A Comparison of Maintenance-Training Methods for Children Diagnosed with Autism

Nicholas L. Weatherly

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A COMPARISON OF MAINTENANCE-TRAINING METHODS
FOR CHILDREN DIAGNOSED WITH AUTISM

by

Nicholas L. Weatherly

A Dissertation
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
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Dr. Richard W. Malott, Advisor

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Nicholas L Weatherly
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>SECTION</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>ii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>vi</td>
</tr>
<tr>
<td>CHAPTER</td>
<td></td>
</tr>
<tr>
<td>I. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>Early Intensive Behavioral Intervention (EIBI)</td>
<td>1</td>
</tr>
<tr>
<td>Maintenance-Training Methods</td>
<td>3</td>
</tr>
<tr>
<td>Partial-Reinforcement Schedules</td>
<td>4</td>
</tr>
<tr>
<td>Overlearning</td>
<td>7</td>
</tr>
<tr>
<td>The Purpose of this Study</td>
<td>8</td>
</tr>
<tr>
<td>II. METHODS</td>
<td>11</td>
</tr>
<tr>
<td>Participants</td>
<td>11</td>
</tr>
<tr>
<td>Brian</td>
<td>11</td>
</tr>
<tr>
<td>Chris</td>
<td>11</td>
</tr>
<tr>
<td>Felicia</td>
<td>12</td>
</tr>
<tr>
<td>Setting</td>
<td>12</td>
</tr>
<tr>
<td>Design and Procedures</td>
<td>13</td>
</tr>
<tr>
<td>Procedural Integrity</td>
<td>16</td>
</tr>
<tr>
<td>Maintenance Method 1: Overlearning (Continuous Reinforcement)</td>
<td>17</td>
</tr>
<tr>
<td>Maintenance Method 2: Overlearning (Partial Reinforcement with Scheduled Thinning)</td>
<td>17</td>
</tr>
<tr>
<td>Control Condition</td>
<td>18</td>
</tr>
<tr>
<td>Maintenance Testing</td>
<td>18</td>
</tr>
<tr>
<td>Interobserver Agreement</td>
<td>18</td>
</tr>
<tr>
<td>Curricular Programs</td>
<td>19</td>
</tr>
</tbody>
</table>
Table of Contents – continued

CHAPTER

Motor Imitation ................................................................. 19
Matching – Letters ............................................................. 19
Matching – Pictures ........................................................... 20
Receptive Instruction Following ............................................. 20

III. RESULTS ........................................................................ 21

IV. DISCUSSION .................................................................... 24
    General Discussion ........................................................ 24
    Limitations and Future Directions ...................................... 27
    Conclusions ...................................................................... 30

REFERENCES ........................................................................ 32

APPENDICES

A. Procedural-Integrity Form .................................................. 43
B. Maintenance Testing (Brian): Matching – Pictures ...................... 44
C. Maintenance Testing (Brian): Motor Imitation .......................... 45
D. Maintenance Testing (Chris): Motor Imitation .......................... 46
E. Maintenance Testing (Chris): Receptive Instruction Following .... 47
F. Maintenance Testing (Felicia): Matching – Letters ..................... 48
G. Maintenance Testing (Felicia): Receptive Instruction Following .... 49
H. Final Performance During Maintenance-Testing Sessions after 40 Post Training Days (Across All Six Programs) .................. 50
I. Median Maintenance Performance during All Maintenance- Testing Sessions .......................................................... 51
J. Median Maintenance Performance after 40 Post-Training Days (Across All Six Programs) ................................................. 52
K. Skill Acquisition Length across Programs and Participants ........ 53
L. HSIRB Approval Letter and Proposal (Project Description) ......... 54
M. Additional Information on Early Intervention Literature ............ 61
APPENDICES

N. “Motor Imitation” Curricular Program ................................................................. 67
O. “Matching - Letters” Curricular Program ............................................................ 68
P. “Matching - Pictures” Curricular Program ............................................................ 69
Q. “Receptive Instruction Following” Curricular Program ......................................... 70
LIST OF FIGURES

1. Final Performance during Maintenance-Testing Sessions ................................................. 21
CHAPTER I

INTRODUCTION

Early Intensive Behavioral Intervention (EIBI)

Early intensive behavioral interventions (EIBI) administered during preschool years have been shown to produce a significant and socially valid impact on children diagnosed with autism and other developmental disorders (Anderson, Avery, DiPetro, Edwards, & Christina, 1987; Birnbrauer & Leach, 1993; Fenske, Zalenski, Krantz, & McClannahan, 1985; Green, Brennan, & Fein, 2002; Harris, Handleman, Gordon, Kristoff, & Fuentes, 1991; Lovaas, 1987; Remington et al., 2007; Sheinkopf & Siegel, 1998; Weiss, 1999). The field of applied behavior analysis has given the treatment of Autism Spectrum Disorder, Pervasive Developmental Disorders (PDD), and PDD-Not Otherwise Specified (PDD-NOS) a great deal of professional recognition since Lovaas outlined the successful use of behavioral applications in this area (1981; 1987). In order for these interventions to reliably produce effective results, they should involve empirically validated training components (Butter, Mulick, & Metz, 2006).

Howard, Sparkman, Cohen, Green, and Stanislaw (2005) provided a protocol for these early intensive behavioral interventions that was empirically demonstrated to be superior to the more traditional interventions often seen in typical special education classrooms (e.g., “eclectic” treatment, music therapy). Their protocol consisted of eleven criteria:

1) The intervention should start at an age of one to five years.
2) It should be in place 20 to 30 hours per week.

3) Learning opportunities should consistently occur in the home, school, and community.

4) The intervention should be approximately four to six hours of direct treatment per day, with scheduled breaks and structured procedural schedules to eliminate excessive pauses.

5) It should be focused on the children, in conjunction with, but not solely relying on training caregivers with the assumption it will be correctly provided to the parents.

6) Individual goals should be set for each child.

7) The intervention should be continuously assessed.

8) There should be a team of trained assistants involved.

9) It should last at least 14 months.

10) Parents should be educated on the intervention methods.

11) Behavioral principles should be applied to the intervention.

In addition, the intervention methods should avoid ineffective training components that have little to no empirical support (e.g., holding therapy), those that have been found to be ineffective (e.g., sensory integration therapy), and especially those that have been found to be harmful in scientific studies (e.g., facilitated communication) (Biklen, 1992, 1993; Biklen & Shubert, 1991; Green, 2008; Montee, Miltenberger, & Wittrock, 1995).

Several studies have demonstrated that EIBI programs produce superior results as compared to intensive “eclectic” programs that involve a combination of behavioral and
non-behavioral interventions. These programs include early intervention/special education classrooms with training components, such as speech therapy and music activities, commonly seen in classrooms for typically developing children (Eikeseth, Smith, Jahr, & Eldevik, 2002; Green, 2008; Howard et al., 2005; Lovaas, 1987; see Appendix M for additional related EIBI information). Howard et al. reported that, based on the inferior results produced by these typical autism educational classrooms, children would “lose more ground to their typically developing peers the longer they remain in such intervention programs” (p. 377).

Maintenance-Training Methods

The importance of achieving steady performance results following the termination of treatment has always been a fundamental concern for both behavior analysts and educators (Baer, Wolf, & Risley, 1968; Freeland & Noell, 2002; Pereira & Winton, 1991; Stokes & Baer, 1977). Smith (1999) noted the general lack of maintenance in many behavioral and non-behavioral programs as a “crucial omission” because skill acquisition during the original training does not guarantee continuation of those behaviors after the training is terminated; and a lack of skill maintenance would defeat the purpose of early intervention. Maintenance has been defined as the extent to which behavior change continues following the termination or reduction of treatment (Freeland & Noell, 2002; Stokes & Baer, 1977). Stokes and Baer reviewed 270 applied behavior analysis articles and identified strategies used to support the generalization, or maintenance, of behavior change. The most prominent strategy to address generalization (across responses, settings, and experiments) and maintenance was labeled *Train and Hope*, with 135 of the 270 articles categorized into this group and 65% of these involving maintenance. This
strategy involved training for maintenance and periodically probing for performance after
the intervention had been terminated. Any existent maintenance would be documented,
but not actively pursued, demonstrating the need for programming. Also, these articles
reported only limited or anecdotal data and did not address whether the level of
performance maintenance was considered sufficient in terms of the therapeutic goals of
the various training programs. Other strategies included introducing the client to
contingencies available in their natural environment (Ayllon & Azrin, 1968; Baer &
Wolf, 1970; Buell, Stoddard, Harris, & Baer, 1968; Hall & Broden, 1967; Horner, 1971;
Seymour & Stokes, 1976; Stolz & Wolf, 1969) and equating stimulus conditions between
the training and maintenance conditions (Walker & Buckley, 1972).

Partial-Reinforcement Schedules

Response maintenance, which can be weakened by extinction, can be improved
through the use variables that increase resistance to extinction (Lerman & Iwata, 1996).
One such variable is the schedule of reinforcement, specifically the use of
indiscriminable contingencies to help increase resistance to extinction, as measured by
response rate, number of responses, or time required to meet the extinction criterion
(Broden, Bruce, Mitchell, Carter, & Hall, 1970; Ferster & Skinner, 1957; Fowler & Baer,
1981; Kazdin, 1973; Kazdin & Polster, 1973; Pendergrass, 1972; Schwarz & Hawkins,
maintenance when using partial (intermittent) reinforcement (PRF), as compared to
continuous reinforcement (CRF), during correspondence training for nutritious snack
choices with daycare children. Kazdin and Polster (1973) compared the use of partial-
reinforcement schedules with continuous-reinforcement schedules to increase the
maintenance of social skills with two males diagnosed with mental retardation. Once reinforcement was terminated, the participant who received PRF during social skills training continued to interact socially with peers, whereas the participant who received CRF did not. Baer, Williams, Osnes, and Stokes (1984) used delayed reinforcement as a maintenance method for verbal and nonverbal behaviors with typically developing preschool children. Dunlap, Koegel, Johnson, and O’Neill (1987) used thinned reinforcement schedules with intermittent and delayed contingencies to effectively maintain academic behaviors (e.g., performing geometric and geographic puzzles, coloring, beginning letter-printing) with children diagnosed with autism. Although studies demonstrating maintenance effects have evaluated various maintenance methods, none of the studies employed a comparison condition that involved training without a maintenance method.

Even with these studies, Freeland and Noell (1999, 2002) found that no standard procedure existed for promoting maintenance through the use of intermittent or delayed contingencies. This led them to produce a series of experiments evaluating various maintenance-training methods with typically developing children. In 1999, Freeland and Noell produced an increase in student responding (digits completed correctly on multiplication and addition mathematics problems) with continuous reinforcement, and maintenance of responding during maintenance phases after manipulating the schedule using delayed partial reinforcement. The authors replicated this study in 2002 with the goal of extending their results across additional students (typically developing third grade girls) and different mathematics skills (the addition of single digits with sums to 18). Both students stopped completing the mathematics problems during the extinction
sessions that followed a period of training in which the students were offered a reinforcer at the end of each session if their performance scores were at or above goal. However, performance maintained during the extinction sessions that followed the training phases in which reinforcers were delayed and only provided intermittently.

In 1977, Koegel and Rincover used thinned PRF during skill training (nonverbal imitation and receptive instruction following) to produce response maintenance and generalization across settings and tutors. Their results showed that response maintenance during extinction trials was positively related to the intermittency of the reinforcement schedule. Although Koegel and Rincover demonstrated the importance of assessing deficits observed in generalization such as a loss of antecedent stimulus control (Rincover & Koegel, 1975) and maintenance, the use of PRF schedules in applied settings with children diagnosed with autism is limited (Dunlap et al., 1987). Variables such as new peers, different classrooms, new teachers/tutors, and additional curricular programs can be controlled for in the simulated classroom settings most commonly used in the literature on partial reinforcement, but pose methodological difficulties in applied settings. Because resistance to extinction often focuses on measures of response rate, is it important to analyze other factors associated with a particular training method (e.g., stimulus control, response differentiation) that often involve measures of accuracy.

The term partial reinforcement effect (PREE) has been used to describe the increase in resistance to extinction that follows exposure to partial schedules of reinforcement (PRF) (see Lewis, 1960; Mackintosh, 1974, for reviews). In their review of basic and applied extinction literature, Lerman and Iwata (1996) reported that PREE has been observed across a variety of populations and skill areas, as well as with both
free-operant and discrete-trial protocols, although primarily with between-subject designs (see Nevin, 1988, 1992; Svartdal, 2000, 2008 for analyses on the “reversed” PREE often reported in within-subject designs). Lerman and Iwata also stated that resistance to extinction is inversely related to the percentage of reinforced responses during acquisition. Capaldi and colleagues have produced studies with both humans and nonhumans suggesting that resistance to extinction may be related to components comprising the schedules of reinforcement, such as the number of consecutive non-reinforced trials prior to reinforcement, and not simply the schedule of reinforcement alone (Capaldi, 1964; Capaldi & Bowen, 1964; Capaldi, Berg, & Sparling, 1971).

Overlearning

In their review, Lerman and Iwata (1996) reported that PREE is more likely to occur when partial-reinforcement schedules (PRF) are combined with other variables, including lengthy acquisition training (Uhl & Young, 1967). One maintenance strategy used to produce superior skill retention is overlearning. Overlearning training involves the deliberate continuation of practice beyond reaching an established mastery criterion (Driskell, Cooper, & Willis, 1992; Rohrer & Taylor, 2006; Rohrer, Taylor, Pashler, Wixted, & Cepeda, 2005). During this continued practice, overlearning is said to have occurred if performance scores maintained relatively consistently around mastery criterion. Overlearning has been successfully used to maintain performance across a number of academic and technical skill areas (Gilbert, 1957; Richardson, 1973; Rohrer & Taylor, 2006), and is often referred to in educational and technical texts (e.g., Aamodt, 1999; Foriska, 1993; Hagman & Rose, 1983; Lovaas, 1981; Maurice, Green, & Luce, 1996; Spector, 2000; Stokes & Osnes, 1988). Resistance to extinction is often measured
based on response rate, however overlearning effects are primarily measured based on accuracy of responding, often of verbal chains such as word lists (Krueger, 1929; Postman, 1962), components of a 35-mm camera (Bromage & Mayer, 1986), a series of merchandise brands (Craig, Sternthal, & Olshan, 1972), and geography facts (Rohrer et al., 2005). A meta-analysis conducted by Driskell et al. (1992) showed that the overlearning effect might dissipate at longer maintenance intervals (e.g., longer than four weeks). Although overlearning has shown success producing maintenance of motor skills with individuals diagnosed with various levels of mental retardation and developmental disabilities (Chasey, 1977; Chasey & Knowles, 1973; Conners, 1990; Hagin, 1983; Vogel & Konrad, 1988), there have been no empirical studies demonstrating overlearning effects with children diagnosed with autism.

The Purpose of this Study

Maintenance cannot be assumed to occur without sufficient programming (Foxx & Faw, 1990; Freeland & Noell, 1999; Stokes & Baer, 1977), and with persistent neglect of programmed maintenance protocols in treatment programs (Baer et al., 1968; Chandler, Lubeck, & Fowler, 1992; Favell & McGimsey, 1993; Freeland & Noell, 2002; Northup, Vollmer, & Serrett, 1993; Pereira & Winton, 1991) the development of an empirically based method for programming for maintenance still appears to be a crucial concern for behavior analysts and educators. The goal of early intervention, or any training method, is to create enduring changes in the behavior of the children (Guralnick, 1998; Smith, 1999). With the success of EIBI, it is imperative that empirically based methods addressing effective ways to program skill maintenance be extended into this area.
Variables that can increase resistance to extinction and enhance response maintenance, such as overlearning and partial-reinforcement schedules, are already incorporated in current generalization and maintenance literature (Freeland & Noell, 2002; Stokes & Baer, 1977). Also, texts on early intervention strategies with children diagnosed with autism often refer to manipulating the variables related to the reinforcement schedule for a duration of time after a skill has been acquired (Lovaas, 1981; Maurice et al., 1996). For example, Maurice et al. stated that a response should be considered mastered if, after a period of gradually fading the frequency and type of reinforcement following skill acquisition, the child has generalized the skill and it has been maintained for at least three weeks (pp. 191-192). However, there is limited applied (non-simulated) research in this area describing programmed maintenance methods (Chandler et al., 1992; Freeland & Noell, 2002; Northup et al., 1993; Rutherford & Nelson, 1988). These maintenance recommendations also appear to be based primarily on the overlearning literature that largely involves response accuracy with verbal chains, and the partial reinforcement effect that pertains to the rate of responding during extinction. Both research areas fail to address stimulus control across simultaneous discriminations, a skill often trained in early intervention curricular programs (e.g., matching-to-sample, object identification).

The purpose of the current study was to compare the effects of two different maintenance-training methods and one control condition on response accuracy (i.e., stimulus control, response differentiation) with four different curricular programs (matching to sample with letters, matching to sample with pictures, motor imitation, and receptive instruction following). Three children enrolled in a public preschool autism
educational classroom were involved in this study. Each was trained with two of the four curricular programs, using both maintenance-training methods and the control condition with each program. One maintenance method involved a period of overlearning using continuous reinforcement. A second maintenance method also involved a period of overlearning following skill acquisition, however instead of continuous reinforcement, the reinforcement schedule was thinned from a fixed-ratio 2 schedule to a fixed-ratio 3 schedule. During the control condition, no subsequent training took place following skill acquisition.
CHAPTER II

METHOD

Participants

Participants were selected from a public autism preschool program (Howard et al., 2005) in southwest Michigan. The children selected for participation must have entered the preschool classroom with a diagnosis of early childhood developmental delay (ECDD) or autism. The participant pool contained primarily male students, and all three participants selected were males. Given that the study involved comparing different maintenance-training methods within two separate curricular programs for each child, a child could only be considered for inclusion in the current study if he were scheduled to begin at least two new curricular programs. Only three children met this criterion.

Brian

Brian (age 3 years, 9 months) had been enrolled in the preschool classroom where the current study took place for five months. During these five months he had mastered 12 curricular programs including various attending (e.g., eye contact), imitation, matching, and identification skills. He was also making rapid progress with his vocal verbal behavior. Brian displayed occasional tantrums during transitions and curricular programs.

Chris

Chris (age 4 years, 5 months) had been enrolled in the preschool classroom for two years. During these two years he had mastered 21 curricular programs across
training areas such as fine motor skills (e.g., string beads, peg board), appropriate play (e.g., roll ball), attending, imitation, and matching. Chris had made little progress with his vocal behavior, however was able to communicate using his non-vocal verbal skills (i.e., PECS). He displayed occasional disruptive behaviors during curricular programs.

**Felicia**

Felicia (age 3 years, 8 months) had been enrolled in the preschool classroom for nine months. During these nine months she had mastered 15 curricular programs including various identification, imitation, matching, and manding skills. She was making rapid progress with her vocal verbal behavior, with infrequent episodes of noncompliance during curricular programs.

**Setting**

The staff:child ratio in the classroom was 1:1, with undergraduate and graduate students from a local university tutoring the children. A certified special education teacher directed the classroom, with the help of two classroom aides who had bachelor’s degrees in psychology and training in behavior analysis. In addition, four graduate teaching assistants and a professor from the Behavior Analysis Program in the university’s psychology department were involved. These graduate students included the author of the current study and three other behavior-analysis doctoral and master’s students who trained and supervised the tutors working with the preschool children in the classroom. The children attended school for three hours a day, five days a week. Daily activities included discrete-trial training, Picture Exchange Communication Systems (Bondy & Frost, 1994), activities of daily living, and other typical preschool activities.
such as music group and snack time. Weekly or semi-weekly activities included occupational therapy, speech therapy, and physical therapy.

The preschool classroom where this research was done was the first of three preschool classrooms that encompass the Autistic Impaired (AI) Preschool Program within this public school. Children advanced to the next level classroom once the classroom teacher and parents felt that basic pre-learner skills had been mastered in this first preschool classroom. The classroom housed 27 students who attended school year-round; their ages ranged from 18 months to five years of age. As was typical in this classroom, all of the discrete-trial training for the children in this study was conducted in individual study carols.

Design and Procedures

This experiment was designed to evaluate two overlearning methods (continuous reinforcement and thinned partial reinforcement) and one control condition that did not involve overlearning (all described later). A multielement design was used to compare the two different maintenance-training methods and the control condition so that each of the three children could serve as his or her own control, thus reducing inter-subject variability (Martella, Nelson, & Marchand-Martella, 1999). For each child, this multielement design was replicated across two different curricular programs (also described later). Therefore, each child was trained with 6 different sets of discriminative stimuli, one for each of the three conditions (i.e., two different overlearning conditions and one control) in each of the two curricular programs. For each of the children’s 6 sets of discriminative stimuli, continuous reinforcement was used during acquisition. The training was conducted in the children’s normal classroom setting and integrated into
their normal training schedule, where the children typically completed a specific curricular program two to three times per a three-hour school day. In this study, a child rotated among the 6 sets of experimental training stimuli (3 sets per curricular program for each of the two curricular programs) before any one of the sets was used again. For example, a child might be working with the matching-letters program and with the motor-imitation program. The matching program might involve stimulus set 1 (the letters A, B, and C), set 2 (E, F, and G), and set 3 (H, I, and J). The imitation program might involve stimulus set 4 (waving good bye, touching his elbow, and tapping the desk), along with sets 5 and 6 and their imitative stimuli (the model’s behavior).

Each experimental training session consisted of 10 discrete trials with 1 of the 6 sets of stimuli. Typically, four experimental sessions were conducted each day with a total of 4 of the 6 stimulus sets, interspersed among the non-experimental curricular programs specified by the child’s Individual Educational Program (IEP); therefore, it would typically take one and a half days to train one session with each of the six sets of stimuli. Tutors were instructed to provide no extra training with the experimental curricular programs.

As standard in the classroom, the tutors recorded the percentage of discrete trials in which the child made a correct response for each 10-trial session. The tutor recorded whether the response was correct only for trials where the child actually responded to the instruction with a response in the relevant response class, for example, if the child actually placed the sample card on one of the three comparison cards in a matching-to-sample program and did so without prompting. If a response was not made within the amount of time specified in the curricular program (i.e., 3 seconds), a least-to-most
prompting strategy was used with no reinforcement provided for prompted responses. This prompt hierarchy was standard in this classroom and was also used with incorrect responses. Disruptive responses and failures to respond were recorded but not included in the calculation of the percentage of correct responses; therefore, each session was conducted until 10 actual responses were made. The purpose of this protocol was to ensure that the accuracy of responding was being measured, not simply whether the response occurred (as is common in resistance to extinction literature). The number of trials without a relevant response ranged from 0 – 5 per session during the acquisition and maintenance-training phases with a mean of one. This was consistent across curricular programs, however varied slightly across children. There were no sessions during maintenance testing in which a noncompliant response was observed. (Note that, at the time of this study, the standard classroom procedure was to only run 10 trials, even if some of the trials did not include relevant responses.)

Brief multiple-stimulus without-replacement preference assessments (Carr, Nicolson, & Higbee, 2000) were conducted prior to each 10-trial training session. The first three reinforcers selected by each child during these assessments were used for that session. If a child completed five consecutive training sessions with performance accuracy at 50% or less, the experimenter would have modified the curricular program; however, this never occurred for any of the three children.

Training sessions for a given set of stimuli were conducted until responding was at least 90% correct on two consecutive sessions. Then, for that set of stimuli, the pre-assigned maintenance-training method or control condition was implemented. Thus, maintenance training would be conducted with some of the sets of stimuli, while some of
the other sets could still be in the skill-acquisition phase. The mastery criteria in the classroom where this study took place were at least 80% correct responding for three consecutive sessions or at least 90% for two consecutive sessions. To be consistent across all children and programs, the mastery criterion for the current study was 90% correct responding for two consecutive sessions.

At the end of this study, re-acquisition training was implemented for each set of stimuli where a child’s performance had fallen below the 90% mastery criterion and was continued until that criterion was once again attained. Once mastery criterion was attained, the maintenance-training method demonstrated to be most effective as a result of this study (i.e., overlearning with partial reinforcement) was implemented.

**Procedural Integrity**

The child’s regular tutors ran the experimental sessions approximately 83% of the time, with the author of the current study running the other 17% of the sessions. These percentages were fairly equal for each of the three children. Two tutors were assigned to each child (one tutor per 1.5 hour shift), and were trained by experienced graduate students, who also monitored their performance approximately two to three times per week to ensure procedural integrity across all of their child’s curricular programs. In addition, the author met with each tutor prior to the start of this study to explain the details of the project and provide additional training as needed (e.g., how to implement the fixed-ratio schedules).

The tutor’s behavior during a training/testing session was measured during each trial to assess whether (a) the instruction (discriminate stimulus) was delivered correctly, (b) the tutor accurately recorded whether the child’s response was correct or incorrect,
and (c) the tutor followed the appropriate reinforcement schedule or prompt hierarchy (if needed) immediately after the child’s response (Appendix A). This procedural-integrity score was assessed based on the number of correct behaviors observed divided by the total number of behaviors. Procedural integrity was assessed for 26% of all sessions and averaged 100% for all seven tutors (including the author) involved in this study. Procedural integrity sessions generally occurred during the same days for all three children; therefore integrity was assessed for a comparable number of sessions across children. Interobserver agreement (IOA) was assessed via video for all of these sessions by comparing the overall procedural-integrity score between independent observers (i.e., trained graduate students) for each session, with a mean IOA of 100%.

**Maintenance Method 1: Overlearning (Continuous Reinforcement)**

During this continuous-reinforcement overlearning phase, training continued for 20 sessions (approximately two to three weeks following skill acquisition) using a continuous-reinforcement schedule. These overlearning sessions occurred during the same scheduled time each day, as had the skill-acquisition phase. After the 20th overlearning session, the program was removed from the child’s daily training schedule, and a new curricular program, irrelevant to this study, was put in its place based on the child’s IEP, as was also done with the other maintenance method and the control condition.

**Maintenance Method 2: Overlearning (Partial Reinforcement with Schedule Thinning)**

This second maintenance method was the same as the preceding, except reinforcement was thinned during these 20 overlearning sessions. For the first 10 overlearning sessions, a fixed-ratio 2 schedule of reinforcement was implemented in
which every other consecutive correct response was reinforced. For the remaining 10 overlearning sessions, a fixed-ratio 3 schedule of reinforcement was implemented in which every third consecutive correct response was reinforced. These schedules were based on recommendations reported in texts on early intervention with children diagnosed with autism (Lovaas, 1981; Maurice et al., 1996).

Control Condition

In addition to the two maintenance-training methods, a control condition was assigned to one stimulus set within each curricular program. During the control condition, training for the assigned stimulus set was discontinued immediately following skill mastery.

Maintenance Testing

The maintenance-testing phase began for each child once training had stopped for a given set of stimuli. Approximately every 10th calendar day following the end of training, the child’s tutor or the author administered one 10-trial maintenance-testing session in extinction. The primary dependent variable was the percentage of correct responses the child made during these testing sessions.

Interobserver Agreement

For each participant, IOA was assessed for 67% of the skill-acquisition sessions, 59% of the maintenance-training sessions, and 100% of the maintenance-testing sessions. As with the procedural integrity assessments, IOA was generally scored during the same days across all three children, therefore was assessed for a comparable number of sessions across children. Because the responses were relatively easy to discriminate across the four curricular programs (e.g., matching a sample card to one of three
comparison cards) the mean IOA score for all sessions and across all three children was 100%. An agreement was defined as two independent observers agreeing on whether the child made a correct response during a discrete learning trial, during a 10-trial learning session. The point-by-point agreement formula was used to calculate IOA: \( \frac{\text{# of agreements}}{\text{# of agreements} + \text{disagreements}} \times 100\% \).

Curricular Programs

Because some of the children were scheduled to begin training on the same programs, four programs were involved in the current study. These programs were interspersed with other curricular programs in the child’s daily training schedule. Given the multielement design, curricular programs were only used in this study if they consisted of at least 3 sets of stimuli that could be taught independently.

Motor Imitation

The objective of this program was for the child to imitate the motor action performed by a tutor when instructed, “Do this.” The tutor provided this instruction while simultaneously modeling a motor action (e.g., tapping the desk). Each stimulus set involved three different motor actions (e.g., waving good bye, touching the elbow, clapping hands), presented randomly by the tutor for a 10-trial session (Appendix N). Both Chris and Brian completed this program.

Matching – Letters

For this program, three laminated letter-cards were placed on the table in front of the child. The tutor then presented the child with a letter-card and instructed child to “Match same.” A correct response was recorded if the child correctly matched the letter-card to the identical letter-card on the desk. Each phase of the program involved three
letters, presented randomly by the tutor for a 10-trial session (Appendix O). Felicia completed this program.

**Matching – Pictures**

For this program, three pictures (colored drawings) were placed on the table in front of the child. The tutor then presented the child with a picture and instructed the child to “Match same.” A correct response was recorded if the child matched the picture presented by the tutor to the identical picture on the desk. Each phase of the program involved three pictures, presented randomly by the tutor for a 10-trial session (Appendix P). Brian completed this program.

**Receptive Instruction Following**

The tutor provided the child with an instruction to perform a specific action (e.g., “touch your nose,” “stomp your feet”). A correct response was recorded if the child performed the action specified by the tutor. Each phase of the program involved three actions, presented randomly by the tutor for a 10-trial session (Appendix Q). Both Chris and Felicia completed this program.
CHAPTER III

RESULTS

The overlearning training phase involving a thinned partial-reinforcement schedule (PRF) produced the greatest maintenance for five of the six curricular programs when compared against the overlearning training phase involving continuous reinforcement (CRF) and the no-overlearning control condition. Maintenance was measured by the children’s percentage of correct responses made during the final maintenance-testing session only, and did not include all the maintenance-testing sessions since the end of training. There was no consistent difference between the overlearning (CRF) and control conditions (see Figure 1).

![Figure 1. Final Performance during Maintenance-Testing Sessions](image.png)
Along with producing the highest percentage correct during the final testing sessions, the overlearning (PRF) training method produced a performance at or above the 90% mastery goal for all six programs; however, the overlearning (CRF) and control conditions each produced a performance at or above the 90% goal for only one of the six programs during these final testing sessions. In addition, the median percentage correct was 90% for the overlearning (PRF) method and only 75% for the overlearning (CRF) and control conditions.

The above comparisons between the two maintenance methods and the control condition were made after the same number of days following training with a given curricular program. For example, for the receptive instruction following curricular program, Chris was trained for 22 sessions to mastery, with no overlearning sessions. He was trained for eight sessions to mastery plus 20 sessions of overlearning (CRF); and he was trained for 20 sessions to mastery plus 20 sessions of overlearning (PRF). Thus the total number of training sessions varied among the two maintenance-training methods and the control condition. Therefore, maintenance was tested after the same number of sessions since the end of maintenance training (or since the end of skill-acquisition training for the control condition), regardless of whether a maintenance-training method or the control condition was involved, rather than at the same number of sessions since the start of skill-acquisition training. For example, the first maintenance test occurred 10 days after the end of training for each of the three conditions, then 20 days after the end of training, etc. Thus the time since the end of training was controlled for, but not the time since the start of training. However, suppose maintenance had been tested after the same number of sessions since the start of training. Typically, when would the first
maintenance testing for the control condition have occurred? Because training for the
control condition ended after the acquisition phase, the testing would have occurred after
many more sessions without training than would have been the case for the two
overlearning methods (with their 20 extra overlearning sessions); and thus the results
would have been biased against the control condition.

As just mentioned, each of the maintenance-training methods and the control
condition within a given curricular program involved different numbers of training
sessions. Therefore, each of those three conditions also involved different numbers of
days following training. For example, Chris had only 40 days following training for the
overlearning (PRF) condition, whereas the other two conditions had 50 and 60 days. But
to control for days since training, the final maintenance test was given after 40 post-
training days for each of the maintenance methods and the control condition. Because
the number of post-training days varied greatly among the six curricular programs, the
day on which the final maintenance test occurred also varied greatly among curricular
programs. This was done to assess the maximum impact of the maintenance methods. In
general the differential impact of the overlearning (PRF) maintenance-training method
seemed to increase as a function of days since training (see Appendices B through D).
CHAPTER IV

DISCUSSION

General Discussion

The current study was designed to compare two overlearning maintenance-training methods using different schedules of reinforcement (continuous vs. thinned partial reinforcement), along with a control condition involving no maintenance training, in the context of behavioral skills training with nonverbal children diagnosed with autism. The participants were enrolled in a public school autism preschool program designed to train children in the pre-academic skills needed for success in subsequent classrooms, including classrooms involving their typically-developing peers. Four curricular programs were involved in the study, with comparisons made across three children. A multielement design was used to compare the two maintenance-training methods and the control condition within each curricular program assigned to the children. The classroom teacher assigned two programs to each participant based on their Individual Educational Program (IEP) goals. In general, the results show that overlearning using a thinned partial-reinforcement schedule maintained performance at the 90% mastery criterion more effectively than either the overlearning (CRF) or the control condition.

It is apparent that the 20 additional continuous and partial-reinforcement sessions that followed skill acquisition produced overlearning, as shown through the percentage of
correct responses consistently at or above the mastery criterion during these overlearning training sessions. These overlearning sessions not only provided an increased number of sessions and discrete-trial presentations, but also an increased number of reinforcers used during this skill training. In their review of extinction literature, Lerman and Iwata (1996) stated that basic human and nonhuman studies have shown that the number of reinforcers used during skill training, the number of trial presentations, and the length of skill training may affect resistance to extinction. They also stated that these variables could be manipulated to enhance responses maintenance, which can be weakened by extinction effects. One reported way that these variables can influence extinction involves an increase in resistance to extinction as the number of reinforcers and length of skill training increases (Cooper, Heron, & Heward, 1987; Grant & Evans, 1994; Kazdin, 1994; Mercer & Snell, 1977). Other reports include an increase in resistance to extinction resulting from partial-reinforcement schedules (partial reinforcement effect) (Lewis, 1960; Mackintosh, 1974), specifically based on factors related to the reinforcement schedule such as combining PRF with lengthy acquisition training (Uhl & Young, 1967). Lerman and Iwata reported that studies have shown an increase in resistance to extinction when partial-reinforcement sessions follow a period of continuous reinforcement (Nation & Boyajian, 1980; Pittenger, Pavlik, Flora, & Kontos, 1988).

The current study addresses many of these claims made by the resistance to extinction literature. Many of the variables that can weaken maintenance by extinction effects (e.g., reinforcement schedule during skill acquisition, and length of overlearning) were kept constant to allow for manipulation of the reinforcement schedule that followed skill acquisition. In the current study, although overlearning (CRF) produced more
reinforcers during skill training as compared to overlearning (PRF), it failed to produce superior maintenance. Behavior maintained greater with overlearning (PRF), which followed a period of skill acquisition involving continuous reinforcement. It is interesting to note that, of the six skill-acquisition phases across all three children, the lengthiest skill-acquisition phase was within Chris’ receptive instruction following program (Appendix K), which also produced the greatest overlearning (PRF) effect during maintenance testing (100% correct during the final maintenance-testing session) and the largest difference between methods (30% higher than both the overlearning-CRF and control conditions during the final testing sessions).

Although overlearning (PRF) produced a greater percentage correct during maintenance-testing sessions, what component of the response was maintained and what component can be said to have extinguished? Given that the definition of a correct response used in the current study involved an operant attempt (i.e., did not include non-responding), behavior did not extinguish throughout any of the training phases in terms of the children making some sort of operant response to the instruction. Nor was there a noticeable increase in latency. The behavior changes that occurred during maintenance-testing sessions involved the correctness of the response following the instruction. In other words, the behaviors were never extinguished (i.e., a response was always made); however, the variability in the correctness of the responding increased. Response accuracy was always at or above 70%.

The incorrect responses observed during maintenance-testing sessions were also either one of the responses previously reinforced in the presence of the particular discriminative stimulus (e.g., “Do this”), or they shared the response class. In other
words, the incorrect responses were from the previously reinforced response class and were not novel responses from other unrelated response classes, showing maintenance of response differentiation. Lerman and Iwata (1996) reported that when a behavior is extinguished other responses from that response class would emerge to gain access to reinforcement, although few studies have addressed this issue.

Limitations and Future Directions

Given the lack of applied literature in the area of response maintenance, this area should continue to be examined in the future. Although some settings do not contain the clinical situations that can support controlled experimentation and random assignment for practical, methodological, or ethical reasons (Green et al., 2002; Kazdin, 1982, 1998; Perry, Cohen, & DeCarlo, 1995), behavior analysts still can and should use designs that provide some control rather than settling for non-experimental designs (Anderson et al., 1987; Lovaas, 1987; Sheinkopf & Siegal, 1998; Smith, 1999). The importance of sound methodologies when evaluating the effectiveness of different treatment and treatment components is especially important when the goal is large-scale dissemination of that treatment that affects a large number of individuals, such as with Lord and Schopler (1994) and McGee, Daly, and Jacobs (1994). A useful strategy with this type of opportunity would be to evaluate individual components of a treatment package (Smith, 1999). Identifying the components of the most effective and efficient maintenance methods and the empirical validation of those methods may help with the dissemination of these successful methods into public school autism programs that have historically contained less effective training methods (Eikeseth et al., 2002; Howard et al., 2005).
Although the classroom teacher in the current study worked with the author to address many of the methodological concerns seen in applied research, there were still variables that could have influenced performance. Because the tutors had access to the training materials at all times during the child’s school day, it was difficult to assess whether the skills taught in the current study were only being taught during the scheduled training sessions. However, the author informed the tutors to provide training only during the scheduled sessions and periodically monitored their behavior across these other curricular programs throughout the days in which procedural integrity and IOA were assessed. No tutors were observed implementing unscheduled training sessions. This was consistent with reports from the trained observers and classroom staff.

This classroom also did not allow for random assignment of particular curricular programs. The author met with the classroom teacher to select programs based on the students’ Individual Educational Programs (IEP). The selection of programs based on IEP goals and not based on a reliable assessment of skill deficits could have resulted in the training of skills that children may have previously acquired elsewhere. A small number of skill-acquisition sessions during skill mastery may have been a result of this limitation (Appendix K). For example, Brian’s matching-pictures program, the only program in which overlearning (PRF) did not produce superior maintenance, had the fewest number of skill-acquisition sessions across stimulus sets (3 per set). However, Brian’s performance scores during the first acquisition sessions ranged from 70% - 80% correct across stimulus sets, with a median of 80%. These data suggest that he had already acquired considerable matching skills prior to the start of training and may account for the lack of overlearning effect within that particular curricular program.
With the success of applied behavior analysis in the area of autism and developmental disabilities, maintenance of skills necessary for educational success is a crucial concern. Research on overlearning and partial reinforcement effects with nonverbal individuals with developmental disabilities is limited and nonexistent with children diagnosed with autism. The inconsistent applied results reported in the PREE literature shows a need to address these effects using sound within-subject designs in applied settings. Future studies should continue to examine the components that may increase the effectiveness of partial reinforcement such as the number of reinforcers, the magnitude of reinforcers, and varying lengths of testing for maintenance effects (Lerman & Iwata, 1996).

The current study showed the effectiveness of combining overlearning (PRF) with a preceding skill-acquisition phase that involved continuous reinforcement. Future studies could examine variables related to this sequence such as using partial reinforcement during acquisition and altering the partial-reinforcement schedule used (e.g., fixed vs. variable reinforcement). Other maintenance recommendations commonly seen in the EIBI literature should also be empirically validated and disseminated to help promote more effective and efficient maintenance methods. This direction could include evaluating the effectiveness of using reinforcers from different stimulus classes that are often categorized as more likely to be available in the natural environment (Lovaas, 1987).

With the current design, it is not possible to tell the extent to which any slight decrement in accuracy obtained during the final maintenance-testing sessions resulted from the number of days since the last training sessions or the number of intervening
maintenance-testing sessions conducted in extinction. This confounding could be eliminated in future research. There is also a possibility that, although the maintenance-testing trials were conducted during extinction, presenting the opportunity to respond to discriminative stimuli in other curricular programs could have helped maintain responding and the relatively high level of stimulus control.

Another direction for future research would be to compare the effectiveness of overlearning on the maintenance of correct responding using a percentage of overlearning relative to the number of trials required for skill acquisition (e.g., Craig et al. 1972; Krueger, 1929) instead of a set number of overlearning sessions. For example, instead of using a 20-session overlearning phase, the overlearning phase could be a particular percentage of the sessions needed for the initial skill acquisition. The percentage could be varied to assess its impact on maintenance.

Conclusions

Lerman and Iwata (1996) stated that there is a need for applied investigations that not only focus on transfer of training, but on maintenance of responding as well. The results of the current study showed a superior overlearning effect using partial-reinforcement training sessions following a skill-acquisition phase in which correct responding was continuously reinforced. This overlearning (PRF) effect was observed across post-training time and during extinction sessions, including not only maintenance of operant responses to discriminative stimuli (instructions) but also a general maintenance of stimulus control across discriminations. These results provide empirical evidence about variables that can be manipulated to improve maintenance of stimulus control with nonverbal children diagnosed with autism. Given the success of behavior
analysis in training early academic skills, an empirically validated maintenance method could help children maintain those skills needed to continue succeeding throughout their education.
REFERENCES


and maintenance in extra-therapy responding. *Journal of Applied Behavior Analysis, 10*, 1-12.


Pendergrass, V. E. (1972). Timeout from positive reinforcement following persistent


APPENDIX A

PROCEDURAL-INTEGRITY FORM

Date: ________/______/______ Tutor: ________ Child: ________ Program: ________
Child's Performance Score: ______

<table>
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<td>(immediate, used preferred reinforcer, correctly followed current reinforcement schedule)</td>
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* *Tutor's Performance Score: __________ IGA: __________

*Procedural-integrity score (tutor's performance score):

The number of correct behaviors divided by the total number of behaviors (30)
MAINTENANCE TESTING (BRIAN): MATCHING – PICTURES

Maintenance Testing:
"Matching - Pictures"

- Overlooking - CBF
- Overlooking - FBF (blind)
- Count - No overlapping sessions

Percentage of Correct Responses

Number of Days (after termination of program)
APPENDIX C

MAINTENANCE TESTING (BRIAN): MOTOR IMITATION

Maintenance Testing:
"Motor Imitation"

[Graph showing trends in percentage of correct responses over days.]
APPENDIX D

MAINTENANCE TESTING (CHRIS): MOTOR IMITATION
APPENDIX E

MAINTENANCE TESTING (CHRIS): RECEPTIVE INSTRUCTION FOLLOWING

Maintenance Testing:
"Receptive Instruction Following"

- Overtraining - CNT
- Overtraining - PRF (dimed)
- Control: No overtraining sessions

Percentage of Correct Responses (out of 10 trials) vs. Number of Days (after termination of program)
APPENDIX F

MAINTENANCE TESTING (FELICIA): MATCHING – LETTERS

Maintenance Testing:
"Matching - Letters"

Number of Days
(after termination of program)

Percentage of correct responses

[Graph showing data over a timeline]
APPENDIX G

MAINTENANCE TESTING (FELICIA): RECEPTIVE INSTRUCTION FOLLOWING

Maintenance Testing: "Receptive Instruction Following"

[Graph showing data points over time (10 days to 60 days) with percentage of correct responses (out of correct trials).]

Felicia
APPENDIX H

FINAL PERFORMANCE DURING MAINTENANCE-TESTING SESSIONS AFTER 40 POST-TRAINING DAYS (ACROSS ALL SIX PROGRAMS)
APPENDIX I

MEDIAN MAINTENANCE PERFORMANCE DURING ALL MAINTENANCE-TESTING SESSIONS
APPENDIX J

MEDIAN MAINTENANCE PERFORMANCE AFTER 40 POST-TRAINING DAYS
(ACROSS ALL SIX PROGRAMS)
APPENDIX K

SKILL-ACQUISITION LENGTH ACROSS PROGRAMS AND PARTICIPANTS

![Bar graph showing skill-acquisition length across programs and participants.](image_url)
APPENDIX L

HSIRB APPROVAL LETTER AND PROPOSAL (PROJECT DESCRIPTION)

WESTERN MICHIGAN UNIVERSITY

Date: July 30, 2007
To: Richard Malott, Principal Investigator
    Nicholas Weatherly, Student Investigator
From: Amy Naugle, Ph.D., Chair
Re: HSIRB Project Number: 07-07-24

This letter will serve as confirmation that your research project entitled "A Systematic Evaluation of a Pre-school Autism Intervention: Croyden Avenue School Practice" has been approved under the exempt 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: July 30, 2008
Date: May 5, 2008

To: Richard Malott, Principal Investigator
    Nicholas Weatherly, Student Investigator

From: Amy Naugle, Ph.D., Chair

Re: HSIRB Project Number: 07-07-24

This letter will serve as confirmation that the changes to your research project "A Systematic Evaluation of a Pre-school Autism Intervention: Croyden Avenue School Pracica" requested in your memo received 5/5/2008 (clarification regarding classroom procedures) have been approved by the Human Subjects Institutional Review Board.

The conditions and the duration of this approval are specified in the Policies of Western Michigan University.

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: July 30, 2008
**Protocol Outline**

Project Title: **A Systematic Evaluation of a Pre-school Autism Intervention: A Comparison of Maintenance-Training Methods**

**Abstract**

The purpose of this study will be (1) to evaluate an intensive behavioral treatment for three preschool-aged children diagnosed with autism and (2) to adjust the treatment and assessment procedures as needed, based on that evaluation. This program evaluation and treatment/assessment adjustment are part of the standard continuous quality improvement efforts of the classroom where the study will be conducted. The study will be documented through direct observation and video recordings, which will capture the child’s behavior. The study will take place in the Early Childhood Developmental Delay (ECDD) preschool classroom at Croyden Avenue School, where the treatment is provided by undergraduate and graduate practicum students. The specific aspects of the treatment program to be evaluated in this study deal with the maintenance of skills once the child has learned them. We are asking permission to use these evaluation data and the records of the treatment/assessment adjustments in a dissertation, presentations, and publications to document the effectiveness of this continuous quality improvement effort.

**Purpose/Background Information**

I (Richard Malott) am training BA, MA, and PhD students to be human-service practitioners, generally with a specialty in preschool autism and early childhood developmental delays, not to be either basic or applied researchers. I am not using the researcher/practitioner model. However, I am training my students to continuously evaluate the effects of their work with the children and to modify their treatment/training procedures accordingly. So our first criterion in any practicum, thesis, or dissertation is that the children directly involved in those projects will immediately benefit from their involvement, not just that their involvement will contribute to the long-term betterment of the treatment of subsequent children, though we also have that as a goal, of course.

The current project will involve objectively evaluating the performance of three children diagnosed with autism. The study will examine the current protocol targeting the maintenance of skills mastered by each student involved in the study and will also evaluate different maintenance strategies. Given the importance of training prerequisite skills necessary for a child to learn more advanced post-preschool skills it is essential that a skill, or skill set, maintain in the child’s repertoire after a mastery criterion has been met. Recommended protocols for maintaining a mastered skill involve a process of altering the reinforcement frequency and type, along with a system of maintenance assessment (Maurice, Green, & Luce, 1996; Lovaas et al., 1981). This maintenance process begins by gradually decreasing the frequency and type of reinforcement to a level in which a reinforcer (preferably one that is available in the child’s natural environment) is provided contingent on only some, not all correct responses (e.g., after every third correct response). While altering the reinforcement of a mastered skill, the frequency of training trials may also be reduced along with the number of times the skill is assessed each week. The skill must maintain at a performance criterion (e.g., 8 correct responses...
out of 10 discrete trials) for a given number of weeks. If the skill maintains at the
criterion for at least 3 weeks, many consider the skill to be mastered (Stokes & Osnes,
1988; Maurice, Green, & Luce, 1996). However, it may be beneficial to perform
assessments to empirically demonstrate that the skill has maintained over a period of
months, especially if performance problems ensue with subsequent skill acquisition
sessions where the presumably maintained skills are crucial prerequisites. However we
know of no relevant studies showing such long-term skill maintenance. As part of the
classroom's standard continuous quality improvement, the classroom is currently in the
process of moving to a new maintenance protocol modeled after the standards described
earlier.

**Participant Recruitment**

All participants will be preschool-aged children who are currently enrolled in the
Early Childhood Developmental Delay (ECDD) Classroom at Croyden Avenue School.
The children selected for participation must have entered the Early Childhood
Developmental Delay (ECDD) classroom at Croyden Avenue School with a diagnosis of
Early Childhood Developmental Delay (ECDD) or Autism. The student age range will
be from 2 to 6 years of age. Although the participant pool contains primarily male
students, we will select participants from the entire pool of both boys and girls. The
Early Childhood Developmental Delay (ECDD) classroom teacher will recommend
children to participate in the study based on her involvement with the parents and the
previous involvement of parents in the classroom. An informed consent form will be sent
home to the parents recommended by the classroom teacher asking for permission to use
their child’s data for this dissertation, publications, and presentations. The parents will be
assured that neither names nor any other identifying information will be used in
publications, presentations, or in the dissertation. Whether or not the parents consent for
our use of the data for the dissertation, publications, and presentations their children’s
performance will still be closely monitored and their children will receive any improved
maintenance protocols that are developed. As part of standard classroom protocol, the
parents already sign an informed consent form asking for permission to use their child’s
data, pictures, and/or videos for future training, presentations, and/or publications. Tutors
record daily performance data for each child as part of their Psychology 3570 or
Psychology 5990 practicum duties and will not be asked to perform any additional tasks
not included as a regular part of their practica.

**Informed Consent Process**

All data collection methods that involve the children participating in this study are
used as a regular part of the undergraduate and graduate practica during which this study
will take place. All parents participating in the study will receive two copies of an
informed consent document asking permission for their data to be used confidentially for
a dissertation, publications, and/or presentations. They will have the opportunity to sign
and return one copy and keep the other copy for their records. As stated earlier, all
results will be displayed confidentially for each participant. The consent forms will be
returned to Nicholas Weatherly. The focus of our data collection process will be the
performance of the children, not the performance of the tutors. The tutors and classroom
teacher will only be asked to perform the duties already required as part of their regular obligations. For HSIRB protocols concerning the practicum students, see the section below, though data concerning their performance will not be part of this study.

**Research Procedure**

As part of standard classroom procedure Richard Malott, his graduate students, and the Early Childhood Developmental Delay (ECDD) classroom staff are constantly working to improve all aspects of the treatment provided to the children to improve each individual child’s performance. This standard procedure involves an initial Pre-primary Evaluation Team assessment (PET), yearly IEP goal-setting meetings between Croyden staff and parents, parent meetings, data collection, data analysis, changes made to the training system based on the data analyses, and continuous quality improvement of all procedures, data collection methods, and treatment methods. Specifically, data collected include the percentage of correct responses for each child for the procedures assigned to him or her as part of enrollment in Croyden Avenue School, the occurrence of problem behaviors, and skills obtained throughout their time at Croyden Avenue School.

In this study, we will concentrate on skills mastered and maintained over time. As mentioned earlier, the Early Childhood Developmental Delay (ECDD) classroom is currently in the process of revising the maintenance protocol to better serve the children. The classroom currently lacks an official maintenance protocol, so the purpose of the current study is to evaluate the need for a maintenance protocol and the effectiveness of different maintenance strategies. The first maintenance strategy will involve continuation of training for 20 sessions after the child has mastered that particular training phase at the 90%-for-10-trials mastery criterion used in the classroom. During this maintenance strategy, each correct response will be reinforced. For the second maintenance strategy, training will again continue for 20 sessions following the mastery of a different training phase (within the same training procedure) however reinforcement will be thinned during these sessions. For the first 10 maintenance sessions, every other consecutive correct response will be reinforced. For the remaining 10 maintenance sessions, every third consecutive correct response will be reinforced. The third maintenance strategy will be a control condition in which no subsequent training will occur following the mastery of a different training phase (within the same training procedure). This condition is similar to the classroom’s current maintenance protocol and will assess the need for a maintenance protocol. Each participant will have each of the three maintenance strategies applied to two new training procedures. For example, if Child A is scheduled to start a Match Letters training procedure, once the first phase is mastered the first maintenance strategy will be implemented. Once the second phase is mastered the second maintenance strategy will be implemented. Once the third phase is mastered the third (control) maintenance strategy will be implemented.

All personnel involved with the new maintenance protocol will receive instructions describing the above procedural details from Nicholas Weatherly, and will also be supervised by Nicholas Weatherly. All improvements made to classroom skill maintenance are part of standard continuous quality improvement designed to constantly improve the service provided to the children in the classroom. All data sources are
already part of the undergraduate and graduate practica through Western Michigan University. These projects and their approved HSIRB Project Number are as followed:

- Professional Psychology Practicum: 04-01-42
- Pre-Practicum: 06-12-12
- Intermediate/Advanced Practicum: 05-06-04
- Language Facilitation Training System: 06-12-09

**Methodology**

The model for this study will be a multi-element design. As part of this design, each of the three phases taught as part of the training procedure will be taught simultaneously. The children in the ECDD preschool classroom typically completed a specific training procedure 2–3 times per day. Given the multi-element design used for the current study, the participants will still complete the training procedures that involve the maintenance strategies, however each time they complete the training session for that procedure they will complete a different phase. For example, if the *Match Letters* procedure is used in the current study, the first time the child completes a training session for that procedure they will complete phase 1 (*letters A, B, and C*), the second time they complete the training session during that day they will complete phase 2 (*letters D, E, and F*), and third time they complete the training session that day they will complete phase 3 (*letters G, H, and I*). This cycle repeats until the mastery criterion has been met, as well as throughout the maintenance-training sessions. Given this design, procedures can only be included in this study if the phases can be taught separately, without needing the early phases for completion of future phases. All data for the children involved in the study are collected and evaluated as part of the normal duties of the Croyden Avenue Early Childhood Developmental Delay (ECDD) preschool classroom. Nicholas Weatherly will be analyzing those data as part of this study.

**Risks and Costs to and Protections for Participants**

There are no known risks to the participants.

**Benefits of Research**

A primary objective of this study is to thoroughly evaluate the performance of the children involved in this study and work to continuously improve the maintenance of acquired skills for these children. Given that the most effective maintenance strategy will be disseminated to all other children in this classroom, this project aims to benefit all children in the classroom as well.

**Confidentiality of Data**

The data collected will be stored on a computer disk for at least three years. The computer disk will be filed and locked in Richard Malott’s lab. Once all paper data have been analyzed and compiled for presentation, the original copies of the data will be stored in a box, and locked in a psychology lab at Western Michigan University. The only people who will have access to the disk and paper data will be Nicholas Weatherly and Richard Malott.
References
Howard, Sparkman, Cohen, Green, & Stanislaw (2005) provided a protocol outlining intensive behavior analytic standards based on the most effective intervention components demonstrated in the literature. In other words, this protocol provided guidelines that have been used to produce more successful outcomes than those resulting from treatments that lacked these specified components. The first component of this protocol considers how early the treatment is delivered, with approximately one to five years of age being the standard. The next components comprise standards for what constitute the most intensive treatment, starting with a 20 to 30 hours-per-week instructional requirement. These hours of instruction should contain learning opportunities applied at the home, school, and community. There should also be approximately 4 to 6 hours of direct treatment per day, with scheduled breaks and structured procedural schedules to eliminate excessive pauses. Another best practice component reported is that the treatment should be focused on the children. As within any organization or training system, the treatment components cannot always be delivered to the caregivers alone with the assumption that it will be correctly delivered to the client. The preferred method would be to deliver the treatment directly to the client in conjunction with parent training, both being continuously assessed by a team of trained assistants to allow for improvements to be made at all levels of the training system (e.g. the curriculum trained, the training method, the tutors delivering the training). The final
two components outlined as best practice involve individual goal setting for each child, and a treatment duration that extends to at least 14 months. Throughout this process, behavioral principles should be applied to all treatment methods and systems analysis components. Behavioral principles should also be involved in the selection and analysis of the most effective program (curriculum) that will be administered within these empirically supported early intensive behavior analytic treatment criteria (e.g., Lovaas, 1981).

Following the selection of the most empirically supported early intervention strategy and the most effective program, the next requirement entails the selection of the most effective way to provide the treatment. To ensure continuous quality improvement of the early intensive behavioral intervention provided, the skill-acquisition training method administered to the children must also be empirically based. Certain therapies (e.g. holding therapy, facilitated communication) that are not empirically supported may hinder skill acquisition by taking the focus away from other more effective treatments and/or means of communication. These treatments may also provide family members and caregivers with a false validation of performance success. For example, facilitated communication has been reported to produce literacy in individuals previously thought to be seriously intellectually impaired (Biklen 1992, 1993; Biklen & Shubert, 1991; Montee, Miltenberger, & Wittrock, 1995). However, Montee et al. (1995) demonstrated a lack of validity in the functional communication procedure when they experimentally assessed seven adults who were reported to be communicating fluently through facilitated communication. They found that the clients responded with a correct typed answer only
when the facilitator had access to the same information, responded incorrectly each time the facilitator had no or false information, and typed whichever stimulus was presented to the facilitator when it was different from the one provided to the client. The most empirically supported instructional method for teaching new behaviors and discriminations to children diagnosed with autism has been the discrete-trial training method (Smith, 2001). This treatment has been described as being most effective when combined with additional instructional approaches (e.g. incidental teaching, naturalistic learning) that help initiate the use of the skills acquired through discrete-trial training, generalize and transfer those skills, and reduce any prompt dependency.

Several studies have compared the outcomes of early intensive behavioral interventions with programs that lacked these specified standards. Lovaas (1987) reported few gains with children diagnosed with autism that received training consistent with the type of training provided in typical small education classes common in most public education programs. In 2002, Eikeseth, Smith, Jahr, & Eldevik compared intensive behavioral treatment with an equally intensive “eclectic” treatment provided to young children with autism. The eclectic treatment was described as using a combination of teaching methods (e.g., discrete-trial therapy, TEACCH, sensory integration therapy) that is comparable to many public school autism educational programs. Results showed significantly higher levels of performance during training and follow-up with the intensive behavior treatment as compared to the intensive eclectic treatment, suggesting the type of treatment is more crucial than the intensity of the treatment. These results were also confirmed with the comparisons made by Howard et al. (2005). In this study,
the authors compared an intensive behavior analytic treatment with a public school autism educational program that was run by a special education teacher and a generic local community special education program identified as an early intervention or communicatively handicapped preschool program. General findings of the study reported no statistically significant differences between the mean performance scores of children in both the autism educational program group and the local community special education program group; however, reported statistically significant differences in the mean scores within the intensive behavior analytic treatment group (which were higher in all tested skill domains except for motor skills) as compared to the other two groups.

The results of the Eikeseth et al. (2002) and Howard et al. (2005) studies illustrate the importance of identifying effective training components prior to wide-scale administration of training packages that may include non-empirically based components. Howard et al. (2005) also reported that, based on their findings, children involved in typical public autism educational programs that use a more eclectic training method would “lose more ground to their typically developing peers the longer they remain in such intervention programs” (p. 377). One reason offered for the ineffectiveness of this type of treatment is the multiple transitions from one type of therapy to another throughout the day. These transitions may be to and from locations that involve different training methods that have limited scientific effectiveness and are provided by a varying number of adults involved in the program (e.g., speech therapist, occupational therapist, discrete-trial therapist). Early outcome studies demonstrate the significance of providing effective training components to train children diagnosed with developmental disabilities
to acquire the pre-learner behaviors needed to help improve learning rates towards those of their typically developing peers.

In order to assess the validity of existing autism programs, Smith (1999) provided summaries and analyses of all published outcome data from each of the seven behavior analytic preschool autism programs (Douglas, LEAP, May, Murdoch University, PCDI, UCLA, UCSF) and the two non-behavioral programs (TEACCH, Colorado Health Science). One of his largest concerns was that most of these studies lacked even the most basic features of scientifically sound studies (e.g., experimental design, reliable assessments) that would allow for a reliable conclusion of the effectiveness of the treatment. He also found that, upon reanalysis of the data provided in these studies, most of the results were “less favorable” than the authors had reported. These inconsistencies included low IQ gains when significant gains were reported, the use of high-functioning children at intake, and assessments of maintenance gains over time that may not have included all children that participated in the original study. With regard to the maintenance of skills previously learned Smith noted that 11 of the 12 studies failed to provide data on children’s progress following the termination of the treatment. He noted this as a “crucial omission” because skill acquisition during treatment does not guarantee continuation of these behaviors post-treatment, and a lack of skill maintenance would defeat the purpose of early intervention. However, the long-term effects of the intensive behavior analytic treatment provided in Lovaas’ UCLA model was reported to have the most rigorous methodology of all studies reviewed, with preliminary evidence indicating long term evidence of other behavior analytic treatments (Matson, Benavidez, Compton,
Paclawskyj, & Baglio, 1996). Short and long-term benefits of non-behavioral interventions currently appear to have a lack of validation.
APPENDIX N

"MOTOR IMITATION" CURRICULAR PROGRAM

**MOTOR IMITATION**
**PROCEDURE SHEET**

<table>
<thead>
<tr>
<th>Step</th>
<th>Tutor Actions</th>
<th>Student Actions</th>
<th>Reinforcement</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The tutor sits facing the student and establishes eye contact with the student. The tutor says &quot;<strong><strong><strong>, clap hands&quot;, &quot;</strong></strong></strong>, touch nose&quot;, or &quot;______, arms out&quot;. Randomly rotate between all three stimuli.</td>
<td>Student makes the appropriate imitative response within 3 seconds of the S's.</td>
<td>Provide immediate reinforcement after every correct response (unless told otherwise by NCS).</td>
<td>Student does not make the appropriate response within 3 seconds of the S's. Repeat S's and provide a least-to-most prompt hierarchy until correct response is made. 90% or greater for 2 consecutive sessions.</td>
</tr>
<tr>
<td>2</td>
<td>The tutor sits facing the student and establishes eye contact with the student. The tutor says &quot;<strong><strong><strong>, tap desk&quot;, &quot;</strong></strong></strong>, touch elbow&quot;, or &quot;______, stomp feet&quot;. Randomly rotate between all three stimuli.</td>
<td>Student makes the appropriate imitative response within 3 seconds of the S's.</td>
<td>Provide immediate reinforcement after every correct response (unless told otherwise by NCS).</td>
<td>Student does not make the appropriate response within 3 seconds of the S's. Repeat S's and provide a least-to-most prompt hierarchy until correct response is made. 90% or greater for 2 consecutive sessions.</td>
</tr>
<tr>
<td>3</td>
<td>The tutor sits facing the student and establishes eye contact with the student. The tutor says &quot;<strong><strong><strong>, touch wall&quot;, &quot;</strong></strong></strong>, wave bye&quot;, or &quot;______, arms up&quot;. Randomly rotate between all three stimuli.</td>
<td>Student makes the appropriate imitative response within 3 seconds of the S's.</td>
<td>Provide immediate reinforcement after every correct response (unless told otherwise by NCS).</td>
<td>Student does not make the appropriate response within 3 seconds of the S's. Repeat S's and provide a least-to-most prompt hierarchy until correct response is made. 90% or greater for 2 consecutive sessions.</td>
</tr>
</tbody>
</table>
# "MATCHING – LETTERS" CURRICULAR PROGRAM

## MATCHING – LETTERS

**PROCEDURE SHEET**

<table>
<thead>
<tr>
<th>Trial</th>
<th>Stimulus</th>
<th>Participant</th>
<th>Stimulus 1</th>
<th>Response 1</th>
<th>Stimulus 2</th>
<th>Response 2</th>
<th>Response 3</th>
<th>Behavioral Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A, B, C</td>
<td>S6</td>
<td>A</td>
<td>Match A</td>
<td>B</td>
<td>Match B</td>
<td>C</td>
<td>90% or greater for 2 consecutive sessions</td>
</tr>
<tr>
<td>2</td>
<td>D, E, F</td>
<td>S6</td>
<td>D</td>
<td>Match D</td>
<td>E</td>
<td>Match E</td>
<td>F</td>
<td>90% or greater for 2 consecutive sessions</td>
</tr>
<tr>
<td>3</td>
<td>G, H, I</td>
<td>S6</td>
<td>G</td>
<td>Match G</td>
<td>H</td>
<td>Match H</td>
<td>I</td>
<td>90% or greater for 2 consecutive sessions</td>
</tr>
</tbody>
</table>

---

The tutor sits facing the student and establishes eye contact with the student. The tutor places the letters A, B, and C on the table. The tutor hands the student a letter card and says, "_________, match same." Randomly rotate between all three stimuli.

Student matches the letter presented by the tutor to the identical letter on the desk within 3 seconds of the S6.

Provide immediate reinforcer after every correct response (unless told otherwise by EIC).

Student does not make the response within 3 seconds of the S6.

Repeat S6 and provide a least-to-most prompt hierarchy until correct response is made.

---

The tutor sits facing the student and establishes eye contact with the student. The tutor places the letters D, E, and F on the table. The tutor hands the student a letter card and says, "_________, match same." Randomly rotate between all three stimuli.

Student matches the letter presented by the tutor to the identical letter on the desk within 3 seconds of the S6.

Provide immediate reinforcer after every correct response (unless told otherwise by EIC).

Student does not make the response within 3 seconds of the S6.

Repeat S6 and provide a least-to-most prompt hierarchy until correct response is made.

---

The tutor sits facing the student and establishes eye contact with the student. The tutor places the letters G, H, and I on the table. The tutor hands the student a letter card and says, "_________, match same." Randomly rotate between all three stimuli.

Student matches the letter presented by the tutor to the identical letter on the desk within 3 seconds of the S6.

Provide immediate reinforcer after every correct response (unless told otherwise by EIC).

Student does not make the response within 3 seconds of the S6.

Repeat S6 and provide a least-to-most prompt hierarchy until correct response is made.
# "MATCHING – PICTURES" CURRICULAR PROGRAM

## APPENDIX P

### MATCHING – PICTURES

**PROCEDURE SHEET**

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Response</th>
<th>Action</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The tutor sits facing the student and establishes eye contact with the student. The tutor places picture cards #6, #5, and #1 on the table. The tutor hands the student a picture card and says, &quot;... match same.&quot; Randomly rotate between all three stimuli.</td>
<td>Student matches the picture card presented by the tutor to the identical picture card on the desk within 3 seconds of the S&lt;sup&gt;0&lt;/sup&gt;.</td>
<td>Provide immediate reinforcement after every correct response (unless told otherwise by NoC).</td>
<td>Student does not make the appropriate response within 3 seconds of the S&lt;sup&gt;0&lt;/sup&gt;. Repeat S&lt;sup&gt;0&lt;/sup&gt; and provide a least-to-most prompt hierarchy until correct response is made. 90% or greater for 2 consecutive sessions.</td>
</tr>
<tr>
<td>2</td>
<td>The tutor sits facing the student and establishes eye contact with the student. The tutor places picture cards #8, #10, and #2 on the table. The tutor hands the student a picture card and says, &quot;... match same.&quot; Randomly rotate between all three stimuli.</td>
<td>Student matches the picture card presented by the tutor to the identical picture card on the desk within 3 seconds of the S&lt;sup&gt;0&lt;/sup&gt;.</td>
<td>Provide immediate reinforcement after every correct response (unless told otherwise by NoC).</td>
<td>Student does not make the appropriate response within 3 seconds of the S&lt;sup&gt;0&lt;/sup&gt;. Repeat S&lt;sup&gt;0&lt;/sup&gt; and provide a least-to-most prompt hierarchy until correct response is made. 90% or greater for 2 consecutive sessions.</td>
</tr>
<tr>
<td>3</td>
<td>The tutor sits facing the student and establishes eye contact with the student. The tutor places picture cards #3, #4, and #9 on the table. The tutor hands the student a picture card and says, &quot;... match same.&quot; Randomly rotate between all three stimuli.</td>
<td>Student matches the picture card presented by the tutor to the identical picture card on the desk within 3 seconds of the S&lt;sup&gt;0&lt;/sup&gt;.</td>
<td>Provide immediate reinforcement after every correct response (unless told otherwise by NoC).</td>
<td>Student does not make the appropriate response within 3 seconds of the S&lt;sup&gt;0&lt;/sup&gt;. Repeat S&lt;sup&gt;0&lt;/sup&gt; and provide a least-to-most prompt hierarchy until correct response is made. 90% or greater for 2 consecutive sessions.</td>
</tr>
</tbody>
</table>
APPENDIX Q

"RECEPTIVE INSTRUCTION FOLLOWING" CURRICULAR PROGRAM

<table>
<thead>
<tr>
<th>Step</th>
<th>Tutor's Instruction</th>
<th>Student's Response</th>
<th>Tutor's Prompt</th>
<th>Next Step</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The tutor sits facing the student and establishes eye contact with the student. The tutor says &quot;________ tap desk&quot;, &quot;<strong><strong><strong><strong>, arms up&quot;, or &quot;</strong></strong></strong></strong>, touch nose&quot;. Randomly rotate between all three stimuli.</td>
<td>Student makes the appropriate response within 3 seconds of the S°. Provide immediate reinforcement after every correct response (unless told otherwise by the S).</td>
<td>Student makes the appropriate response within 3 seconds of the S°.</td>
<td>Repeat S and provide a least-to-most prompt hierarchy until correct response is made.</td>
</tr>
<tr>
<td>2</td>
<td>The tutor sits facing the student and establishes eye contact with the student. The tutor says &quot;________ wave bye&quot;, &quot;<strong><strong><strong><strong>, touch elbow&quot;, or &quot;</strong></strong></strong></strong>, clap hands&quot;. Randomly rotate between all three stimuli.</td>
<td>Student makes the appropriate response within 3 seconds of the S°. Provide immediate reinforcement after every correct response (unless told otherwise by the S).</td>
<td>Student makes the appropriate response within 3 seconds of the S°.</td>
<td>Repeat S and provide a least-to-most prompt hierarchy until correct response is made.</td>
</tr>
<tr>
<td>3</td>
<td>The tutor sits facing the student and establishes eye contact with the student. The tutor says &quot;<strong><strong><strong><strong>, arms out&quot;, &quot;</strong></strong></strong></strong>, stamp feet&quot;, or &quot;________, touch wall&quot;. Randomly rotate between all three stimuli.</td>
<td>Student makes the appropriate response within 3 seconds of the S°. Provide immediate reinforcement after every correct response (unless told otherwise by the S).</td>
<td>Student makes the appropriate response within 3 seconds of the S°.</td>
<td>Repeat S and provide a least-to-most prompt hierarchy until correct response is made.</td>
</tr>
</tbody>
</table>