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A DISCRIMINATION TRAINING PROCEDURE TO ESTABLISH CONDITIONED REINFORCERS FOR CHILDREN WITH AUTISM†

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Although conditioned reinforcers are used in many behavioral intervention programs for individuals with developmental disabilities, little research has been conducted to determine optimal methods for establishing conditioned reinforcers. An early method that has received relatively little research attention is to condition a neutral stimulus as a discriminative stimulus and then use the stimulus as a programed consequence during skill acquisition. The current study evaluated the effects of a discrimination training procedure on establishing conditioned reinforcers for three children with autism. For all participants, previously neutral stimuli reinforced behaviors after acquiring discriminative properties during discrimination training. Copyright © 2014 John Wiley & Sons, Ltd.

Identification of reinforcers is an essential step in the development of interventions for individuals with autism. Over the last 30 years, a large body of research on preference assessments has been established, providing clinicians with a research-based technology for identifying stimuli to use as reinforcers during teaching (e.g., DeLeon & Iwata, 1996; Fisher et al., 1992). However, an important goal for this population is often not just increased appropriate responding maintained by *any* type of reinforcers but also appropriate responding maintained by natural reinforcers. This may be challenging for clinicians because stimuli that function as reinforcers for typically developing people often do not function as reinforcers for individuals with developmental disabilities (Charlop, Kurtz, & Casey, 1990; Harper, Symon, & Frea, 2008; Lohrmann-O'Rourke & Browder, 1998). Consequently, intervention manuals for children with autism often recommend pairing the delivery of known reinforcers (e.g., popcorn) with neutral stimuli (e.g., praise) to establish new, conditioned

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reinforcers (e.g., Anderson, Taras, & Cannon, 1996; Barbera, 2007; Leaf & McEachin, 1999; Sundberg & Partington, 1998). Unfortunately, guidance provided by such manuals typically consists of instructions to 'pair' or present 'simultaneously' and does not include specific information about the optimal schedule or sequence of stimuli, what stimuli to present, or how to evaluate the effectiveness of a pairing procedure.

The lack of specific recommendations about how to arrange or evaluate pairing should not be surprising, as there is currently no well-developed, research-based technology on establishing conditioned reinforcers to guide clinicians. Such a technology would be particularly relevant for children with autism because of the importance of establishing social stimuli as reinforcers. For example, Klintwall and Eikeseth (2011) found a positive relation between social reinforcers and outcome after a year of early intensive behavioral intervention.

A review of the research on establishing conditioned reinforcers with clinical populations suggests that there are a number of methodological variables that warrant consideration and should guide future research in this area. Of particular importance is the type of pairing procedure used. Using a respondent conditioning conceptualization, the pairing methods have been grouped by some researchers according to the temporal and sequential arrangement of the neutral stimulus and reinforcer. Trace pairing consists of the neutral stimulus being presented and then terminated before the presentation of the reinforcing stimulus (e.g., Birnbrauer, 1971; Girardeau, 1962; Levin & Sterner, 1966). Simultaneous pairing consists of a reinforcing stimulus and a neutral stimulus being presented and terminated at the same time (e.g., Ardoin, Martens, Wolfe, Hilt, & Rosenthal, 2004; Miller & Drennen, 1970). Delay pairing consists of a neutral stimulus being presented before and with some overlap of the presentation of the reinforcing stimulus (e.g., Holth, Vandbakk, Finstad, Grønnerud, & Sørensen, 2009). In response–stimulus pairing, the neutral stimulus and reinforcer are presented together (in one of the previously mentioned arrangements) contingent upon a response (e.g., Dozier, Iwata, Thomason-Sassi, Worsdell, & Wilson, 2012). Although each of these studies has produced conditioned reinforcers, a fifth type, a discrimination training procedure, may be superior to these methods.

In the typical discrimination training arrangement, the neutral stimulus is first established as a discriminative stimulus (S^D) by reinforcing a specific response in its presence. Next, the new S^D is tested as a conditioned reinforcer by delivering it contingent upon a response and comparing responding before and after discrimination training. After failing to see the effectiveness of simultaneous pairing, Lovaas et al. (1966) used the discrimination training procedure and demonstrated that 'good' was established as a conditioned reinforcer after being established as an S^D for food with two 'schizophrenic' children. Lauten and Birnbrauer (1974) demonstrated the effectiveness of the discrimination training procedure to establish vocal praise as a conditioned reinforcer with boys with 'mental retardation'.

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More recently, Isaksen and Holth (2009) used the discrimination training procedure with four children diagnosed with autism to establish smiles and nods as S^Ds for reinforcement; however, neither was tested for reinforcing properties. Holth et al. (2009) compared the discrimination training procedure used in Isaksen and Holth to a delay pairing method with children with autism, children with Down's syndrome, and typically developing children. Results showed that although responding increased in both conditions, the discrimination training procedure resulted in more responses for five out of seven of the participants (two out of the four children with autism).

One aspect of the discrimination training procedure that has not been examined in the context of establishing conditioned reinforcers with clinical populations is the development of a specific stimulus as an S-delta while establishing the S^D. In the absence of the S^D, studies have arranged for the target response to be blocked (e.g., Holth et al., 2009) or extinguished (e.g., Lovaas et al., 1966). However, a specific S-delta was never paired with these contingencies. Some research indicates that alternating the presentation of S^D and S-delta may result in faster discrimination (e.g., Myers & Myers, 1963; Smith, 1972; Steinman, 1968). A similar procedure has also been recently used in the stimulus–stimulus pairing literature to increase vocalizations of children with autism (e.g., Esch, Carr, & Grow, 2009).

Prior to establishing a conditioned reinforcer, it is important to demonstrate that the stimulus to be conditioned is, in fact, neutral. Of the studies evaluating pairing procedures with clinical populations, only Holth et al. (2009) and Dozier et al. (2012) conducted formal assessments to do this. Dozier et al. employed a multi-element design during the first phase of their study in which baseline (nothing delivered contingent on a specific response) was compared with praise alone (praise delivered upon the response) and demonstrated that praise was a neutral stimulus. Other studies conducted informal observations to provide support for the neutrality of the stimuli. It is similarly important to demonstrate that the 'known reinforcers' actually have reinforcing effects. Only Holth et al. and Dozier et al. conducted a formal reinforcer assessment; other studies conducted parent interviews to identify putative reinforcers (e.g., Isaksen and Holth) or incorporated restricted access to the stimuli outside of experimental sessions to establish reinforcing value (e.g., Lovaas et al.).

Finally, it is important to demonstrate the operant level of all responses prior to pairing. If a reinforcement effect is later observed, this assessment provides support for attributing these effects to the pairing procedure alone. Furthermore, the use of a new response (i.e., different than during pairing) to evaluate the reinforcing value of conditioned stimuli eliminates the possibility that reinforcement during the conditioning procedure might account for increases in the rate of responding (Skinner, 1938). A number of studies have used the new-response method (e.g., Girardeau, 1962; Levin & Sterner, 1966; Lovaas et al., 1966; Miller & Drennen, 1970), but only one study with clinical populations (i.e., Holth et al., 2009) formally assessed responding prior to pairing.

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Although it is known that neutral stimuli can be established as conditioned reinforcers via a pairing process, more research is warranted. Thus, the purpose of the current study was to use a multiple-probe design across stimulus/response sets to evaluate the effects of a discrimination training procedure on the reinforcing effectiveness of neutral stimuli. Pretests were conducted to demonstrate neutrality of the stimuli and responses as in Holth et al. (2009). An S^D and S-delta were established for the same response during discrimination training, and the reinforcing potency of the stimuli established as S^Ds was tested using new responses. To demonstrate the effectiveness of this preparation, replications were conducted across and within participants.

METHOD

Participants

Three children diagnosed with autism (American Psychiatric Association, 2000) by a clinician independent from the researchers participated in the study: Marc (six years and three months old), Joe (six years and one month old), and Robyn (six years and nine months old). Participants were selected based on the following: (i) having a diagnosis of autism; (ii) tolerating manual prompts without engaging in aggression, disruption, or self-injurious behavior; and (iii) being able to remain seated for 5 min while engaged in an activity. This information was first ascertained during a caregiver interview and confirmed via direct observation. All participants attended a self-contained classroom in a public school for 6.5 h each day. Joe and Robyn were in the same classroom, and Marc was in the same grade but was in a different self-contained classroom in the same building.

The *Assessment of Basic Language and Learning Skills—Revised* (Partington, 2006) was conducted with each participant by the classroom teacher prior to the study. Results indicated that all participants were able to mand for at least five high-preference items vocally (Marc and Joe) or with signs (Robyn) and demonstrated generalized identity matching and generalized imitation. According to teacher report, all three participants had a limited selection of nonedible stimuli that functioned as reinforcers.

Materials and Setting

A maximum of two 30-min sessions were conducted per day approximately four days per week. Sessions were conducted in a 2.74- by 1.83-m room at the participants' school that was quiet and free from distractions. The room contained various school materials, including a table and chairs. Materials for the study included a video camera for primary and secondary data collection, a timer, a piece

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of paper for the paper-touch response, a digital picture frame, and preferred edibles stored in an opaque container. An apparatus was built for the current study to hold response switches used during the response assessment, discrimination training, and pretest and posttest sessions. The apparatus was a 38.1- by 55.9- by 7.6-cm wooden box with a 6.4- by 10.2-cm rectangle cut out of the top and a round 1.3-cm hole on the right panel near the back where a light bulb was located. Under the apparatus was a 9-V battery. In the rectangular hole, circuit boxes could be placed and removed easily. Each circuit box housed a switch with two wires that were connected to the battery and the light bulb. The circuit box also had two wings on opposite corners that could be flipped in order to hold the box in place. Visual stimuli were two-dimensional pictures shown on the 15.2- by 8.9-cm screen of a Shomi® digital picture frame. The apparatus, switches, and visual stimuli are depicted in Appendix A. The picture frame was controlled by a remote control device operated by the experimenter.

Preexperimental Procedures

Preference Assessment

Prior to the study, a survey was administered to each participant's caregivers that asked questions about their child's preferred edibles, food allergies, and approval to restrict access to high-preference items to experimental sessions. Based on the answers from this survey, eight items were assessed in a multiple stimulus (without replacement) preference assessment (MSWO; DeLeon & Iwata, 1996). The five highest ranked items were selected to be evaluated in a subsequent reinforcer assessment (refer to stimulus assessment in the succeeding texts).

Response Assessment

The purpose of this assessment was to identify nine low-rate responses that could later be used during discrimination training and pretest and posttest sessions. The nine response switches are depicted in Appendix A. Responses were selected that the participants could easily be prompted to perform and to which they had no prior exposure. At the beginning of each response assessment session, the participant was manually prompted to engage in the response and was then instructed, 'Do whatever you like, but please stay in your chair'. No programed consequences were delivered following responses. Using the procedures described by Holth et al. (2009), responses were selected to be used during the study if no responses occurred during the last 30 s or if the participant left the chair (i.e., moved 30 cm or more away from the chair) at any point during the 5-min session.

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Stimulus Assessment

The purpose of this assessment was to identify neutral stimuli to be established as S^Ds and S-deltas during the study and reinforcing stimuli to be used during discrimination training (note: the terms S^D and S-delta are used to describe stimuli that are being programed as such). For the neutral stimuli, a search was conducted on Google Images (www.google.com/imghp) for pictures that did not have a specific name and to which the participants would likely have no history of exposure. Several behavior analysts were consulted and assisted in selecting the stimuli. Caregivers were then asked to rank the stimuli on a Likert-type scale from 1 to 5, with 1 indicating their child would be very uninterested in the picture and 5 indicating their child would be very interested in the picture. The stimuli with the lowest ranking scores were assessed first until six stimuli were identified as potentially neutral.

For the reinforcers, the five highest ranked edible items that were identified during the MSWO preference assessment were tested. During the assessment, a baseline consisting of 1-min sessions was conducted in which the participant was manually prompted to touch a piece of paper placed in front of him/her two times. The participant was then instructed, 'Do whatever you like, but please stay in your chair'. No programed consequences were delivered contingent upon paper touches. Next, the 1-min sessions continued in a multi-element design, with a different stimulus delivered contingent upon paper touches in each session. Finally, a reversal to baseline was conducted. Stimuli were selected as 'neutral stimuli' for the study when the response frequency remained consistently low during all sessions. Stimuli were selected as reinforcers when the response frequency increased substantially when the stimulus was presented contingent on the response, and the response frequency decreased during a return to baseline.

Experimental Design and Data Collection

A multiple-probe design across stimulus/response sets was used to evaluate the effects of the discrimination training procedure on responding. Each stimulus/response set was evaluated during pretest and posttest conditions. S^D/S-delta pairs were established by pairing stimuli with similar frequencies of responding during the neutral stimulus assessment and then quasi-randomly assigning them as S^Ds or S-deltas for each stimulus/response set. An example of stimulus and response assignment (for Robyn) is shown in Table 1.

During free-operant pretest and posttest sessions, data were collected on the frequency of responses when the S^D was delivered contingent upon one response and on the frequency of responses when the S-delta was delivered contingent upon a different response. These data were collected from video and summarized as the frequency of responding per min during each 5-min session. One response was

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Table 1. Stimuli and response assignments for Robyn.

		Set 1	Set 2	Set 3
S^D	Stimulus	Sound waves	Ink blots	Sideways division sign
	Response	Pull	Frankenstein	Left/right toggle
S-delta	Stimulus	Plaid	Horizontal lines	Sand
	Response	Sideways turn	Red button	Turn
Discrimination training	Response	Light switch	Rocker	Horn

recorded when the light turned on or off (for the horn, one response turned the light on and off). The light system (i.e., bulb, battery, switch, and wires) was tested before every session by the experimenter to ensure that the light was functioning properly and would accurately indicate a response. The light on the apparatus was used as an indicator of each response to the experimenter but could not be seen by the participant.

During discrimination training sessions, data were collected per trial on independent responses that occurred within 3 s of the presentation of the S^D and S-delta. These data were summarized as the percentage of trials with a correct independent response per condition in each session.

Experimental Procedures

Pretest

S^D and S-delta sessions were conducted in quasi-random order. At the beginning of each session, the response was prompted twice with the neutral stimulus (to be established as the S^D or S-delta) delivered contingent upon each response. After the second prompted response, the participant was instructed, 'Do whatever you like, but please stay in your chair'. The neutral stimulus was then delivered for 2–4 s contingent upon every subsequent response. Each session lasted for 5 min, and sessions were conducted until responding stabilized across five sessions in each condition. This served as the baseline.

Discrimination Training

The purpose of this condition was to establish one stimulus as an S^D and one stimulus as an S-delta (for each set of stimuli). Each discrimination training session consisted of 10 trials. During the first step of discrimination training, a neutral stimulus was established as an S^D. The participant sat at a table with the experimenter standing behind and to the right of him/her at a 45° angle. Before each session, the experimenter displayed five edible reinforcers to the participant and asked, 'Which would you like?' Once the participant selected an edible, the apparatus was placed

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in front of the participant, and the digital picture frame was placed on the apparatus in front of the operandum to block access to the switch. The neutral stimulus was then presented for 2 to 4 s on the frame as a digital picture. The frame was then lifted and placed behind the operandum to allow access to the switch. If a response did not occur within 3 s, the participant was prompted to engage in the response, and the reinforcer was delivered. Prompts were systematically faded across trials by fully manually prompting for two trials, tapping on the student's arm for two trials, and presenting a gesture prompt for two trials. If at any point a prompt was insufficient to produce the response, the previous prompt level was implemented for two additional trials. If the participant engaged in multiple responses with the operandum (e.g., flipping the switch up and down more than two times) or if he/she attempted to engage in an incorrect response with the operandum (e.g., hitting the button with a foot), the response was blocked, and the participant's hands were manually guided to the table for 2 s. The participant was then manually prompted to engage in the response one time with a reinforcer being delivered contingently. After each correct independent response, the edible selected by the participant was delivered, and the picture frame was replaced in front of the operandum. After 100% correct independent responding occurred for two consecutive sessions across two days, the second step of training was initiated.

During the second step of discrimination training, a different stimulus was established as an S-delta. Differential reinforcement was arranged such that responding was reinforced in the presence of the stimulus from the first step (S^D) and not reinforced in the presence of this new stimulus (S-delta). S^D trials (conducted identical to those in Step 1) were interspersed with S-delta trials with both stimuli being presented equally in quasi-random order (Smith, 1972). The S-delta was presented for 2 to 4 s, and the digital frame was lifted and placed behind the operandum. If a response occurred, the trial was terminated, and the blank picture frame was placed in front of the operandum. If a response did not occur within 4 s, the trial was terminated, and the blank picture frame was placed in front of the operandum. The intertrial time between trials was 4–6 s. Sessions consisted of 20 trials with 10 S^D presentations and 10 S-delta presentations. The criterion for beginning the posttest condition was two consecutive sessions with 100% correct independent responding during both S^D and S-delta trials across two days. When responding in one stimulus condition reached criterion before the other, discrimination training continued until responding in each condition reached criterion.

Posttest

Following discrimination training, posttest sessions were conducted to determine the effects of discrimination training on the stimuli (i.e., determine if the S^Ds functioned as

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conditioned reinforcers and the S-deltas did not). Sessions were conducted as in the pretest condition.

Interobserver Agreement

Interobserver agreement (IOA) during preexperimental assessments and pretest and posttest phases was calculated using the exact agreement method (the number of 30-s interval agreements divided by the number of 30-s interval agreements plus disagreements multiplied by 100). An agreement was defined as each data collector scoring the same number of responses during a 30-s interval. At least 50% of randomly selected sessions were scored during each assessment and during pretest and posttest phases for each participant. IOA was 100% for all participants except for Joe's posttest sessions ($M = 99.4\%$; range, 90–100%).

IOA during discrimination training was calculated by dividing the number of agreements in a session by the number of agreements plus disagreements multiplied by 100%. These data were collected for 50% of randomly selected sessions, and IOA was 100% for all three participants.

Procedural Integrity

During the preexperimental assessments, the pretest sessions, and the posttest sessions, procedural integrity data were collected on the following: (i) initial prompting of the response and delivery of the stimulus and (ii) delivery of the stimulus contingent upon subsequent correct independent responses. These data were collected using 30-s interval recording and summarized as the percentage of intervals with correct implementation of procedures. Procedural integrity data were collected for 56% of response assessment sessions and 50% of pretest and posttest sessions for all participants. During the reinforcer/neutral stimulus assessment, procedural integrity data were collected during 50% of sessions for Joe and Robyn and during 51% of sessions for Marc. All sessions were scored with 100% of intervals with correct implementation of procedures.

Procedural integrity data were collected during 50% of discrimination training sessions for all participants. Procedural integrity data were collected on the following: (i) presentation of the neutral stimulus; (ii) prompting of the response; (iii) prompt level used; (iv) delivery of the reinforcer contingent on the response during S^D trials; and (v) nondelivery of the reinforcer during S-delta trials. These data were collected trial by trial and summarized as the percentage of trials with correct implementation of procedures. All sessions were scored with 100% of trials implemented correctly. IOA on procedural integrity data was collected during at least 33% of randomly selected sessions across all phases, and agreement was 100% for each participant.

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RESULTS

During the stimulus assessment, similar patterns of responding were obtained for all participants. As seen in representative data for one participant in Figure 1, Marc did not engage in the target response when no programed consequences were delivered. When arbitrary stimuli were delivered contingent upon the target response, his rate of responding remained at near-zero levels ($M = 0.5$; range, zero–two responses). When edibles were delivered contingent upon the target response, his rate of responding increased substantially above arbitrary-stimulus levels ($M = 19.6$; range, 12–26 responses). Stimulus assessment data for the other participants are available from the corresponding author upon request.

Discrimination training data for all participants are depicted in Figure 2. As can be seen in the top panel, Joe's responding in Sets 1, 2, and 3 showed rapid mastery (i.e., three sessions) during Step 1. During Step 2, discriminated responding occurred quickly (i.e., four–six sessions) for all three sets. As can be seen in the middle panel, Marc required more sessions than Joe but showed rapid mastery of Step 1 (i.e., three–four sessions) and Step 2 (i.e., four–eight sessions). As can be seen in the bottom panel, Robyn required more sessions than Joe and Mark to reach criterion during Step 1 (i.e., 3–11 sessions) and Step 2 (i.e., four–nine sessions). Her rate of responding during Step 1 increased to criterion during session 10, concurrent with a change in the size of the reinforcer to an entire goldfish cracker instead of ¼ of a goldfish cracker. Interestingly, as observed with Marc and Joe, Robyn's responding reached the mastery criterion in fewer sessions with Sets 2 and 3.

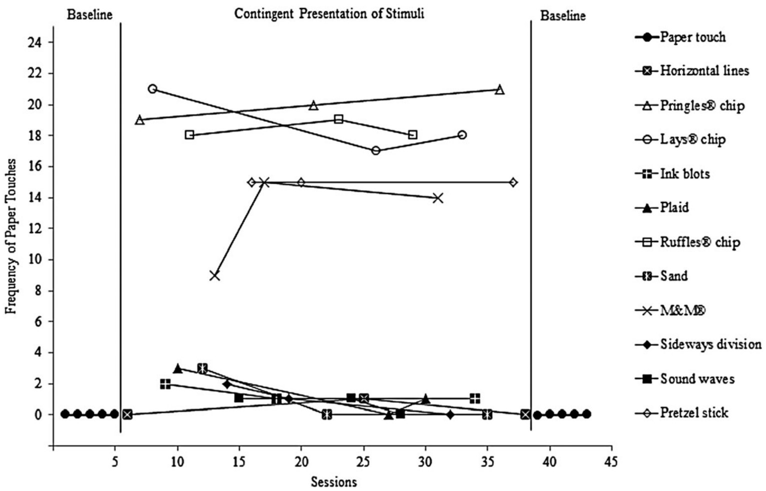

Figure 1. Stimulus assessment data for Marc.

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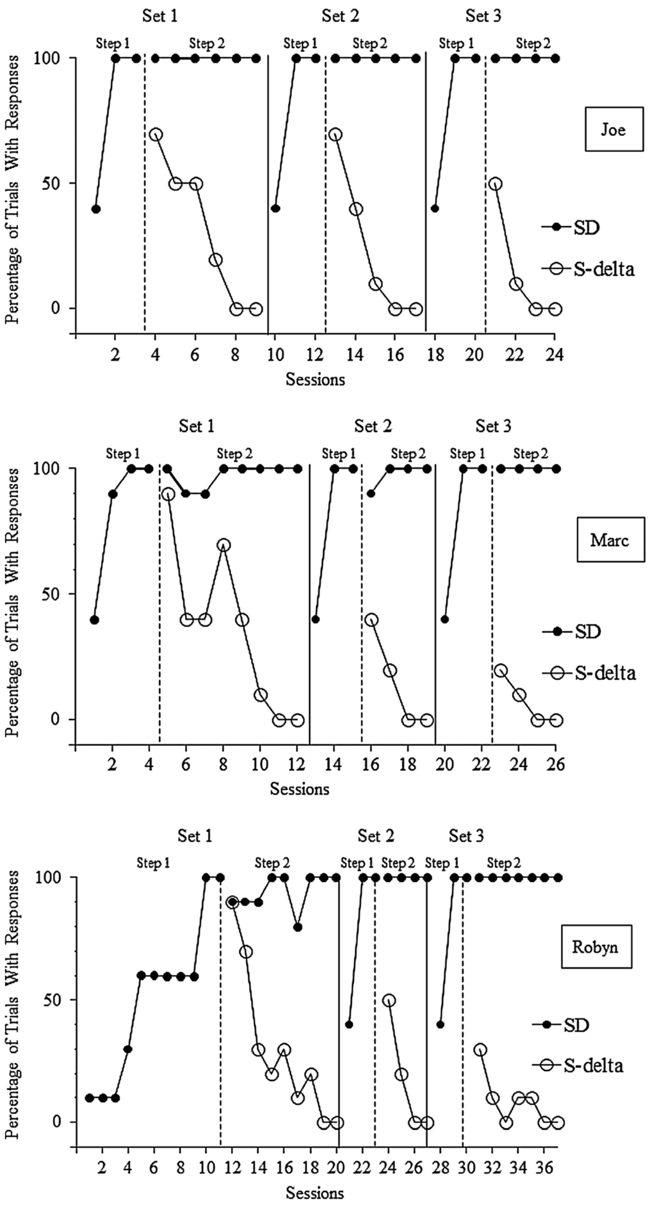

Figure 2. Discrimination training data for Joe (top), Mark (middle), and Robyn (bottom).

Pretest and posttest data for Joe are depicted in Figure 3. Similar patterns of responding were observed across stimulus sets. During pretest sessions, his rate of responding was low and stable. Following discrimination training, his responding in S^D sessions

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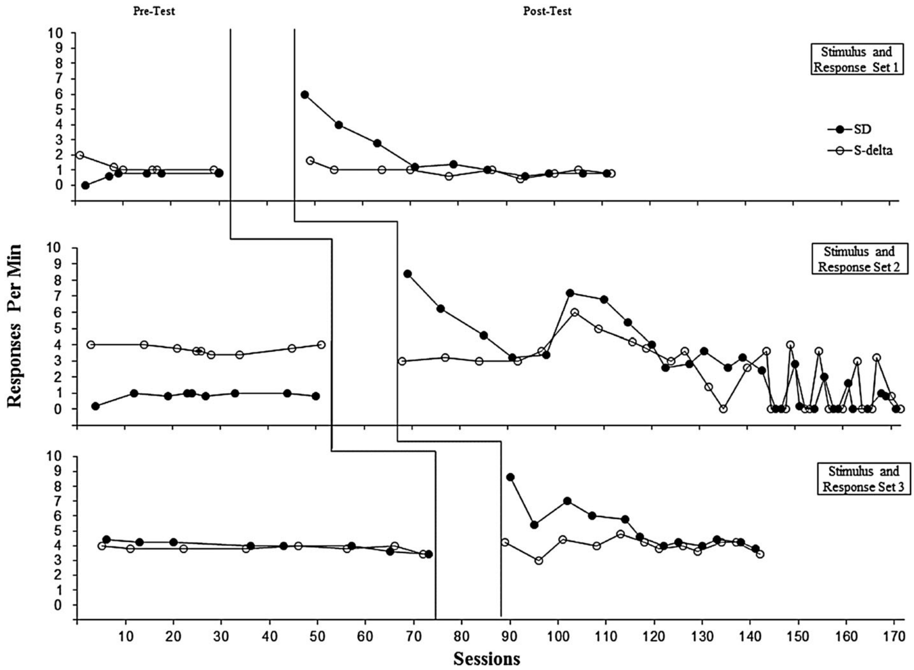

Figure 3. Joe's rate of responding across stimulus/response sets prediscrimination and postdiscrimination training.

increased, while his responding during S-delta sessions remained similar to pretest sessions. Although his level of responding during S-delta pretest sessions was sometimes higher than during S^D pretest sessions, his level was consistent and did not increase following discrimination training. During S^D posttest sessions, Joe's rate of responding eventually decreased over consecutive sessions to near or below pretest levels.

Pretest and posttest data for Marc are depicted in Figure 4. As observed with Joe, similar patterns of responding were observed across stimulus sets, with low, stable responding during pretest sessions and increased responding in only S^D sessions of the posttest. Marc's responding decreased over consecutive sessions to near or below pretest levels during S^D sessions. Interestingly, during Set 1, his rate of responding during the posttest increased concurrent with implementation of the posttest for Set 2. However, as observed with Sets 1 and 3, his rate of responding subsequently decreased.

Pretest and posttest data for Robyn are depicted in Figure 5. As observed with Joe and Marc, similar patterns of responding were observed across stimulus sets with low, stable responding during pretest sessions and increased responding in only S^D sessions of the posttest. Robyn's rate of responding decreased rapidly to pretest levels during S^D sessions within one to two sessions.

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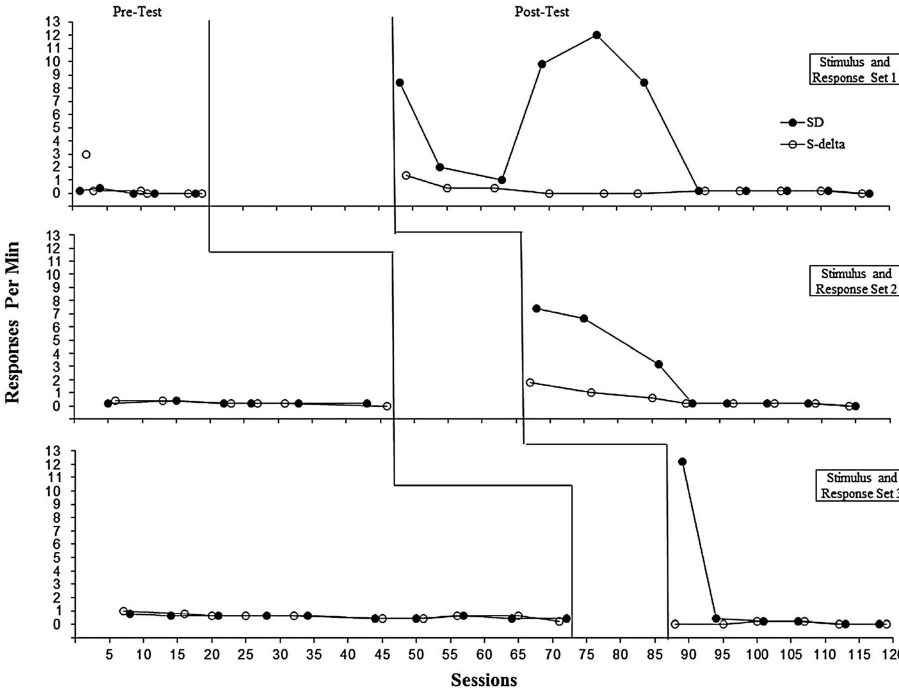

Figure 4. Marc's rate of responding across stimulus/response sets before and after discrimination training.

Representative within-session data during posttest S^D sessions for one participant, Joe, are depicted in Figure 6. Joe's (Set 1) responding during the initial minutes of the first two posttest sessions was higher than in subsequent sessions. Interestingly, responding decreased over the course of each session and then increased at the beginning of the next session. Although not shown, similar patterns of within-session responding were observed with Marc and Robyn across sets (data available upon request).

DISCUSSION

The current study evaluated the effects of a discrimination training procedure on the reinforcing effectiveness of arbitrary stimuli with children with autism. Specific procedures were incorporated to increase methodological rigor relative to earlier studies (i.e., use of novel responses, stimulus assessments, and extended pretests to demonstrate neutrality of the stimuli and responses, two within participant replications) and enhance differential responding (i.e., alternation of S^D and S-delta trials). For all three participants, responding in the S^D condition increased during all three posttest evaluations and remained low in the S-delta condition.

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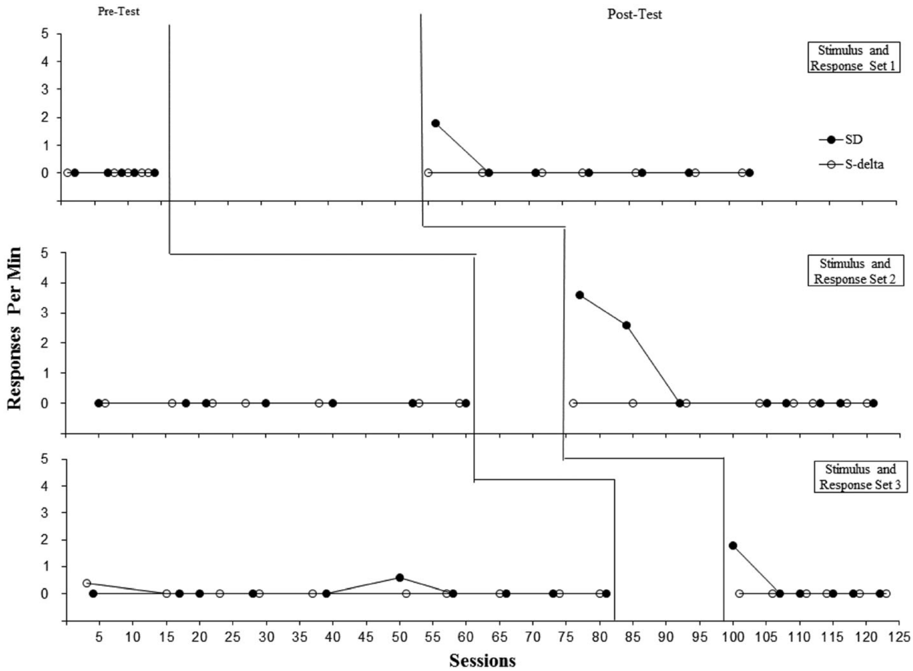

Figure 5. Robyn's rate of responding across stimulus/response sets before and after discrimination training.

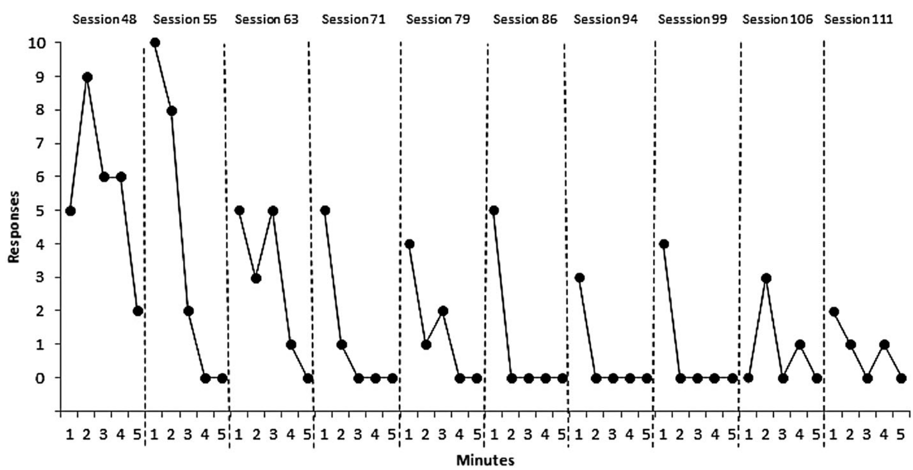

Figure 6. Joe's responding per min for posttest S^D Set 1.

The discrimination training procedure used in the current study was a relatively quick (i.e., 28–53 min per set) and effective procedure for establishing stimuli as S^Ds and S-deltas for all participants. The alternation of S^D and S-delta trials (rather

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than S^D trials alone) may offer an advantage by increasing stimulus salience (Esch et al., 2009). In addition, responding during S-delta trials provided a comparison to demonstrate a differential increase in responding during S^D trials. The discrimination training procedure in the current study also differed from that of previous studies in that the response did not produce direct reinforcement; rather, the response was arbitrary, and the reinforcer was delivered by another person. For example, the response used in Lovaas et al. (1966) was the participant walking over to the experimenter and retrieving the edible, and the response used in Holth et al. (2009) required the participant to take the preferred item. Although direct reinforcement could possibly lead to more immediate reinforcer delivery, the current preparation was, nevertheless, effective. During discrimination training, several anecdotal observations are worth mentioning. First, during the initial Step 2 S-delta trials of Set 1, participants often turned to look at the experimenter after responding as if preparing to receive an edible (as they did during the S^D trials of the training). Interestingly, this was sometimes followed with a succession of quick responses, a pattern typical of an extinction burst.

A second noteworthy anecdotal observation during discrimination training is that Joe seemed to tact some of the features of the visual stimuli. During Step 2 of training for Set 1, in the presence of the S^D ink blots, he said, 'squiggles', and in the presence of the S-delta sand, he said, 'brown bumps'. Later, during the Set 1 posttest, he similarly seemed to mand for the presence or absence of these stimuli saying, 'Go, squiggles, go' and 'Brown bumps, no'. Similarly, Joe seemed to tact the three horizontal lines 'line-line-line' and the sideways division sign 'dot dot down'. Manding for the occurrence of the S^D and the nonoccurrence of the S-delta in between trials may provide support for the function of the S^D as a reinforcer. It may also suggest that Joe had developed rule-governed behavior about the functions of these stimuli.

Third, Robyn required more trials to meet criterion during discrimination training in Step 1 of Set 1 than during Step 1 of Sets 2 and 3. Further, Robyn required more trials to meet criterion during discrimination training than did the other participants. When reinforcer magnitude was increased during session 10 of discrimination training, responding increased. There are two reasons that this change in reinforcer magnitude may have been effective. Considering Robyn did not respond during the majority of her pretest sessions, perhaps the response effort was too great for the magnitude of the reinforcer being delivered. It was also noted that during several of the sessions prior to session 10, Robyn played with the crumbs of the goldfish that had fallen from the broken pieces onto the table or the chair. As Robyn had been observed playing with small pieces of material in other settings, perhaps the crumbs served as a competing reinforcer. The differences in Robyn's responding during discrimination training are also noteworthy in light of her communication deficits (i.e., signing) compared with the other participants (i.e., vocal communication).

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The rate of responding for all three participants for all three stimulus/response sets increased from pretest to the initial posttest sessions. This indicates that the discrimination training procedure was effective in establishing these stimuli as conditioned reinforcers. The duration of time that the stimulus functioned as a reinforcer during unpairing (i.e., posttest) differed for each participant, with the fewest number of sessions until responding returned to pretest levels for Robyn and the most sessions for Joe. As additional evidence that the visual stimulus was serving as a reinforcer, within-session responding occurred in a scalloped pattern (i.e., first data point of a subsequent session being higher than the last data point in the previous session), similar to patterns observed in spontaneous recovery during respondent extinction (Pierce & Cheney, 2008).

Interestingly, Marc's responding during posttest sessions for all three sets stabilized at below baseline levels (i.e., baseline: 0.2, posttests: zero responses per min). It is possible that engaging in the response was at first minimally automatically reinforcing, but continued engagement in the response reduced the value of the automatic reinforcement. It was also noted that for Marc's Set 1 posttest, responding during S^D trials increased in the fourth posttest session concurrent with the posttest for Set 2. It is possible that discrimination training for Set 2 affected responding in Set 1. A similar effect may have occurred with Joe in Set 2 after the introduction of Set 3.

Robyn's response rate was consistently lowest during pretest and posttest sessions for all three sets. It is interesting to note that during the majority of posttest sessions for Sets 1 and 2 and for a few of Set 3 S^D sessions, Robyn remained in her seat for the entire 5-min sessions. In contrast, during pretests for S^D and S-delta sessions and posttests for S-delta sessions, Robyn left her chair often within the first 30 s of the session. This may further indicate the reinforcing effectiveness of the S^D. Also, it appeared that Robyn was attending to the stimuli presented during the S^D sessions during posttests. One example of Robyn attending to the stimuli was that during the first S^D posttest for Set 2, Robyn traced the vertical line of the visual stimulus (i.e., sideways division sign) on the picture frame after the picture had disappeared. This indicates that she had at the very least attended to the stimulus and that this procedure with modifications may be an effective method to condition new reinforcers for her.

One potential limitation of the current study is that, because of scheduling issues, sessions were sometimes conducted with several days in between them. This may have slowed acquisition during discrimination training and/or produced faster decreases in responding during posttest sessions. Some evidence of this may be seen in the number of days between Robyn's first and second S^D posttest for Set 1 that was six days, while the number of days between Robyn's first and second S^D posttest for Set 2 was one day. Set 2 had responding during the second posttest session, while Set 1 had no responding during the second posttest session. Future studies should consider conducting sessions more closely together.

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As would be predicted based on previous research on conditioned reinforcement (e.g., Morningstar, Myers, & Myers, 1966; Myers, 1960), responding eventually decreased for all participants during the posttest condition. These orderly data indicate that an important next step in research is the development of methods for maintaining responding after pairing. Three other questions for future research concern optimal types of pairing, programing for generalization, and schedules of pairing. First, the current study demonstrated that the discrimination training method (along with other procedures) was effective in conditioning stimuli as reinforcers for children with autism. Additional research is needed comparing this procedure to other types of pairing to determine the optimal pairing arrangement for conditioning reinforcers. This may be particularly relevant for individuals with autism because of the commonly observed occurrence of restricted stimulus control (i.e., stimulus overselectivity; Lovaas, Schreibman, Koegel, & Rehm, 1971). In a typical delay pairing arrangement, it is possible that some learners with autism may not attend to any or all presentations of the neutral stimulus. The discrimination training method may provide an advantage over the delay method by requiring a response following every presentation of the neutral stimulus, which may function as an observing response (e.g., Grow & LeBlanc, 2013).

Second, the present study examined pairing a reinforcer with one type of neutral stimulus and used a fixed ratio 1 (FR-1) schedule of reinforcement for S^D presentations. Future research could program for generalization by conditioning many exemplars of the neutral stimulus. For example, if one is trying to establish praise as a reinforcer, varying the verbal stimuli used may produce a broader range of verbal stimuli that will have reinforcing effectiveness.

Last, several previous studies that investigated the discrimination training procedure to condition reinforcers evaluated the schedule of reinforcement used during discrimination training (e.g., Lauten & Birnbrauer, 1974; Lovaas et al., 1966; Morningstar et al., 1966; Myers, 1960; Myers & Myers, 1963). Myers and Myers examined the effects of different schedules of reinforcement on the effectiveness of the S^D as a conditioned reinforcer with typically developing children. Schedules of 100 and 50% were used when pairing a token with candy reinforcement. Although it is evident that an intermittent schedule of reinforcement was used, it is unclear whether an FR or variable ratio schedule was used. Results showed that the 50% reinforcement groups made more responses than the 100% reinforcement group. Lovaas et al. (1966) examined alternating between extinction and training trials during what would be comparable to the posttest of the present study. They found that this was effective in maintaining the reinforcing effectiveness of the previously neutral stimulus. Future studies might examine what ratio of extinction to training trials would be the most effective. Determining the most effective method for increasing the longevity of the reinforcing effectiveness of stimuli would be essential to creating a technology for conditioning reinforcers for individuals with autism. Such a

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technology would contribute to the ultimate goal of applied behavior analysis of maintaining responding in the natural environment for learners with impairments related to conditioned reinforcement.

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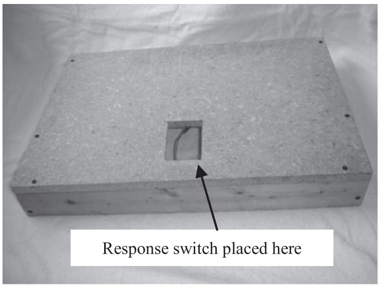
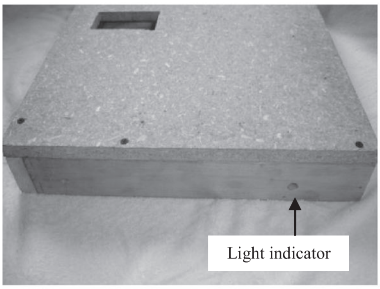
APPENDIX A:

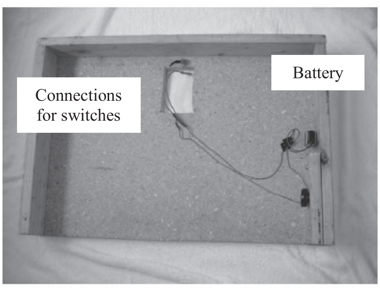
Apparatus



Front view

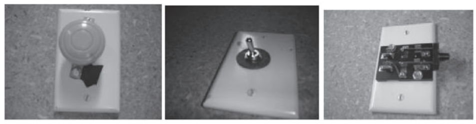


Side view

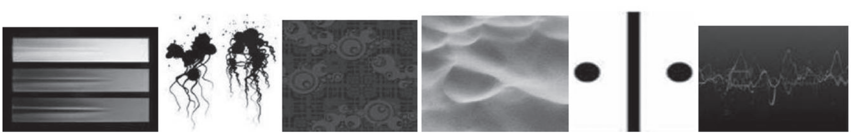


Bottom view

Response Switches



Visual Stimuli
(Stimuli 3, 4 and 6 were in color)



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