The Effects of Differential Reinforcement of Unprompted Responding on Skill Acquisition of Children with Autism

Amanda M. Karsten

Western Michigan University

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THE EFFECTS OF DIFFERENTIAL REINFORCEMENT OF UNPROMPTED RESPONDING ON SKILL ACQUISITION OF CHILDREN WITH AUTISM

by

Amanda M. Karsten

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Amanda Karsten
THE EFFECTS OF DIFFERENTIAL REINFORCEMENT OF UNPROMPTED RESPONDING ON SKILL ACQUISITION OF CHILDREN WITH AUTISM

Amanda M. Karsten, M.A.
Western Michigan University, 2007

The common recommendation to reserve the most potent reinforcers for unprompted responses during acquisition programming, sometimes referred to as differential reinforcement of independent responding, has little published empirical support for its purported benefits (enhanced rate of acquisition, decreased likelihood of errors and prompt dependence). The purpose of the current investigation was to compare the delivery of high-quality reinforcers exclusively following unprompted responses (differential condition) with the delivery of high-quality reinforcers following both prompted and unprompted responses (non-differential condition) on the rate of skill acquisition for two children with autism. Participants were taught multiple pairs of target skills (picture sequencing, tacting) using a discrete-trial preparation in conjunction with both differential and non-differential teaching procedures. Alternating treatments and reversal designs were used to evaluate the effects of both conditions on the rate of acquisition for each participant. Results demonstrate that the differential reinforcement procedure reliably produced skill acquisition whereas the non-differential reinforcement procedure did not.
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INTRODUCTION

Efforts to design and validate interventions that promote the acquisition of independent social, self-care, and academic skills among children with autism remain a central topic of study in behavior analysis (Bibby et al., 2001; Green, Brennan, & Fein, 2002; Smith, 1999). Early and intensive behavioral intervention (EIBI) for children with autism, in its most comprehensive form, is characterized by the presentation of thousands of training trials administered over the course of approximately 20-40 hours of one-on-one instruction per week (Maurice, Green, & Luce, 1996). Reinforcing consequences are delivered contingent upon accurate or improved performance, and various methods of response prompting and prompt fading are employed to facilitate the efficient acquisition of a variety of unprompted, developmentally appropriate skills. A sample from the range of pre-academic, daily living, and social skills addressed by way of EIBI include basic learner repertoires (e.g., looking, sitting), receptive discriminations, vocal language, and behaviors associated with toileting, mealtime, and other daily routines. The ultimate goal of EIBI is to prepare young children to learn in a general education setting with relatively few supports or instructional accommodations.

A number of detailed curricula (e.g., Leaf & McEachin, 1999) and procedural manuals (Maurice, Green, & Foxx, 2001; Maurice et al., 1996; Sundberg & Partington, 1998) are now widely available to clinicians and to parents of children with autism. In response to the increased accessibility of clinical services and materials relevant to implementing and maintaining EIBI programs in the home and school, and due to the substantial investment of time and financial resources required of families pursuing behavioral treatment options for children with autism, the behavior-analytic community
must continue to reciprocate with diligent efforts to experimentally evaluate the effectiveness, and efficiency, of common procedural recommendations. Notable contributions in the development of teaching techniques designed to enhance the performance of the learner during EIBI include advances in the areas of stimulus preference assessment, reinforcer variation, and task interspersal, among others.

Stimulus Preference Assessment

EIBI programs are ultimately dependent on the identification of a number of preferred stimuli that are likely to function as reinforcers for a specific learner at a given time. Pace, Ivancic, Glynnis, Iwata, and Page (1985) were among the first to address the need for direct-observation methods to identify stimuli that would likely function as reinforcers for the behavior of individuals diagnosed with developmental disabilities. Their single-stimulus preference assessment entailed the presentation of a variety of stimuli, one at time, and subsequent observation of the rate of approach responses initiated by the participants across stimuli. Results indicated that items approached greater than 80% of trials reliably functioned as reinforcers, whereas items approached less than 50% of trials did not. One potential limitation of the single-stimulus preference assessment is that the individual will not necessarily interact with or approach every stimulus, making preference estimates difficult. Furthermore, some items might be approached simply because there are no alternatives.

The paired-stimulus (PS) assessment, an alternative to single-stimulus preference assessments, was developed and evaluated by Fisher et al. (1992). This assessment requires that every selection response of the client occur in the presence of two stimuli such that each item is presented concurrently with every other item at least
once. By forcing a choice between two stimuli, the PS preference assessment was the first to produce results arranged in a hierarchy of preference (i.e., ranked in terms of high, medium, and low preference).

Most recently, DeLeon and Iwata (1996) compared paired stimulus (PS), multiple stimulus with replacement (MSW), and multiple stimulus without replacement (MSWO) preference assessments in terms of the degree of correlation between assessment outcomes and the amount of time required to administer each assessment. Multiple stimulus preference assessments are implemented by presenting as many as 8 to 10 stimuli, simultaneously, and providing the individual with an opportunity to select each item from the array. After a specific stimulus is selected, the placement of stimuli is randomized and the selected item is either removed from (MSWO) or replaced in (MSW) the array for subsequent choice trials. The investigators found a high correlation among the number and type of reinforcers identified as preferred by the MSWO and PS assessments. Additionally, measures of administration time across assessment types suggested that the time required to complete an MSWO preference assessment was approximately half the duration required for a PS assessment. An attempt to further refine and validate a reliable and economical approach to reinforcer identification was advanced by Carr, Nicolson, and Higbee (2000) in their evaluation of a brief MSWO assessment, wherein the investigators reduced the number of presentations for each stimulus array from 5 to 3. In short, the procedures for conducting an accurate, informative stimulus preference assessment are, at present, clearly delineated and substantially improved along the dimension of time-efficiency. These outcomes should directly inform the techniques employed by practitioners to
distinguish reinforcers with the highest probability of producing acquisition at any point over the course of intervention.

Reinforcer Variation

One means of enhancing the performance of children with autism involves the manipulation of certain dimensions of programmed reinforcers. For example, the effects of reinforcer variation on the performance of children with autism was investigated by Egel (1980) who demonstrated an increased rate of responding across 10 children with autism when varied rather than constant reinforcers were provided. In an extension of this study, Egel (1981) demonstrated that, for three boys with autism, the delivery of a constant reinforcer across trials produced decreases in the frequency of correct responses and on-task behavior compared to a condition in which varied reinforcers were available. Bowman, Piazza, Fisher, Hagopian, and Kogan (1997) found that varied low-preference stimuli were more reinforcing than a single high-preference stimulus. Most recently, Kohler, Iwata, Roscoe, Rolider, and O’Steen (2005) conducted two studies evaluating the effects of presenting varied versus non-varied (single) low quality (LQ), high quality (HQ), and non-preferred (NP) stimuli as consequences for eight adults with developmental disabilities. Study 1 assessed participant preference for LQ (single and varied) versus HQ (single) stimuli, and found that none all of the participants demonstrated preference for the LQ stimuli, regardless of variation. Study 2 resulted in mixed findings with respect to the effects of the varied and non-varied (single) presentation of HQ and NP stimuli contingent upon performance. The introduction of varied NP stimuli improved the performance of one participant, as compared to the frequency of responding produced when a single NP
stimulus was delivered contingently. The performance of a second participant was non-responsive to both the varied presentation of NP stimuli and the addition of a single HQ stimulus to the rotation of consequences. Finally, results from a third participant indicated that the introduction of a HQ stimulus to the varied presentation of otherwise NP stimuli did enhance performance. Overall, the investigators found that reinforcer variation is insufficient to increase the relative reinforcing effectiveness of NP stimuli to a single HQ stimulus. This suggests that the use of high quality stimuli in teaching is a prerequisite for harnessing the benefits of reinforcer variation.

The literature on the reinforcer variation effect confirms that the reinforcing effectiveness of specific and consistent consequences diminish as a function of the degree of satiation of the learner. Hence, optimal performance is best ensured when therapists vary the reinforcing consequences that are delivered following instances of accurate or improved responses.

Task Interspersal

In addition to providing a variety of systematically identified reinforcers to enhance learner performance, the instructional technique of task interspersal, or alternating between maintenance (previously mastered) and acquisition tasks during a series of teaching trials, has been shown to facilitate the learning of adults with mental retardation (Neef, Iwata, & Page, 1977) and children with autism participating in EIBI. Dunlap and Koegel (1980) used task interspersal and traditional massed-trial sessions to teach pre-academic skills to two girls with autism, the results of which indicated that the interspersal condition produced faster acquisition. Subsequently, Dunlap (1984) found that four children with autism learned more efficiently when 5 varied teaching targets
and 5 maintenance tasks were randomly interspersed during training sessions as compared to the rate of learning observed in conditions where only constant (1 task) or varied (5 tasks) teaching targets were presented in the absence of interspersed maintenance tasks. Overall, the existing literature on task interspersal suggests that this procedure enhances acquisition by increasing the probability of reinforcement within training sessions, and hence, it is well suited for implementation in the context of EIBI programs for children with autism.

**Differential Reinforcement**

One procedure, first proposed by Lovaas, Freitas, Nelson, and Whalen (1967) and commonly represented among general teaching guidelines across program manuals and curricula (Maurice et al., 1996; MacDuff, Krantz & McClannahan, 2001; Sundberg & Partington, 1998), recommends reserving high quality reinforcers for instances of unprompted responding. For example, a learner who emits the response “cat” in the presence of a picture of a cat and partial verbal prompt “c” on a given trial would receive a small or mildly preferred reinforcer, whereas, the same learner would receive a larger or highly potent reinforcer after emitting the response “cat” in the presence of the picture, alone, on subsequent trials. Lovaas et al. employed such a procedure while teaching 11 children diagnosed with schizophrenia or autism to imitate motor behaviors relevant to maintenance of personal hygiene, simple games, printing and drawing, and basic interpersonal skills. The authors specifically prescribed the incorporation of a differential reinforcement component for unprompted responses stating, “this step is a rather important one in training, since continual reinforcement for prompted behavior probably would prevent a shift into imitative responding” (p. 174).
This differential reinforcement technique has been implicated as a useful tool in decreasing the occurrence of prompt dependence and learner errors, and promoting rapid acquisition (MacDuff et al., 2001). The manipulation of the quality of programmed consequences for unprompted responses is often coupled with prompt fading techniques to produce transfer of stimulus control and, in turn, differentially reinforce instances of the unprompted responses that follow when the response prompt of the therapist is no longer the only controlling stimulus for the response. For example, in the manual *Behavioral Intervention for Young Children with Autism*, Maurice et al. (1996) recommend that “When it becomes evident that he (the learner) is beginning to understand what you’re are asking him to do, reserve reinforcement only for correct responses that occur following the first request (i.e., before the correction trial)” (p. 187). Similarly, Sundberg and Partington (1998) advocate the delivery of high-quality reinforcers contingent upon the first instance of an unprompted response in the treatment manual and curriculum *Teaching Language to Children with Autism or Other Developmental Disabilities*, stating:

“The objective at this point in the training is to get the child to say “eat” prior to the delivery of the echoic prompt. When this occurs, the child should be immediately reinforced, perhaps with a larger piece of food if it is the first time, or a high quality response” (p. 124).

If the differential reinforcement of unprompted responding provides a means to facilitate the acquisition of unprompted responding under appropriate stimulus control, the corresponding procedures for teaching children with autism can be modified such that unprompted responses are produced earlier in training, and the probability of prompt dependence resulting from imprecise prompt fading techniques may be reduced. Ultimately, the procedures associated with EIBI could gain efficiency and minimize the
risks (i.e., prompt dependence) associated with reinforcing prompted responses over an extended period of time.

Olenick and Pear (1980) attempted to evaluate the utility of this differential reinforcement procedure with three children diagnosed with severe mental retardation. Participants were trained, under systematically manipulated schedules of reinforcement, to label pictures across a progression of prompt and probe trials. Reinforcers were non-differentially delivered for responses emitted by the learner on prompt and probe (all prompts withheld) trials during the initial training phase. A lean schedule (fixed ratio \([FR\] 6 or 8) for prompted responses, and a differentially rich schedule (continuous reinforcement) for unprompted responses was implemented during subsequent training phases. The authors compared the speed of acquisition (defined as the cumulative number of picture names reaching criterion as expressed across days), accuracy of responding on prompt and probe trials (defined as correct responses relative to correct plus incorrect responses), and frequency of responding on probe trials across differential and non-differential reinforcement conditions.

Olenick and Pear (1980) reported more efficient acquisition, greater frequency of responding on probe trials, and more accurate probe responses during the differential reinforcement of unprompted responding conditions for all three participants. However, some methodological issues should be considered in an interpretation of these findings. First, the training sequence adopted by the authors, and adapted from Stephens, Pear, Wray, and Jackson (1975), involved contingencies wherein a correct response on a prompt trial was immediately followed by an opportunity to respond on a probe trial. Under the differential reinforcement condition, these probe trials produced more
reliable access to reinforcing stimuli than the prompt trials. It is possible that the presentation of probe trials, under these conditions, functioned as conditioned reinforcers for accurate responding on prompt trials. Hence, this training method may have inflated the degree to which the accuracy measure reported under the differential reinforcement of unprompted responding condition is a result of the independent variable, per se. An increase in errors on probe trials, each of which resulted in the immediate presentation of a prompt trial, was also observed during the condition in which the differential reinforcement of prompted responses was implemented.

Second, and of particular concern, Olenick and Pear (1980) did not employ teaching procedures that can be likened to the “discrete trial training” methods implemented in contemporary EIBI. For example, the participants initiated every trial by pressing a button, whereas, clinically, the therapist initiates trials by presenting relevant visual or verbal stimuli to the client. Although specific training trials adhered to the prescribed structure for a discrete trial (discriminative stimulus, followed by a prompted response, followed by a reinforcing consequence), the incorporation of frequent, contingent probe trials and the means by which mastery for a particular picture label was tested (completion of three 10-step sequences in a single 20-min session and an unprompted response on a single probe for 3 consecutive days) may limit the degree to which the current findings are replicable in more traditionally structured training environments. Finally, the decision to manipulate reinforcers for prompted and unprompted responses by altering the schedule of reinforcement across trials is a departure from the recommendations of more contemporary clinical resources for administrators of EIBI programs (e.g., Sundberg & Partington, 1998). The potential
benefits of the use of the treatment component under evaluation are relevant to children with autism who participate in such instructional programs, and hence, little can be assumed with respect to the utility of providing higher quality reinforcers for unprompted responses until an experimental evaluation is conducted under more representative conditions. To date, the Olenick and Pear (1980) investigation is the only published evaluation of the effects of differential reinforcement of unprompted responding on skill acquisition, despite numerous recommendations from the clinical literature.

Purpose of the Current Study

The purpose of the current investigation was to contribute to the line of research initiated by Olenick and Pear (1980) and conduct an experimental evaluation of the effects of the differential reinforcement of unprompted responding on the acquisition of vocal (tact) and motor (picture sequencing) responses for two children diagnosed with autism. The current study extends previous research in several ways. First, the teaching procedures used in the evaluation were closely derived from discrete-trial-training methods that are commonly employed in EIBI, including 1) therapist-initiated trials, 2) training administered in blocks of 10 trials, 3) one format for all trials, 4) frequent preference assessments, and 5) interspersal of alternative acquisitions tasks for one of the participants. In this way, the results of the evaluation have the possibility of providing direct implications for current clinical practice. Additionally, because the use of probe trials was eliminated, the current study controlled for the possibility that the results of evaluation are inflated as a function of the specific relation between training and testing trials in the differential reinforcement conditions. In order to prevent the
possible facilitative effects of interspersing maintenance tasks from influencing the rates of acquisition under all training conditions, a massed-trial approach to teaching was applied with one participant, and a preparation in which the interspersed trials were rotated to inhibit acquisition was implemented with the second participant. Finally, reinforcer quality was manipulated on the dimensions of reinforcer type (praise and food vs. praise alone) during the differential reinforcement training condition, thereby correcting for the increased number of training trials required to produce a single reinforcer, and acquire the associated response, when the quality of reinforcement is manipulated along the dimension of frequency.
METHOD

Participants and Setting

Two children diagnosed with autism as specified in the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; American Psychiatric Association, 1994) were recruited from area schools and a university-based outpatient clinic for children with autism. Participant 1 was a 5-year-old boy who attended a general education classroom with the assistance of a full-time paraprofessional aid. Participant 1’s autism quotient on the Gilliam Autism Rating Scale (GARS; Gilliam, 1995), which was completed by a parent for each participant prior to his or her involvement in the study, was 83. This score falls in the low-average range, suggesting that participant 1 displays fewer behaviors and developmental patterns than are commonly observed among other individuals with a diagnosis of autism. Participant 1’s adaptive behavior composite score on the Vineland Adaptive Behavior Scales (VABS; Sparrow, Balla, & Cicchetti, 1984) was 77, placing him at the 6th percentile among his typically developing peers. Overall, these results are indicative of below average functioning. Participant 1’s VABS age-equivalent scores across the domains of communication, socialization, daily living skills, and motor skills ranged from 0-years, 9-months to 7-years, 1-month, with relative strengths in the daily living skills domain and relative weaknesses in the socialization domain.

Participant 2 was a 3-year-old boy diagnosed with autism who attended a full-time preschool for children with autism. Participant 2’s autism quotient on the GARS was 80, suggesting that he demonstrates fewer behavioral and developmental patterns than the majority of other individuals with a diagnosis of autism. Participant 2
communicated vocally through the use of gestures and several different one-word requests (e.g., juice, tickle, up). He had also acquired generalized vocal and motor imitative repertoires, and was reported to engage in low levels of noncompliance (verbal protest) and aggression (slapping, hair-pulling) under structured teaching conditions. Participant 2’s adaptive behavior composite score on the VABS was 94, placing him at the $34^{th}$ percentile among his typically developing peers. Although, a score of 94 indicates functioning in the average range for a child of his age, participant 2’s results also suggest that he is currently functioning at the level of a 1-year, 9-month child with respect to expressive language, while his interpersonal skills were identified as equivalent to those of a 1-year, 7-month old child. His remaining age-equivalent scores across the domains of communication, socialization, daily living skills, and motor skills ranged from 2-years, 5-months to 5-year, 5-months, with relative strengths in the motor skills domain and relative weaknesses in the socialization and communication domains.

All experimental sessions were conducted in a quiet area of the child’s home. Sessions were conducted with the therapist seated across from or next to the participant at a table. Reinforcing stimuli were stored out of reach and sight from the participant during sessions.

Preference Assessments

In order to identify food that would function as reinforcers for participant 2’s and participant 1’s responses during training, and highly preferred toys to be made available during periodic 5-min breaks, parents completed the Reinforcer Assessment for Individuals with Severe Disabilities (RAISD; Fisher, Piazza, Bowman, & Amari,
A total of 7 toys and 6 to 7 foods were selected from the parent reports on the RAISD, and separate stimulus preference assessments were conducted for foods and for toys. During the MSWO preference assessment with foods, each participant had an opportunity to select a bite-sized piece of food from an array of approximately 6 to 7 familiar foods. After naming or reaching for a specific food item, the participants were allowed to consume the food. Food items were removed from the array as they were selected, and the placement of each remaining food item in the array was randomized following every trial. A total of three presentations of the complete array of foods were conducted. The top three preferred foods and toys were determined by examining selection percentages, which were calculated by dividing the total number of instances an item was selected by the total number of choice trials in which the item was presented, and multiplying by 100% (see Appendix B for the data sheet used in this assessment).

Results from the MSWO assessment of foods (bottom panel) and toys (top panel) for participant 1 are reflected in Figure 1, while the results for participant 2 are reflected in Figure 2. The three highest ranked foods identified in this manner were used as programmed consequences throughout experimentation during training sessions, with one exception. Participant 1’s food preferences are displayed in the bottom panel of Figure 1, and reflect that the cereal Honey-bunches of Oats© received a rank of three above gummy candies. Because of the fine and varied nature of the cereal (small flakes, small clusters), and in the interest of providing reinforcers of a consistent size and quality across trials, the 3rd most preferred food was replaced by the 4th most preferred food.
The MSWO preference assessment for toys consisted of procedures identical to those described for the assessment of preferred foods, except that a period of 30 s to engage with the selected toy was provided after every selection response. The top three preferred toys were made available during the 5-min break scheduled for each participant upon the completion of 2 blocks of trials in a single session.

Figure 1. Preference assessment data for participant 1.

Finally, a brief stimulus preference assessment during which the top three preferred foods were presented to the participant was also conducted prior to each
training session. The first item selected or otherwise indicated by the participant was then used as the programmed consequence throughout the subsequent training session.

Figure 2. Preference assessment data for participant 2.

Dependent Variables

Treatment sessions were conducted 3-5 days per week and were 5-10 min in duration. A maximum of 6 sessions were conducted during each visit to minimize the possibility of satiation to the programmed food reinforcers. Performance data were summarized and reported as the percentage of trials in which the participants responded
correctly and independently during each block of trials. A specific target was deemed mastered when the unprompted response was emitted on at least 8/10 trials (80%) across two consecutive sessions when the first trial of each session was correct and unprompted. As an additional criterion, visits were terminated after the occurrence of a single mastery session, and the second potential mastery session was conducted at the beginning of the next visit to the participant's home. Unprompted responses were operationally defined as those that occurred within 3 s of the onset of the trial (i.e., the therapist's instruction and the presentation of relevant stimuli for tacting or sequencing). Picture sequencing and tacting (expressive labeling) were selected as program areas from which targets for each participant were adapted from a published curriculum (e.g., Leaf & McEachin, 1999). Reports from parents and teachers were sought to confirm that participant 1 and participant 2 had no history of training on the selected target responses, and topographically similar responses that may have resulted in the development of a generalized repertoire (e.g., matching to sample, imitation) were excluded as possible targets in the context of the current study. In addition, a single probe trial was implemented at the beginning of training for each target. If the participants emitted an unprompted, correct response on the probe trial, a new target was selected. All probe trials were conducted under extinction. Participant 2 gave an approximate response on the probe trial for one potential tact target over the course of the study ("sleeping"), and participant 1 never responded on a picture sequencing probe trial.
Experimental Design and Procedures

An alternating treatments design was used to evaluate the effects of differential reinforcement of unprompted responding on acquisition for both participant 1 and participant 2. Differential and non-differential reinforcement training conditions were implemented to teach participant 1 eight picture sequences, and to teach participant 2 eight tacts. Two variations of the aforementioned design were implemented during the investigation. All eight of participant 1’s targets were taught as the two training conditions were randomly alternated across sessions on a 1:1 ratio. The first two targets for participant 2 were also evaluated in this manner. However, as these targets were similarly acquired, the alternating treatments design needed to be modified to rule out the possibility that multiple-treatment interference produced the similarity. During the second iteration of participant 2’s evaluation, two tact targets were concurrently taught in a single training condition. Differential and non-differential reinforcement conditions were then systematically altered across pairs of targets in a reversal design. Finally, a termination criterion was upheld for both participants following 10 consecutive sessions for which an overall ascending trend was not evident. At this point, the alternative training condition was implemented with the unlearned target and performance was monitored, again, for signs of acquisition.

Reinforcer Evaluation

To determine the relative reinforcing effectiveness of praise-alone versus praise-plus-food as consequences, two different reinforcer evaluation methods were implemented. In participant 1’s case, an arbitrary response of pressing a foam disc was selected, and programmed consequences were manipulated across 2-min sessions
during which free operant responding produced access to those consequences on a continuous schedule of reinforcement. Prior to each session, a brief MSWO preference assessment was conducted to determine the food item that sometimes was delivered during the following session, depending upon the programmed reinforcers for the current phase of evaluation. Each session began with an experimenter-initiated trial during which participant 1 was instructed to imitate the experimenter’s model of pressing the foam disc a single time. Participant 1’s imitative response was immediately followed by one of three programmed consequences (baseline-no consequence, praise-alone, praise-plus-food). Each programmed consequence corresponded to a condition in the reversal design that was used to evaluate the relative reinforcing effectiveness of those consequences based on changes in the frequency of responding across sessions and phases. The same variety and portion of food, as well as the same tone and topography of praise (“That’s right!”) used during the reinforcer evaluation were later applied in the teaching phase of the investigation. Participant 1’s responding during the reinforcer evaluation was scored and summarized as the frequency of disc presses per session (see Appendix C for the data sheet used in this evaluation).

Alternatively, participant 2 completed a progressive-ratio schedule reinforcer evaluation (Roane, Lerman, & Vorndran, 2001) to determine the relative reinforcing effectiveness of the relevant consequences for this study. In participant 2’s evaluation, an arbitrary response of placing foam tiles in a plastic container was selected. Again, each session was preceded by a brief MSWO assessment to identify the food item that was sometimes delivered during the following session. Each session began with an
experimenter-initiated trial on which participant 2 was asked to imitate placing a single tile in the container, following which the programmed consequence for the current condition was delivered (praise-only, praise-plus-food). During the remainder of each session, reinforcers were delivered on a progressive-ratio schedule for placing tiles in the container (PR 1, PR 3, PR 5, PR 7, and so on). The two reinforcement conditions were presented in a randomized and alternating fashion, and data were collected and summarized in terms of highest schedule requirement that participant 2 met before ceasing to respond for 5 min or attempting to leave the session area on more than three occasions (see Appendix D for the data sheet used in this evaluation). An alternating treatments design was used to demonstrate the relative reinforcing effectiveness of the programmed consequences as indicated by separation of the data paths associated with breaking points for each condition.

Treatment Evaluation

Prior to each experimental session, a brief stimulus preference assessment was conducted in which participant 1 and participant 2 had an opportunity to select among three of the highest ranked foods identified by the MSWO assessment conducted prior to experimentation. The first stimulus named or physically selected in the array by the participant was used as a reinforcer for the training session that immediately follows. A single highly preferred food was identified in this manner prior to each session, although, in the differential reinforcement condition, its presentation was contingent on unprompted performance for all trials following the first occurrence of a correct, unprompted response on a particular task. Hence, the reinforcing stimulus selected prior to each session was not always delivered during that session.
Because the literature indicates that the interspersal of previously trained tasks facilitates acquisition (Neef, Iwata, & Page, 1977), all target responses for participant 1 and the first two responses for participant 2 were taught in a massed-trial format using blocks of 10 trials. In order to control for the possibility that false mastery would be produced during subsequent tact-training sessions with participant 2, a rotation of three previously untrained intraverbal trials were interspersed on a 1:1 ratio with tact trials. The trials were rotated such that the probability of learning the intraverbals remained low throughout the study, and items were replaced in the rotation in the event that participant 2 emitted two unprompted, correct responses to a particular question. This occurred on two occasions during the investigation.

Each teaching trial was initiated by the experimenter saying the name of the participant which, for both participant 1 and participant 2, was a sufficient prompt for them to orient to the experimenter and the materials that were presented shortly thereafter. Training for every target proceeded with the presentation of the relevant discriminative stimulus (instruction and visual stimuli) followed by a 3-s delay before a response prompt was provided by the experimenter. For participant 1, the instruction “Put these in order” was delivered simultaneously with three picture sequencing cards stacked in a randomized manner for each trial. Errors and non-responses both resulted in the delivery of full-physical (hand-over-hand) guidance to place the picture sequencing cards in the appropriate order. For participant 2, every trial began with the presentation of a flashcard depicting an action or emotion which was closely followed by the question “What feeling is this?” or “What are they doing?” In this case, errors or non-responses resulted in the delivery of a verbal model of the target response (e.g.,
"running"). The verbal model was repeated every 3 s until participant 2 accurately echoed the correct response. The targets taught to participant 1 and participant 2, respectively, are summarized in Table 1.

Initially, prompted responses, or those responses that followed the response prompt of the experimenter, were followed by praise ("That's right!") and the delivery of a highly preferred food item across conditions. In the differential reinforcement

Table 1

Target Responses across Teaching Conditions for Participant 1 and Participant 2

<table>
<thead>
<tr>
<th>Participant</th>
<th>Program Area</th>
<th>Target Pairs</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant 1</td>
<td>Picture Sequencing</td>
<td>Storm, Spider</td>
<td>Differential, Non-differential</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Building, Rocket</td>
<td>Differential, Non-differential</td>
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<tr>
<td></td>
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<td>Airplane, Flower</td>
<td>Differential, Non-differential</td>
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<tr>
<td></td>
<td></td>
<td>Bathtub, Bird</td>
<td>Differential, Non-differential</td>
</tr>
<tr>
<td>Participant 2</td>
<td>Labeling</td>
<td>Lonely, Bored</td>
<td>Differential, Non-differential</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Crying, Running</td>
<td>Differential, Differential</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Packing, Watching</td>
<td>Non-differential, Non-differential</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Helping, Cutting</td>
<td>Differential, Differential</td>
</tr>
</tbody>
</table>
condition, contingent praise and access to preferred food was, eventually, only provided in the event that additional unprompted responses occurred after the first unprompted response of the participant. In other words, prompted responses that were emitted following the initial occurrence of the unprompted response in the differential reinforcement condition were followed by praise-only. In the non-differential reinforcement condition, praise and access to the highly preferred food were implemented uniformly contingent upon prompted and unprompted responses (see Appendix E for the data sheet used in this evaluation).

Interobserver Agreement

Interobserver agreement (IOA) data were collected on responding during the reinforcer evaluations and treatment sessions for participant 1 and participant 2. Total agreement was calculated by dividing the lower of two frequency counts by the higher of two frequency counts and multiplying by 100%. IOA was assessed for 38% of participant 1’s reinforcer evaluation sessions and averaged 95.5% (range, 81% to 100%). IOA was assessed for 28% of participant 2’s reinforcer evaluation sessions and was 100%. During treatment, an agreement was defined as a trial for which two independent observers both determined that a response was unprompted and correct or prompted. Overall agreement was calculated for each block of trials by dividing the number of agreements by the number of disagreements plus agreements and multiplying by 100%. IOA data were collected for 46% of participant 1’s treatment evaluation sessions and averaged 98.5% (range, 90% to 100%). IOA data were assessed for 46% of participant 2’s treatment evaluation sessions and averaged 98.3% (range, 80% to 100%).
Treatment Integrity

To ensure the accurate and consistent implementation of the two training conditions, a second independent observer also collected treatment integrity data on the implementation of all experimental training procedures for 45% of sessions for participant 1, and 45% of sessions for participant 2. A treatment integrity score was calculated for each session by dividing the number of entirely correct trial deliveries by the number of trials and multiplying by 100%. For a trial to be considered correct, the therapist was required to present the appropriate discriminative stimulus, wait 3 s, prompt the response (as necessary), deliver the programmed consequences, and provide an inter-trial interval of 20 s, which was an adequate period for consumption. The mean treatment integrity score was 99.6% for participant 1 (range, 90% to 100%), and 98.3% for participant 2 (range, 80% to 100%). Finally, IOA was assessed on treatment integrity data collected from 50% of those sessions for participant 1, and 23% of treatment integrity sessions with participant 2. Mean IOA on treatment integrity data for participant 1 was 100%, and mean IOA on treatment integrity data for participant 2 was 95% (range, 80%-100%).

Additional observations were conducted by a naïve observer for 3 randomly selected pairs of sessions (one differential session, one non-differential session) over the course of training with each participant to ensure that the amount and intensity of praise and other contingent reinforcers, with the exception of those consequences that are to be manipulated in quality, were held constant across training conditions. Observers completed a 9-item, close-ended post-observation questionnaire to potentially document any unsystematic differences in reinforcer or prompt quality between conditions. The
questionnaire is displayed in Table 2. Questionnaire scores for the observer were calculated out of a total of 3-9 points, as not all questions were relevant for all sessions (i.e., sessions during which non-responses and physical prompts never occurred). The score for each observation was obtained with the aid of a pre-written answer key for each session. Treatment integrity results from the naïve observer are summarized in Figure 3.

Table 2

_Treatment Integrity Questionnaire for Naïve Observers_

<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
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<tbody>
<tr>
<td>1. What stimuli were used as consequences during this session?</td>
<td>a. Food</td>
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<td>b. Praise</td>
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<td>c. Both</td>
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<td>2. Which of the following participant responses resulted in praise?</td>
<td>a. Prompted labeling / sequencing</td>
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<td>b. Unprompted labeling / sequencing</td>
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<tr>
<td></td>
<td>c. Both</td>
</tr>
<tr>
<td>3. Which of the following participant responses resulted in both food and praise?</td>
<td>a. Prompted labeling / sequencing</td>
</tr>
<tr>
<td></td>
<td>b. Unprompted labeling / sequencing</td>
</tr>
<tr>
<td></td>
<td>c. Both</td>
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<tr>
<td>4. Was the praise that was delivered during this session enthusiastic?</td>
<td>YES / NO</td>
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<tr>
<td>5. Was a consistent amount of food delivered across trials during the session?</td>
<td>YES / NO</td>
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<tr>
<td>6. What kinds of prompts were used during this session?</td>
<td>a. Verbal prompts</td>
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<td></td>
<td>b. Physical (hand-over-hand) prompts</td>
</tr>
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<td></td>
<td>c. Both</td>
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<tr>
<td>7. What behaviors resulted in the delivery of a prompt during this session?</td>
<td>a. Incorrect responses</td>
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<td></td>
<td>b. Non-responses</td>
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<td></td>
<td>c. Both</td>
</tr>
<tr>
<td>8. Were the verbal prompts, if any, delivered with a neutral tone?</td>
<td>YES / NO</td>
</tr>
<tr>
<td>9. Were the physical prompts, if any, forceful?</td>
<td>YES / NO</td>
</tr>
</tbody>
</table>

Please note any additional procedural differences that you observed between the two sessions in the space provided below.
Figure 3. Questionnaire results for naïve observers.

A second, independent observer collected data on 67% of the observations for participant 1, and 67% of the observations for participant 2. An agreement was scored when both observers answered a question correctly according to the pre-written answer key for each pair of sessions.

Mean overall IOA on checklist data was 100% for participant 1’s sessions, and 95% for participant 2’s sessions (range, 80% to 100%). A single, open-ended
opportunity to report any additional differences in reinforcers or prompts between sessions was also provided following the viewing of each pair of sessions. The primary observer reported only one unsystematic difference, which was that one differential session appeared to have longer delays between trials than all other sessions observed (differential and non-differential alike). This observation, while worth reporting, does not appear to have implications for the overall integrity with which the two treatment conditions were implemented.

HSIRB Approval

Approval from the Human Subjects Institutional Review Board was obtained prior to recruitment of participants and the beginning of the study (see Appendix G for the stamped and approved consent form).
RESULTS

Reinforcer Evaluation

Results from the free-operant and progressive ratio schedule reinforcer evaluations are depicted in Figure 3. Participant 1’s reinforcer evaluation results are depicted in the top panel. During baseline, participant 1’s disc pressing performance was low and steady ($M = 7$ responses per session). During the praise-plus-food phase, the frequency of pressing increased to 49 presses per session ($M = 34.9$ responses per session), while the degree of response variability remained low. A brief reversal phase was implemented during which responding returned to baseline levels, following which the praise-alone phase was introduced.

![Figure 4. Reinforcer evaluation data for participant 1.](image)

During this phase, the frequency of pressing increased slightly above baseline levels ($M = 29$ responses per session), though the overall level of responding remained lower than that which was produced during the praise-plus-food condition. In addition, the degree
of variability during this phase of the reinforcer evaluation was notably greater than baseline or the alternative reinforcement condition. A final reversal phase was implemented during which the frequency of pressing responses, again, returned to baseline levels. Overall, these results indicate that praise-plus-food functioned as a more effective reinforcer than praise-alone for participant 1's disc pressing behavior.

The results from participant 2's reinforcer progressive ratio evaluation are depicted in Figure 5.

![Figure 5. Reinforcer evaluation data for participant 2.](image)

The highest schedule requirement under which participant 2's responding produced a reinforcer, or the break point, was recorded for praise-plus-food and praise-alone conditions. The break points obtained under the praise-alone condition decreased across repeated exposures to this condition and, overall, remained consistently lower (range, 0 to 7) than the break points produced in the praise-plus-food condition (range, 5
to 17). These data demonstrate that praise-plus-food functioned as a more powerful reinforcer for participant 2's tile placing responses than praise-alone during the progressive ratio evaluation.

Based on these results, the praise-plus-food consequence was reserved for unprompted responses in the differential reinforcement teaching condition for both participants, while praise-alone was delivered for prompted responses. In contrast, both unprompted and prompted responses were followed by praise-plus-food under the non-differential teaching condition.

Treatment Evaluation

The results of treatment comparisons for participant 1 and participant 2 are reflected in Figure 6 and 7. Participant 1's acquisition data for eight picture sequences across four phases of alternating differential and non-differential training conditions are displayed in Figure 6.

Figure 6. Treatment evaluation data for participant 1.
During the first comparison between the storm (differential) and the spider (non-differential) sequences, a clear separation emerged between the two training data paths. The differential target was acquired following seven blocks of training. Participant 1’s performance on the non-differential target remained low and stable ($M = 19\%$ correct; range, $10\%$ to $30\%$ correct per block) through the 10-session termination criterion. At this point, the differential reinforcement condition was implemented with the spider sequence, following which participant 1 acquired the sequence in five additional blocks of training. As it is shown across subsequent phases of the evaluation, participant 1 mastered the remaining three pairs of picture sequences rapidly ($M = 3.8$ sessions to mastery; range, 3 to 5 sessions). Despite the emergence of an effective repertoire for quickly acquiring these picture sequencing tasks (i.e., “learning to learn”), the first two phases of the evaluation clearly demonstrate more effective teaching produced in the differential reinforcement condition.

Participant 2’s acquisition data for eight tacts are displayed in Figure 7. The first phase depicts the alternating treatments design evaluation during which two tacts, “lonely” and “bored”, were taught under the two treatment conditions in a massed trial format. Participant 2 mastered the differential target, “lonely”, in 8 sessions. The non-differential tact, “bored”, was acquired in 7 sessions. All subsequent phases of participant 2’s evaluation occurred in the modified alternating treatments design, during which targets were taught in pairs under a single reinforcement condition, and the teaching conditions were systematically manipulated across phases. During the first phase, “crying” and “running” were taught using differential reinforcement contingencies for unprompted responses.
Figure 7. Treatment evaluation data for participant 2.

Participant 2 mastered this pair of tacts in 5 and 8 sessions, respectively. The second phase of participant 2’s evaluation entailed the use of non-differential reinforcement contingencies for unprompted responses, and participant 2’s performance was markedly different than in previous phases. With respect to “packing”, participant 2’s performance was low and steady throughout the phase ($M = 1\%$ correct; range, 0\% to 10\% correct per block). Participant 2’s performance on “watching” reflected an ascending trend across the first 5 sessions of the teaching, however, his responding stabilized at a sub-mastery level thereafter ($M = 50\%$ correct; range, 30\% to 70\% correct per block). An overall ascending trend indicating progress toward the acquisition of the tacts “packing” and “watching” was not detected within the 10 session window for either target, and thus, the non-differential training was terminated and two new tacts (“helping” and “cutting”) were introduced in the following
differential reinforcement phase. The fourth phase of participant 2’s treatment evaluation graph depicts the rapid acquisition of both targets (4 sessions and 8 sessions to mastery, respectively), which precisely replicates data from the phase 2 implementation of differential reinforcement for unprompted responses. Finally, though these data are not depicted in Figure 4, the two unlearned targets from the evaluation of the non-differential reinforcement condition in phase 3 were revisited using the differential reinforcement of unprompted responses. Participant 2 mastered “packing” in 3 sessions, and “watching” in 5 sessions under the alternative teaching condition. Collectively, participant 2’s data demonstrate that the differential reinforcement of unprompted responses is, again, a superior teaching method to the provision of non-differential consequences contingent upon prompted and unprompted responses.
DISCUSSION

The results of this comparison between differential and non-differential reinforcement for unprompted responses during acquisition training suggest that procedures including differential reinforcement components are more effective. This effect was demonstrated for two participants. These findings, though quantified in a somewhat different manner, also replicate the results of the pre-existing evaluation of differential reinforcement procedures conducted by Olenick and Pear (1980). While these data on the benefits of differential reinforcement in acquisition training are collectively strong and point to a somewhat intuitive conclusion, a number of observations and considerations from the study merit closer examination.

Discontinued Participants

The involvement of two additional participants in this investigation was terminated prior to the collection of meaningful evaluation data. In the case of the pilot participant, training on the first pair of targets could not be completed because his family moved out of the region. The second partial participant completed preference assessment and reinforcer evaluation phases of the study before it was observed that he was highly likely to acquire novel responses in the absence of repeated discrete trials. Though parental reports suggested that the participant lacked some receptive identification skills, the researchers were unable to identify a target that he was unable to perform on probe trials. Neither case yielded data that had implications for the research question under investigation.
Participant 1

Regarding participant 1’s data, the differential reinforcement effect was demonstrated in only 1 of 4 phases of treatment comparison. Following mastery of the two initial picture sequences, participant 1’s subsequent acquisition occurred in uniformly few sessions across the two training conditions. This finding suggests that the benefit of the differential reinforcement of unprompted responses might be restricted to those circumstances in which the response being taught is 1) not from a generalized class of responses, and 2) the learner has not yet acquired a generalized repertoire for acquiring novel responses. The second of these factors has been described, anecdotally, with individuals with developmental disabilities as “learning to learn” (Leaf & McEachin, 1999). This effect typically occurs following an extensive history of discrete-trial training and the mastery of a series of behaviors that are prerequisites (sitting, orienting, responding to prompts, etc.) for faster and more advanced learning to occur. Over time, intensive and structured teaching procedures during which reinforcement is delivered contingent upon accurate and improved performance across a variety of skills and program areas may also facilitate more effective responding on new targets. One explanation for this outcome may be that prompts and consequences become more salient, and therefore functional, with repeated exposure. Similarly, a history of reinforcement for responses occurring in the presence of certain teaching materials and instructions may cause those stimuli to acquire more rapid stimulus control over the behavior upon repeated presentation. Additionally, many specific targets require the learner to engage in other more generally applicable responses (i.e., orienting) that, once strengthened, may affect learner performance in the
presence of additional learning tasks. In the case of participant 1, it seems likely that
some behaviors that preceded the initial instances of an unprompted response (e.g.,
method for alternating placement of cards across trials) may have been incidentally
reinforced during the first evaluation, and thereby, facilitated his performance on later
picture sequences. Participant 1’s data set may have implications for clinicians as to the
limits of the differential reinforcement advantage in acquisition training. In sum, a
prolonged history of structured teaching may diminish the effects of differential
reinforcement on learning and the prevention of prompt dependence. This procedure
appears likely to have its most meaningful impact among earlier learners who have
mastered fewer generalized learning repertoires and may be more sensitive to the risk of
prompt dependence.

Participant 2

More should also be said about the first alternating treatments design evaluation
of the differential reinforcement procedure from participant 2’s data set. From these
data, the two conditions appear to be equally effective in producing acquisition;
however, subsequent data contradict this conclusion. A more likely explanation is that
multiple treatment interference prevented the two different conditions from
independently affecting participant 2’s performance. Due to an error in the session
ordering process, participant 2 was exposed to only one non-differential session
followed by three consecutive differential sessions at the beginning of training. After
this concentrated experience with the contingencies implemented as of session 2 in the
differential condition (withholding of food for prompted responses), it seems reasonable
that the resulting history would cause responding under the non-differential condition to
conform to those same contingencies. Participant 2’s performance on the non-differential target immediately increased to 60% accuracy by the second session, further inhibiting the degree to which he experienced the delivery of praise-plus-food for prompted responses during the first evaluation. As a result, participant 2 learned the first two targets following a similar number of teaching sessions.

Proposed Mechanisms of Action

At least three possibilities for the mechanism of action that underlies the learning advantages associated with the differential reinforcement of unprompted responses should be considered. First, it is possible that the non-differential reinforcement procedure failed to produce acquisition because error responses were adventitiously reinforced when high quality consequences were delivered contingent upon the prompted response. Teaching procedures for this study dictated that prompts were delivered after a period of 5-s elapsed following the presentation of the relevant discriminative stimulus, or immediately upon the occurrence of an incorrect response. Error responses, in this case, were followed within seconds by the delivery of the high quality reinforcer. Additional support for the role of contiguous reinforcement of errors in the failure of the non-differential condition is the highly reliable manner in which participant 2 emitted a single, incorrect response in the presence of each tact target (“Pik” for “Packing”, “Washy” for “Watching”). The differential reinforcement condition, therefore, may have achieved its effects by interrupting the relation between error responses and delivery of high quality reinforcement.

Some researchers have proposed that negative reinforcement contingencies can play a significant role in the efficacy of various teaching procedures (Iwata, 1987). If
the prompts delivered contingent upon error responses or failure to respond within the allotted interval introduce a sufficiently aversive condition, the avoidance of those prompts occurring when a target response is emitted may come to function as negative reinforcers for accurate and unprompted responding. During this investigation, participant 1 received full physical (hand-over-hand) prompts during training on picture sequencing, and participant 2 received vocal prompts (repeated at 3-s intervals) during tact training. No specific evidence suggesting the presence or role of negative reinforcers associated with avoidance of prompts was observed in the current investigation. Participants were generally very compliant with the prompting procedures, and levels of problem behavior remained low and independent of the use of physical or vocal prompts throughout the study. Another aspect of the current preparation that may establish negative reinforcers associated with instances of unprompted responses is the delay to reinforcement which occurred on prompted response trials. Though the response prompts utilized in this investigation could be implemented within seconds, it is possible that this delay to reinforcement on prompted trials introduced an aversive condition for participant 1 or participant 2. Future investigations might evaluate the degree to which the presence of negative reinforcers enhance or diminish the efficacy of the differential reinforcement procedure, particularly among those children who exhibit aversion to physical touch or direct attention.

Finally, the superiority of the differential reinforcement teaching condition may have been influenced by a difference in response effort associated with prompted and unprompted responses. It is possible that established responses under the stimulus
control of prompts (compliance with physical or vocal imitation, in this study) are fundamentally less effortful than novel or newly acquired responses. In the absence of a contingency favoring unprompted responses (non-differential reinforcement), less effortful prompted responses may remain at greatest strength. Such an occurrence of prompt dependence may then delay or prevent acquisition until specific procedures for facilitating the transfer of stimulus control are applied (e.g., prompt fading, differential reinforcement of unprompted responding).

Future Research

In conclusion, the differential reinforcement of unprompted responses was, predictably, more effective in producing acquisition of motor and vocal responses for two children diagnosed with autism. The procedure appears to render its greatest benefits early in the teaching of novel program areas and with learners who are still acquiring generalized repertoires that also enhance the effectiveness of teaching procedures (i.e., orienting, sensitivity of responding to prompts and consequences). To the degree that the combined affects and overall differences in treatment outcome that may be produced by performance enhancing procedures in clinical EIBI are yet unknown, additional applied research in this area may be warranted. In particular, future outcome data from programs that do and do not integrate strategies like the differential reinforcement of unprompted responding may help practitioners to further identify the circumstances under which these procedures result in the greatest benefits during intervention. Eventually, administrators of EIBI programs for children with autism may then have an empirical basis for modifying, and potentially streamlining,
their treatment packages to produce learning in the most effective and time-efficient manner.
Appendix A

Recruitment Flier
~ Invitation for Your Child to Participate in a Research Study ~

THE EFFECTS OF THE DIFFERENTIAL REINFORCEMENT ON SKILL ACQUISITION AMONG CHILDREN WITH AUTISM

Dear parent,

We are members of the Psychology Department at Western Michigan University and we work with children who have developmental disabilities. We are currently conducting a study that examines the effects of certain kinds of rewards during discrete-trial training and your child may have an opportunity to participate. We are hoping to find children between the ages of 3 and 12 who currently have a diagnosis of a pervasive developmental disorder such as autism. Children who participate in our study will receive discrete-trial training in a variety of skill areas (e.g., labeling pictures, sorting items by category). If you are interested in speaking to someone about the details of this study, please feel free to contact us.

Amanda Firth, B.A
Graduate Student, Psychology
Western Michigan University
387-4629 (firth_wmu@hotmail.com)

James E. Carr, Ph.D.
Associate Professor
Western Michigan University
387-4925 (jim.carr@wmich.edu)
Appendix B

Preference Assessment Data Sheet
Multiple-Stimulus Preference Assessment:

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<tr>
<th>Date:</th>
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</tr>
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<tbody>
<tr>
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<td>Assessor:</td>
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**Foods**

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**Item Summary**
Calculate total # of times chose/ total trial available for each item

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**Item Summary**
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Appendix C

Reinforcer Evaluation Data Sheet (Participant 1)
**Differential Reinforcement Investigation: Reinforcer Evaluation**

<table>
<thead>
<tr>
<th>Initials:</th>
<th>Session #:</th>
<th>Date:</th>
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</thead>
<tbody>
<tr>
<td>Observer: P / S</td>
<td>Condition:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frequency of Pressing Response</th>
<th>Total Responses:</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
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</table>

IOA = \( \frac{I}{T} \times 100 = \% \)

<table>
<thead>
<tr>
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</tr>
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</tbody>
</table>

IOA = \( \frac{I}{T} \times 100 = \% \)

**Operational Definition: Pressing Response**

Forceful placement of the *hand onto the black, foam disk* while it is laying on the tabletop; at least *half of the hand must be in full contact* with the disk in order to score as a response, and the participant’s *hand must be removed completely* from the disk before subsequent responses can be scored (i.e., no “rocking”).
Appendix D

Reinforcer Evaluation Data Sheet (Participant 2)
Differential Reinforcement Investigation: PR Reinforcer Evaluation

<table>
<thead>
<tr>
<th>Frequency of Pressing Response</th>
<th>Total Responses</th>
<th>SR Delivered?</th>
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<tr>
<td>FR1</td>
<td></td>
<td>Y/N</td>
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<tr>
<td>FR3</td>
<td></td>
<td>Y/N</td>
</tr>
<tr>
<td>FR5</td>
<td></td>
<td>Y/N</td>
</tr>
<tr>
<td>FR7</td>
<td></td>
<td>Y/N</td>
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<tr>
<td>FR9</td>
<td></td>
<td>Y/N</td>
</tr>
<tr>
<td>FR11</td>
<td></td>
<td>Y/N</td>
</tr>
<tr>
<td>FR13</td>
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<td>Y/N</td>
</tr>
<tr>
<td>FR15</td>
<td></td>
<td>Y/N</td>
</tr>
<tr>
<td>FR17</td>
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<td>Y/N</td>
</tr>
<tr>
<td>FR19</td>
<td></td>
<td>Y/N</td>
</tr>
<tr>
<td>FR21</td>
<td></td>
<td>Y/N</td>
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</tbody>
</table>

Operational Definition: Tile Response

Placement of a single tile through the slot on the tub. Multiple tiles that are inserted at one time should be scored as a single response.
Appendix E

Treatment Evaluation Data Sheet
## Treatment Evaluation Data Sheet

**Scoring:** Correct = (+), incorrect = (-)

**IOA:** circle P if primary, S if secondary

<table>
<thead>
<tr>
<th>Treatment Integ</th>
<th>Observer</th>
<th>Session</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sd</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Reinforcement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prompt</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intertrial Interval</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
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<td></td>
<td></td>
</tr>
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<td></td>
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<tr>
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<td></td>
<td></td>
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</tbody>
</table>
Appendix F

Informed Consent Script
Sample Script for Initial Contact with Parent

This script represents the content of the initial contact with parents/caregivers after they have indicated interest in the research study.

1. Greeting, Introduction and identification of status
2. Brief description of the project and purpose
   Would you like some information about the study? We are looking at a procedure to help children learn (such as labeling animals) in early intervention programs. It's a procedure that's been successful in other studies, but these positive effects have not been demonstrated with children diagnosed with autism. Specifically, the procedure involves providing better rewards for correct, unprompted responses to our questions than for prompted responses. If successful, this procedure may lead to fewer errors and quicker learning of the newly taught items. We plan on teaching approximately 6 skills across two programs during this study.

3. Determination of eligibility
   One of the things we have to do is identify children who fit the requirements for the study since the study would not be appropriate for all children. We are working with children who:
   - have a diagnosis of autism or pervasive developmental disorder (NOS)
   - are between the ages of 3 and 12
   - can follow simple instructions (such as “sit down” and “come here”)
   - don’t have significant problem behaviors (like self-injurious behavior or hitting or biting people)

   Does your child fit this description? (Check with the following questions)
   - What is your child’s diagnosis and can you provide written documentation of that diagnosis?
   - How old is your child?
   - How does your child react when an adult comes nearby?
   - When an adult shows him/her a toy?
   - When an adult speaks to him/her?
   - When an adult asks him/her to do something?
   - Does your child ever harm himself or others? (explain)

   If child appears to meet the criteria for participation, continue with # 4 below. If child does not meet the criteria, say to parent:

   We really appreciate your interest in this study. However, it seems that your child doesn’t fit the requirements for participation in the study because ... (age, no documented diagnosis, or behavior problem which would exclude him/her).

   - If your child does have serious problem behaviors at this time, he/she will not be eligible to participate in the study. However, if you are interested in receiving services to reduce your child’s problem behavior or would like to hear more about other
treatments, please call Dr. Jim Carr or Dr. Linda LeBlanc at the WMU Center for Autism (387-4459).

4. Description of procedures
This is what we'll be doing with families who are participating in the study.

- First we'll come to your home or invite you to campus to talk with you about your child (age, preferences, diagnosis). This should take no longer than about an hour.
- Then we will do two assessments; one of what s/he likes to play with and one of things that s/he likes to eat.
- These two assessments will probably take about an hour, maybe a little less.
- Then we will set up a schedule for providing the treatment in your home or on campus. If we decide to have sessions in your home, we will also determine where the best place would be to work.

5. Duration of study
The experimenter will work with your child for about an hour, once a day for 3-5 days a week. We expect the study to last between 2-3 months.

6. Benefits to child
Because this study provides early intervention therapy, we hope that this procedure will help your child learn a variety of items across two program areas (e.g., labeling animals, reading).

7. Voluntary participation, Risks, Precautions
Your participation in this study is completely voluntary and you can discontinue at any time without penalty. We don't anticipate any risks to your child except possibly mild frustration with difficult tasks. We'll try to avoid this by keeping the sessions brief and giving lots of praise and rewards. If your child becomes upset we'll stop the session and try again later. If 5 sessions are discontinued because your child is upset, we will discuss with you your child's further participation in the study. Again, you may withdraw at any time without penalty to you or your child.

8. Whom to call with questions
If you have any other questions or concerns, you can also call Dr. Carr at WMU (387-4925).

9. Invitation
Would you be interested in learning more about the study? (If parent indicates yes, arrange appointment time for initial home visit. If parent declines invitation, thank parent for time and interest). You do not need to make a decision about participating in this study until you have read the consent document and had a chance to ask questions. Once this occurs, you will be asked to sign the consent document.
Appendix G

HSIRB Consent Form
Permission of Parent or Guardian

Principal Investigator: James E. Carr, Ph.D.
Co-investigator: Amanda Firth, B.A.
Student Investigator: Jamie Severtson, B.A.

Your child has been invited to participate in a research project entitled “The Effects of Differential Reinforcement on Skill Acquisition among Children with Autism.” The purpose of this study is to assess whether providing the most powerful rewards only following independent responses will help children with autism to acquire skills more quickly than traditional teaching methods.

Permission for your child to participate in this project means that your child will receive individualized treatment in the preacademic/academic areas of vocal and motor behavior (e.g., following instructions, matching, receptive/expressive language). After a brief interview with you and an initial assessment with your child, your child will be taught approximately 12 specific skills. Unprompted responses to half of the skill programs will result in brief access to your child’s favorite toys and foods. Prompted and unprompted responses to the other half of the programs will result in brief access to your child’s favorite foods, only.

Your child will be asked to participate for approximately 2-3 months, with approximately 3-5, 1-hour visits being conducted per week. During each visit, the experimenter will teach your child using one-on-one training. In a typical session, your child will be seated at a small table, with the experimenter seated either next to or across from your child. Your child will be presented with various pictures and objects and will be asked to say or point to the correct one. If your child is correct and unprompted, he or she will be given praise, a bite of food, and a toy reward. If your child is prompted, he or she will be given praise and a bite of food, as well as a toy reward during some sessions.

The benefits your child may receive in this study are (a) learning new skills and (b) frequent adult attention and preferred rewards. However, in the event that the study is unsuccessful, there may be no benefits resulting from participation in the study. In the event the study is successful, the science of early intensive behavioral treatment might be enhanced.

The primary risk associated with participation in this study is that your child may experience some frustration at being presented with task demands. To counter this risk, all responses will be rewarded and sessions will be kept brief. In addition, if your child shows signs of distress (e.g., crying), sessions will be terminated. If 5 sessions in a row are terminated due to your child’s distress, the experimenter will discuss with you your
child's continued participation in the research. If your child is excused from the study it will be without penalty; however, he/she will lose the opportunity for the treatment provided by this study. As in all research, there may be unforeseen risks to your child; however, these risks should be no different from those associated with the typical school environment. If an accidental injury occurs, appropriate emergency measures will be taken; however, no compensation or treatment will be made available to you or your child except as otherwise specified in this permission form.

As an alternative to participating in this study, behavioral treatment services can be obtained locally from the WMU Center for Autism (269-387-4459) and Esch Behavioral Consultants, Inc. (269-375-9424).

All of the information collected in this study will remain confidential. That means that your child's name will be omitted from all data collection forms and a code number will be used instead. The principal investigator will keep a separate master list with the names of the children and the corresponding code numbers. No names will be used if the results are published or reported at a professional meeting. During the study, the staff will videotape all of the sessions with your child. These videotapes are to be used only for the purposes of data collection and training in this study and will be kept confidential. All information and videotapes will be stored for at least 3 years in locked file cabinets in the Clinical Behavior Research Laboratory (Wood Hall – 1526) or Dr. Carr's office (Wood Hall – 3758) at WMU. Only research staff involved with this project will have access to these videotapes.

You may refuse to have your child participate or you may withdraw your child from this study at any time. Not participating or withdrawing from this study will not negatively affect your child or any other services they are being provided. If you have any questions or concerns about this study, you may contact Dr. James Carr (269-387-4925), Amanda Firth (269-377-4478), or Jamie Severtson (269-387-4629). You may also contact the Human Subjects Institutional Review Board (269-387-8293) or the Vice President for Research (269-387-8298).

This permission document has been approved for use for one year by the Human Subjects Institutional Review Board as indicated by the stamped date and signature of the board chair in the upper right corner. You must not agree to participate in this project if the corner does not have a stamped date and signature.

Your signature below indicates that you, as parent or guardian, can and do give your permission for ______________________________________ (child’s name) to participate in the previously described experimental intervention.

Parent Signature ____________________________ Date _______________

Permission Obtained By ____________________________ Date _______________
Appendix H

HSIRB Approval Letter
Date: June 15, 2005

To: James Carr, Principal Investigator
    Amanda Firth, Student Investigator for thesis
    Jamie Severtson, Student Investigator

From: Mary Lagerwey, Ph.D., Chair

Re: HSIRB Project Number: 05-05-05

This letter will serve as confirmation that your research project entitled “The Effects of Differential Reinforcement of Independent Responding on Skill Acquisition Among Children with Autism” has been approved under the full category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note that you may only conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: May 18, 2006
BIBLIOGRAPHY


