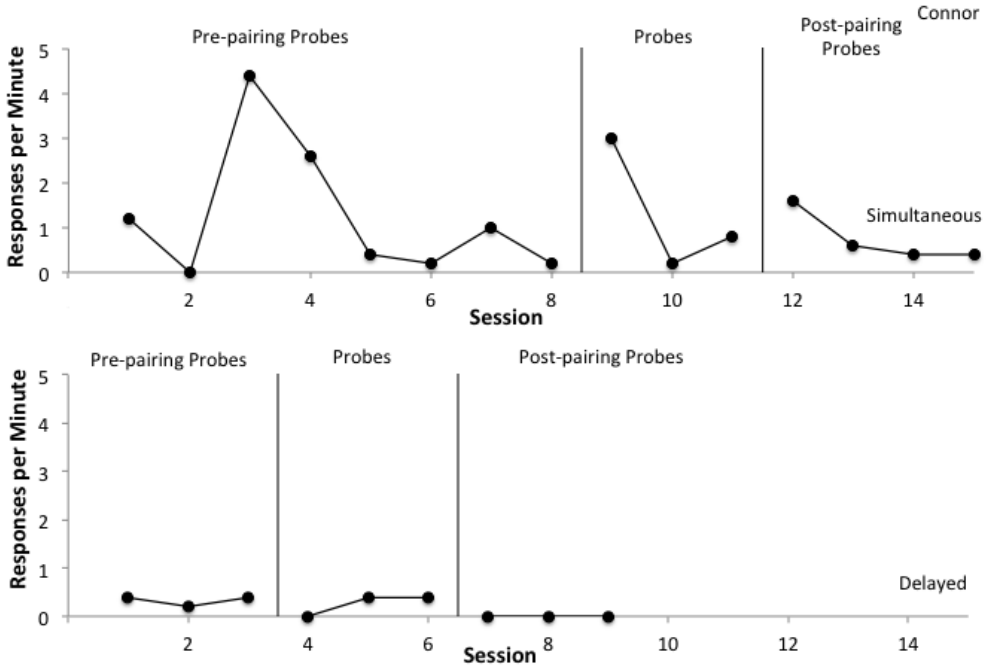

Figure 8. Rate of responding of simultaneous pairing response (top panel) and delayed pairing response (bottom panel) during probe sessions for Connor

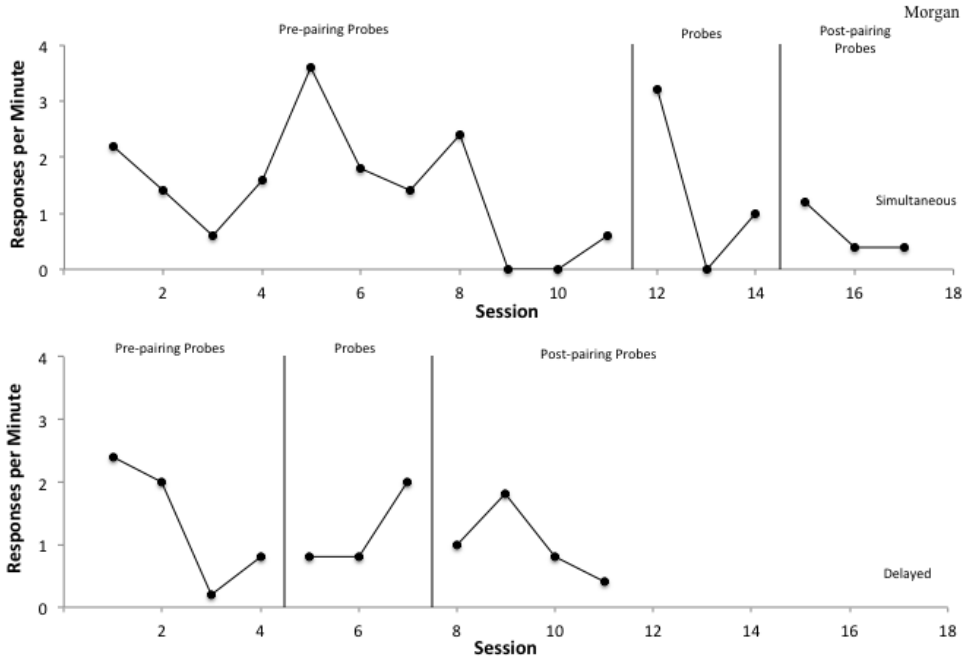

Figure 9. Rate of responding of simultaneous pairing response (top panel) and delayed pairing response (bottom panel) during probe sessions for Morgan

Footnotes

[1] Inter-observer agreement was 0% for one session in which the primary data collector scored zero responses and secondary data collector scored one response.