THE EFFECT OF A DIFFERENTIAL OBSERVING RESPONSE AND AN ERROR CORRECTION PROCEDURE FOR TEACHING CONDITIONAL DISCRIMINATIONS TO CHILDREN WITH AUTISM SPECTRUM DISORDERS

by

Yvonne Lam

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

in

THE FACULTY OF GRADUATE AND POSTDOCTORAL STUDIES

(Special Education)

THE UNIVERSITY OF BRITISH COLUMBIA

(Vancouver)

December 2015

Abstract

A differential observing response (DOR), in which a unique response puts the learner in sensory contact with the sample stimulus (Walpole, Roscoe, & Dube, 2007), is an antecedent strategy used to address faulty stimulus control. Similarly, error correction (EC) procedures are consequence strategies for addressing errors and faulty stimulus control (McGhan & Lerman, 2013). Few studies have compared the combination of an error correction procedure and a DOR; thus, the purpose of this study was to examine this combination for teaching auditory to visual conditional discriminations. The study employed an adapted alternating treatments design with one participant where the primary dependent variable was the number of sessions to reach mastery criterion. A total of three comparative evaluations (i.e., stimulus bundles) were completed in which the auditory-visual stimuli consisted of nonsense consonant-vowel-consonant words assigned to flags. For the first stimulus bundle, more rapid learning was associated with the EC condition. For the second stimulus bundle, neither treatment was associated with more rapid learning, as acquisition in each treatment occurred at the same rate. Finally, for the third stimulus bundle, more rapid learning was associated with the DOR+EC condition. The results indicated that the addition of a DOR to an error correction procedure did not result in more rapid learning of auditory to visual conditional discriminations for the participant. Limitations of the study and directions for future research are discussed.

Preface

This thesis is original, unpublished and independent work by the author, Y. Lam. The project's method was approved by the University of British Columbia's Research Ethics Board (certificate H15-00108).

The author implemented the intervention throughout the study with the supervision from her research supervisor Dr. P. Mirenda. The data were analyzed by both the author, Y. Lam, and a research assistant, Y. Kirwan.

Table of Contents

List of Tables

List of Figures

Acknowledgements

I would like to express my sincerest gratitude to Chris and his parents for being involved with this project. I would also like to thank the research school's board and their staff for their hospitality, as this study would not have been possible without their support.

I offer my enduring gratitude to my research supervisor Dr. Pat Mirenda. Thank you Pat for your mentorship, patience, and above all, for instilling an immense appreciation for research.

I would like to thank Dr. Laura Grow for helping me with the conceptualization and design of this project, and providing feedback as an external examiner. Thanks also to Dr. Joanna Cannon for graciously participating as a member of my committee and offering helpful feedback for the study.

To my colleague and friend, Andrea Kasunic, thank you for providing me with moral support over the past few years. Thank you to my research assistant, Yvonne Kirwan for volunteering your early morning and late afternoon hours to code data.

Thank you to my parents and my brother, Wilson, for always being there. Thank you to my other mom, Rhonda, for all of your support and encouragement.

A special thank you to Rhyan for believing in me, making sacrifices, and supporting me unconditionally throughout this journey in pursuit of higher education.

CHAPTER 1: REVIEW OF THE LITERATURE

Discrete trial training (DTT) is a teaching strategy based on principles of behaviour analysis (e.g., stimulus control, reinforcement). DTT is commonly used in early and intensive behavioural intervention for young children diagnosed with autism spectrum disorder (ASD; Catania, Almeida, Liu-Constant, & DiGennaro-Reed, 2009; Odom, Hume, Boyd, & Stabel, 2012). DTT can be used to teach imitation, receptive language, and expressive language, among other skills (Smith, 2001). As many young children diagnosed with ASD have delays in receptive language skills, many programs in early intervention curricula focus on the development of this skill (Grow & LeBlanc, 2013; Smith, Mruzek, Wheat, & Hughes, 2006).

Receptive language involves a learner responding to the vocal verbal behaviour of others (Grow & LeBlanc, 2013). Deficits in receptive language may result in challenges in a variety of other skill areas such as academics (e.g., reading, writing, and math) and social skills (e.g., following simple instructions; responding to one's name; receptive identification by name, feature, function and class). Receptive language skills that require simple discriminations consist of three components – an antecedent, a response and a consequence. For example, in a simple discrimination, a child might approach an adult after hearing his/her name (S^D) and receive reinforcement for doing so; however, approaching the adult in the absence of hearing his/her name (S^Δ) would not be not reinforced (i.e., extinction). A conditional discrimination consists of four components – a sample stimulus, an array of comparison stimuli, a response, and a consequence; Green, 2001). For example, in an auditory-visual conditional discrimination, a learner might be presented with the auditory sample stimulus *cat* in the presence of pictures of a ball, cat, and desk (i.e., the comparison stimuli). Pointing to the picture of the cat (i.e., the S^D) would result in the delivery of a reinforcer; however, pointing to the picture of the ball or desk (i.e., the S^Δ) would result in response prompting or an error correction procedure.

Faulty Stimulus Control

Errors that are related to faulty stimulus control are particularly problematic during conditional discrimination training (e.g., auditory-visual conditional discriminations). Faulty stimulus control, in which incorrect responding is a result of attending to an irrelevant aspect of the instructional environment, is common among individuals with ASD. Common error patterns include those related to stimulus overselectivity, win-stay responses, position bias, and stimulus bias (Doughty & Hopkins, 2011; Doughty & Saunders, 2009; Dube & McIlvane, 1999; Grow, Carr, Kodak, Jostad, & Kisamore, 2011).

Stimulus overselectivity can be described as attending to only one aspect or feature of a stimulus while ignoring the remaining features (Lovaas & Schreibman, 1971). Overselectivity may be displayed to some degree by typically developing children until around 3 years of age (Reed, Stahmer, Suhrheinrich, & Schreibman, 2013); thus, it is not confined solely to individuals with ASD (Reith, Stahmer, Suhrheinrich, & Schreibman, 2015). Stimulus overselectivity might be observed during receptive sight word instruction. For example, a learner may be able to differentially respond in the presence of the written words cat, big, and mom. However, in this case, it is possible that the beginning letter of these words rather than all three letters influenced the learner's selection response. To increase the likelihood that the learner will attend to all of the components of a written word, a therapist might present the words, cat, can, and sat and evaluate the learner's responses.

Win-stay responses are selection responses to the stimulus that functioned as the S^D in the preceding trial, regardless of the sample stimulus presented during the current trial. Another type of error, positional bias, occurs when the learner reliably selects a stimulus in a particular position of the array (e.g., the stimulus in the left position). Stimulus bias occurs when the learner reliably selects a stimulus regardless of which sample stimulus is presented. Once faulty stimulus control is established, it is difficult to correct the errors while establishing appropriate stimulus control (Schilmoeller, Schilmoeller, Etzel, & LeBlanc, 1979). Thus, it is important to begin training with a procedure that reduces the likelihood of errors and the establishment of faulty stimulus control (Grow & LeBlanc, 2013). Practitioners should use recent literature reviews and research studies to inform the selection of efficient and effective teaching methods that lead to skill mastery, in order to maximize instructional time for other skills (Grow & LeBlanc, 2013; McGhan & Lerman, 2013).

Antecedent-based Approaches for Remediating Faulty Stimulus Control

Two antecedent-based approaches for addressing faulty stimulus control during discrimination training include observing responses (OR) and differential observing responses (DOR). An observing response is an antecedent-based strategy used to increase the learner's sensory contact with the sample stimulus during conditional discrimination training (Grow & LeBlanc, 2013). Doughty and Hopkins (2011) investigated the reduction of stimulus overselectivity by increasing the observing response requirements in a two-sample delayed matching-to-sample task (DMTS). Each trial began with the participant engaging in the OR by clicking the two-sample stimuli in the center of a computer screen either once (i.e., baseline, fixed-ratio (FR) 1 condition) or 10 times (i.e., FR 10 condition). Completing OR requirements resulted in the removal of the two-sample stimuli and the appearance of the three comparison stimuli (i.e., a single stimulus in three of the four corners of the screen). A correct response consisted of clicking the comparison stimulus that was identical to one of the two sample stimuli shown in the preceding screen. Doughty and Hopkins found correct responding increased with the FR 10 OR requirements; however, this level in accuracy of responding was not maintained after a return to the FR 1 OR requirements. The results suggest that the longer sample-stimulus display times associated with the increased OR requirements may have attributed to higher levels in accuracy of responding.

A DOR is similar to an OR except that a unique learner response is associated with each sample stimulus. For example, a learner might repeat an auditory sample stimulus, which varies across trials, before the instructor presents the comparison stimuli (Grow & LeBlanc, 2013). A DOR increases the likelihood that the learner will differentially respond in the presence of multiple sample stimuli (Dube & McIlvane, 1999; Fisher, Kodak, & Moore, 2007). The use of a DOR is an antecedent-based strategy to help avoid faulty stimulus control such as stimulus overselectivity and restricted stimulus control by increasing the likelihood that the learner will attend to the critical features of the sample stimulus (Grow & LeBlanc, 2013; Ploog, 2010; Walpole, Roscoe, & Dube, 2007). While effective, previous research has demonstrated a decrease in accuracy of responding when the DOR is removed (Dube & McIlvane, 1999) and when observing response requirements are decreased (Doughty & Hopkins, 2011).

Dube and McIlvane (1999) investigated the reduction of stimulus overselectivity with nonverbal DORs in two-sample DMTS tasks with three participants. During the compound DOR condition, a DOR trial was presented prior to the two-sample DMTS trial. The DOR trial began when two-sample stimuli were presented on a computer screen; however, once the participant touched the sample stimuli, three additional pairs of stimuli (i.e., the comparison display) appeared in three of the four corners of the screen. The correct pair of stimuli was identical to the two-sample stimuli and the incorrect pairs had only one stimulus that matched the two-sample stimuli. The position of the incorrect stimulus appeared on the right for one incorrect comparison and on the left for the other pair. Once the participant touched the comparison stimuli in the DOR trial, the two-sample DMTS immediately followed without differential reinforcement provided on the DOR trial. The compound DOR produced increases in DMTS accuracy for all three participants; however, removal of the DOR resulted in decreases in accuracy to baseline levels. The authors suggested that future research was needed to explore procedures for removing the DOR from the teaching context while maintaining a high percentage of independent correct responses.

Unlike the Dube and McIlvane (1999) study, Walpole et al. (2007) demonstrated that that the level of accuracy remained high after the removal of a DOR that was embedded in a MTS task. During the baseline condition, overlapping and non-overlapping trials were presented in an alternating manner. In overlapping trials, comparison stimuli consisted of three letter words from the same word set, in which only the third letter of each word was different (e.g., <u>can</u>, <u>cat</u>, and <u>car</u>). Non-overlapping trials consisted of comparison stimuli from different word sets with no letters in common (e.g., <u>cat</u>, <u>lid</u>, and <u>bug</u>). Non-overlapping trials were included for verification of continued discriminations of printed letters and effectiveness of the reinforcing consequences. During the DOR phase, DOR trials were presented prior to an overlapping trial. In DOR trials, the sample and comparison stimuli were the individual distinguishing letters from each word set. For example, the DOR trial with the sample t and comparison stimuli t, n, and r were presented preceding the overlapping trial described above without any differential consequences. Accuracy in responding immediately increased following the introduction of the DOR and remained high after the DOR was removed. In addition, during the generalization condition, in which the distinguishing letter of each word set varied in terms of position, accuracy also remained high. Walpole and colleagues noted two differences between their study and the Dube and McIlvane study. First, in the Dube and McIlvane study, the DMTS task did not allow participants to simultaneously observe the sample and comparison stimuli. Second, the DOR used in the Dube and McIlvane study was a sample-specific matching task. In contrast, the DOR in Walpole et al. study consisted of a matching trial with the component of the sight word that was unique across the sight words.

The findings from Walpole et al. (2007) highlight the importance of DORs that allow learners to simultaneously observe the sample and comparison stimuli. Similarly, the same rationale can be applied to auditory sample stimuli. For example, a therapist might re-present an auditory sample stimulus every 2 s in the presence of comparison stimuli until a response is made or until a predetermined maximum number of repetitions has been reached (Green, 2001). As auditory stimuli are transient, such repeated presentation provides the learner with several opportunities to simultaneously observe the sample and comparison stimuli (Green, 2001). There is preliminary support for the re-presentation of auditory sample stimuli. For example, the addition of a repeated sample stimulus procedure increased the percentage of independent correct responses for one participant during auditory-visual conditional discrimination training (Grow et al., 2011).

Another antecedent-based approach to address faulty stimulus control is a delayed-sample procedure. Doughty and Saunders (2009) used a delayed-sample condition to reduce undesired stimulus control in a printed-letter identity MTS task for one participant and a spoken-to-printed-word MTS for another participant. During the baseline condition for the printed-letter identity MTS task, trials began with the sample stimulus appearing in the center of a touch-sensitive computer screen. Once the sample was touched, two choice stimuli appeared in two of the four corners of the screen, in addition to the sample stimulus. For the spoken-to-printed-word MTS task, baseline condition trials consisted of auditory-visual conditional discriminations (i.e., spoken-to-printed-word). Each trial began with presentation of the auditory sample concurrent with a black square appearing in the center of the screen. The black square disappeared from the screen after it was touched and two choice stimuli (i.e., printed syllables) appeared. The choice stimuli remained on the screen while the auditory sample was repeated every 2 s until a selection was made. To prevent participant responses prior to the presentation of the sample stimulus, the delayed sample condition consisted of presenting the sample stimulus after 5 s elapsed without a response from the participant. Initially, in the delayed sample condition, participant responses decreased in accuracy as a result of pre-sample responses; however, increases in accuracy were observed by the fourth (printed-letter identity) and seventh (spoken-to-printed-word) sessions. High levels of accuracy of responding were maintained after a return to the baseline condition. Although the aforementioned antecedent-based strategies reduce the likelihood of errors, they may not eliminate errors completely. Therefore, consequence-based approaches such as error correction procedures are also used to reduce the frequency of errors.

Consequence-based Approaches for Remediating Faulty Stimulus Control

Error correction is a consequence-based strategy that is often used to address persistent errors and/or faulty stimulus control. The process of selecting a specific type of error correction procedure is a daunting task for any practitioner, as there is wide variability across clinical settings in both teaching procedures and techniques used to reduce or correct errors (Love, Carr, Almason, & Petursdottir, 2009; Odom et al., 2012; Rodgers & Iwata, 1991; Smith, 2001). In addition, with only one exception, the results of studies comparing the efficacy of various error correction procedures have been mixed (i.e., no error correction procedure stands out as more effective or efficient than any other; Leaf et al., 2014; Leaf, Sheldon, & Sherman, 2010; McGhan & Lerman, 2013; Rodgers & Iwata, 1991; Smith et al., 2006; Turan, Moroz, & Crotoeau, 2012). The sole exception was a study in which an error correction procedure requiring an active learner response resulted in more words read correctly, compared to a procedure in which no response was required (i.e., the learner simply attended to the experimenter who modeled the correct response; Barbetta, Heron, & Heward, 1993).

Rodgers and Iwata (1991) identified possible behavioural mechanisms related to the efficacy of several error correction procedures. They compared three error correction procedures during a contingency MTS task. During baseline, correct responses resulted in praise, food items, or pennies; and incorrect responses resulted in a statement that an error occurred. In the baseline condition, differential reinforcement was the potential mechanism for learning. During the error correction condition, the experimenter provided a prompt for an incorrect response and repeated the same trial until an independent correct response occurred, which was then praised. In the error correction condition, differential reinforcement was arranged with an additional negative reinforcement component in which the trial ended contingent on an independent correct response. In addition, each trial ended with an independent, correct response, which may have enhanced the development of appropriate stimulus control. It is also possible that repeated presentation of the same trial might also function as a punisher for incorrect responses. During the avoidance condition, incorrect responses were followed by repeated trials of the task that were unrelated to the target skill. Behavior change in this condition was attributed to punishment in which independent, correct responses functioned to avoid the repeated trials of the unrelated task. Although the taxonomy proposed by Rogers and Iwata provided a useful conceptual analysis of error correction procedures, individualized error correction procedures based on the types of errors, aspects of the task, a learner's history with the task, and different instructional strategies may be more effective across learners and tasks (Smith et al., 2006).

Turan et al. (2012) compared the effectiveness of delay and independent probe error correction procedures. The delay procedure consisted of a 5 s delay following the error, re-presentation of the S^D, and a prompt to respond correctly. Then a new trial (i.e., a different S^D) was implemented. For example, if a learner responded incorrectly by touching the picture of a ball after hearing the auditory stimulus *cat* in the presence of pictures of a ball, cat, and hat (i.e., the comparison stimuli), the instructor waited 5 s to before saying the word *cat* while pointing to the picture of the cat (i.e., model prompt). Then, the instructor presented the next trail. The independent probe procedure consisted of a 3 s delay following an error, re-presentation of the S^D, a prompt to respond correctly, a distractor trial (i.e., a high probability request), and re-presentation of the S^D once more. For example, if a learner responded incorrectly by touching the picture of a ball after hearing the auditory stimulus *cat* in the presence of pictures of a ball, cat, and hat (i.e., the comparison stimuli), the instructor refrained from giving any feedback and waited for 3 s to elapse before saying the word *cat* while pointing to the picture of the cat (i.e., gesture prompt). Once the learner responded correctly by touching the picture of the cat, the next request was a known high probability request (e.g., *clap hands*), before repeating the original trial again by saying *cat.* The delay condition was more effective for two of the three participants and the independent probe condition was more effective for one participant.

Leaf et al. (2010) compared simultaneous and no-no prompting procedures to teach two-choice auditory-visual discriminations. In the no-no prompt procedure, if a learner engaged in two consecutive errors, the experimenter delivered a controlling prompt to ensure the learner responded correctly. For example, if a learner responded incorrectly by touching the picture of a ball after the delivery of the auditory stimulus *cat* in the presence of pictures of a ball, cat, and hat (i.e., the comparison stimuli), the instructor said *no* and repeated the trial. If the learner again responded incorrectly by touching the picture of a ball, the instructor said *no* again, and then repeated the trial a third time by saying *cat* in conjunction with a gestural prompt. In the Leaf et al. study, the simultaneous prompt procedure was identical to the third trial in no-no prompting, in which a controlling prompt is delivered immediately following the error. In both of these procedures, prompted correct responses were followed by the delivery of preferred items. Leaf and colleagues noted two differences between no-no prompting and simultaneous prompting: (a) the rate of prompting (e.g., only one prompt following two incorrect responses in no-no prompting), and (b) the rate of reinforcement (e.g., positive reinforcement is delivered on every trial in simultaneous prompting). Leaf and colleagues found that no-no prompting was more effective than simultaneous prompting for teaching two-choice discrimination tasks to three children with ASD.

Grow and colleagues (2011) used error analyses to develop interventions when stalled progress occurred during auditory-visual conditional discrimination training. For example, the experimenter found that one participant engaged in molecular win-stay responses -- that is, the participant selected the S^D associated with the preceding trial, which interfered with the development of appropriate stimulus control. To address the molecular win-stay responses, an intervention with a DOR (i.e., requiring the participant to repeat the auditory sample stimulus) plus error correction was added to the teaching procedure. The participant met the mastery criteria shortly after introduction of the DOR plus error correction. One limitation of the study was that the individual contributions of the DOR and error correction could not be determined because the experimenters implemented a multi-component intervention. Another limitation was that the effectiveness of the DOR plus error correction was not evaluated using a single subject experimental design. The authors suggested that these limitations should be addressed in future research.

Statement of the Problem and Research Question

Previous research studies have found the addition of an auditory DOR to an error correction procedure to be effective for teaching auditory-visual conditional discriminations. However, these studies did not evaluate the efficiency of this treatment in comparison to an error correction procedure alone, due to limitations of the experimental design of the studies (e.g., Grow et al., 2011; Leung & Wu, 1997). The purpose of the study aimed to fill this gap in the literature by addressing the following question: Does the addition of a DOR to an error correction procedure result in more rapid learning of auditory to visual conditional discriminations, in comparison to an error correction procedure alone for a child with ASD?

CHAPTER 2: METHOD

Participant Recruitment

To recruit participants for the study, invitations were sent home to all students who met the inclusion criteria at an independent school for children with ASD where the experimenter was employed. The inclusion criteria were applied by the researcher in collaboration with the Head of School and included: (a) the ability to work on a 1:1 basis at a table for up to 5 min with little or no problem behaviour; (b) the ability to imitate a pointing response to a picture; (c) the ability to follow an adult's instruction to *say* ____ or *sign* ____ when asked to do so, and to refrain from speaking or signing in the absence of an instruction; and (d) currently working on receptive identification goals as part of an individual education plan (IEP). One participant met all four of these inclusion criteria.

Participant

When the study began, Chris (a pseudonym) was 6 years 9 months old and had been diagnosed wth ASD by a multidisciplinary team at age 2 years 5 months. He is the middle child of three (one of whom also has ASD) in an Asian-Canadian family. Chris was enrolled at the school for 24 months prior to the study, and received 1.5 hours of 1:1 (staff:student) ABA-based therapy and 4.5 hours of 2:3 group-based instruction, 5 days per week. He had also previously been enrolled in an ABA-based preschool for 6 hours per week for 12 months, in combination with home-based ABA-based therapy for 10 hours per week. When this study began, Chris used speech as his primary mode of communication and was able to speak in 3-5 word phrases or sentences and read simple text. One month prior to the start of the study, Chris' age-equivalent scores on the Comprehensive Assessment of Spoken Language (Carrow-Woolfolk, 1999) were 4 years 3 months for basic concepts, 3 years 3 months for antonyms, 2 years 3 months for sentence completion, and 2 years 2 months for syntax construction. Chris' age equivalent score on the Peabody Picture Vocabulary Test – Revised (Dunn & Dunn, 1981) was 3 years 7 months. Although Chris had a history of engaging in non-contextual vocalizations (i.e., scripting), these behaviours did not occur during study sessions.

Setting

The study was conducted at Chris's school, where the experimenter was employed as an assistant behaviour analyst. Sessions took place in a small classroom (2.4 m by 3.1 m) that shared similar properties to an area in which Chris received individualized instruction during the school day. Session materials in the classroom included a table, three chairs, a video camera, toys and activities, and a bin containing the visual comparison stimuli used in this study.

Sessions were conducted for 3 to 5 days per week, between 4 to 8 sessions per day, and were at least 10 minutes apart. The average time per session was approximately one minute. To minimize any disruptions to the participant's daily school routine, sessions took place during two, 45-min intensive teaching periods that were already scheduled in Chris's daily school schedule (one in the morning and one in the afternoon).

Research Design

An adapted alternating treatments design (AATD: Sindelar, Rosenberg, & Wilson, 1985) was used to compare a control condition, an error correction (EC) procedure, and a DOR plus error correction (DOR+EC) procedure for teaching auditory-visual conditional discriminations. Conditions were presented in random order, as dictated by the research design. The AATD differs from an alternating treatments design (ATD) in that the interventions are applied to two or more different but equivalent sets of responses whereas, in an ATD, the effects of two or more interventions are assessed on a single dependent variable. The AATD was selected because it is well suited to compare instructional procedures for teaching skills where learning is irreversible. Although the multiple baseline and multiple probe designs also resolve issues related to irreversible learning, both of these designs are ill-suited for demonstrating a functional relation for multiple interventions.

Materials

Each comparative evaluation consisted of nine auditory-visual stimulus pairs, referred to in the remainder of this paper as a "bundle." Each bundle consisted of three training sets (i.e., three auditory-visual stimulus pairs). Stimulus pairs were generated using country flags that were each assigned a vocal, consonant-vowel-consonant nonsense combination (e.g., *wap*, *tem*, *sid*). This was done to ensure that Chris had no previous experience with either the visual or auditory stimuli and that no incidental teaching would occur. Each training set was assigned to one of the three experimental conditions.

The training sets were equated in terms of difficulty by using a logistical analysis method (Gast, 2010). The auditory stimuli were equated in terms of the (a) number of syllables, (b) initial sounds, and (c) ending sounds. The visual stimuli were selected by ensuring the stimuli were similar in colour or pattern across the training sets (e.g., all featured a star of some type; all had red, white, and blue stripes, etc.). The training sets were equated to increase the likelihood that any differences observed between the conditions were attributable to manipulations of the independent variable rather than differences in the difficulty of the training sets. Figures 1-3 display the auditory-visual stimulus pairs targeted in each bundle.

Figure 1. Stimuli in Bundle 1.

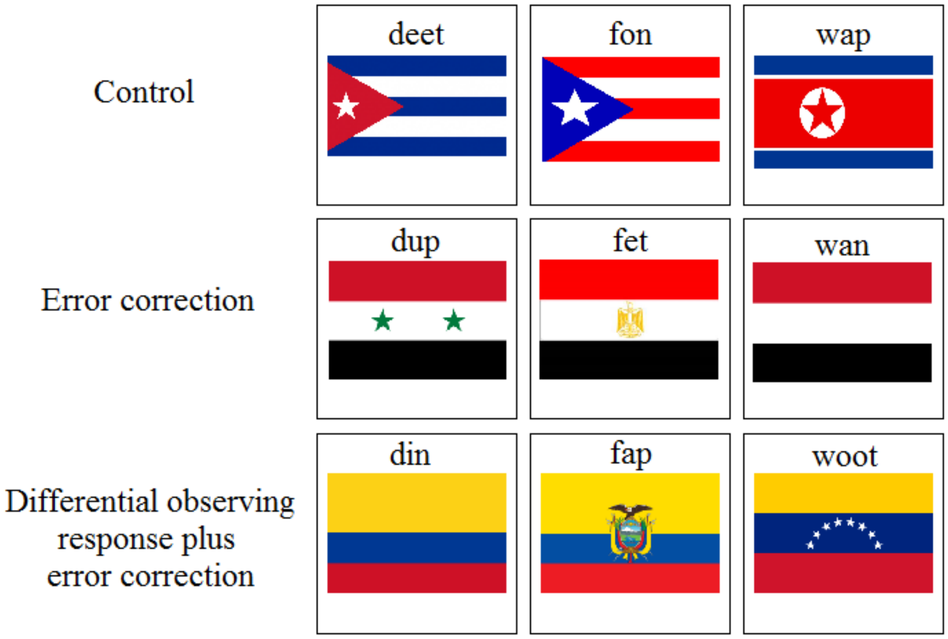


Figure 2. Stimuli in Bundle 2.

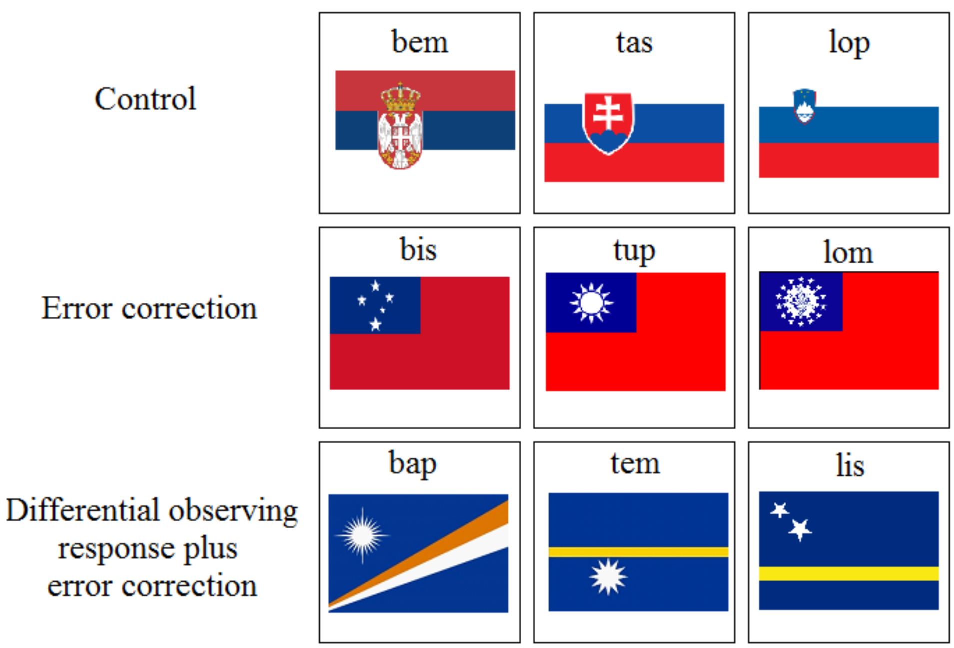
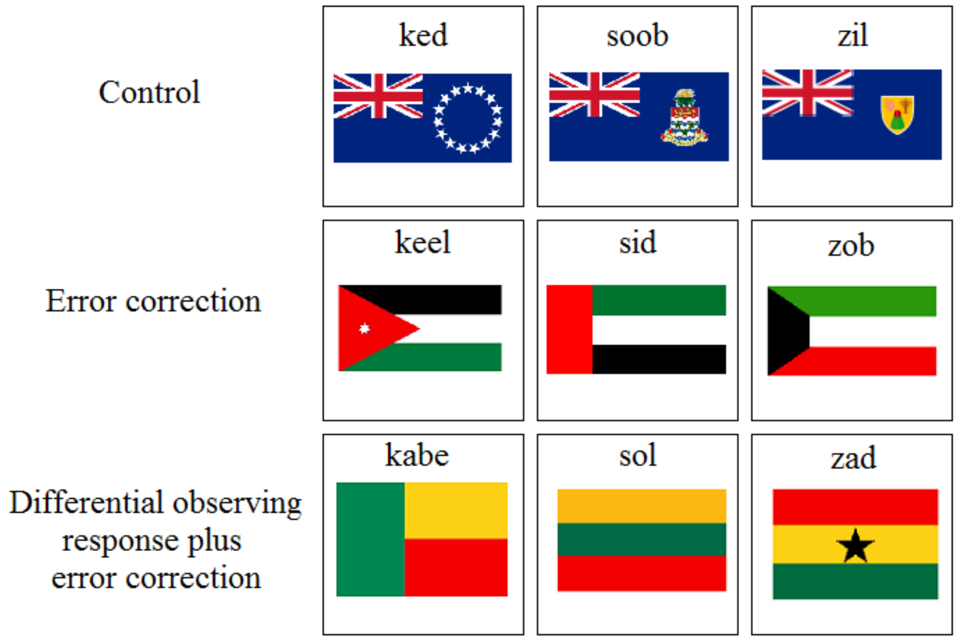


Figure 3. Stimuli in Bundle 3.



Each stimulus set was associated with a colour (e.g., coloured table cloth, coloured sheets of paper, and coloured border) to increase the salience of the experimental conditions (Conners, Iwata, Kahng, Hanley, Worsdell, & Thompson, 2000). In the study, the control condition was red, the EC condition was yellow, and the DOR+EC condition was blue. Each trial sheet consisted of the target visual stimuli printed in a horizontal array on white paper with the relevant coloured border (see Figure 4). With the exception of the DOR+EC condition, all trial sheets were interspersed with coloured sheets of paper, each of which had a visual prompt on the center of the page to remain quiet (see Figure 5). In the DOR+EC condition, the coloured sheets had a visual prompt to engage in the differential observing response *(say ______;* see Figure 5). Each trial sheet was placed in a clear plastic page protector and the materials for each session were held together in a three-ring binder. Trial sheets were created using Boardmaker® Plus! v.6 (Mayer-Johnson, 2004).

Figure 4. Example of trial sheets from Bundle 1.

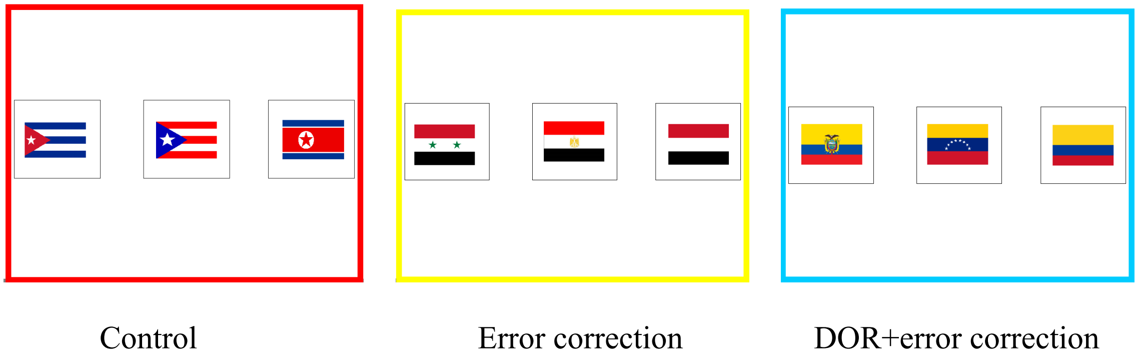
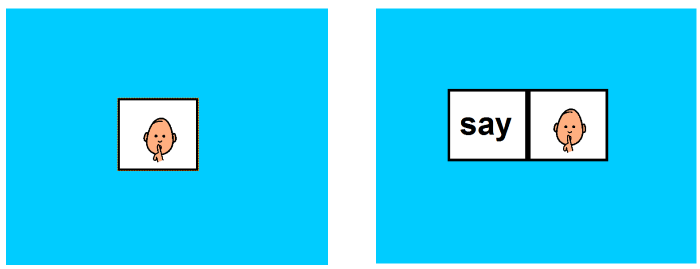


Figure 5. Coloured sheets with *Quiet* (left) and *Say* + *Quiet* (right) visual prompts



Data Collection

Three different data sheets were generated for each condition, with predetermined counterbalancing of the sample and comparison stimuli for the control, EC, and DOR+EC (see Appendices A, B, and C). The stimuli were counterbalanced based on the method described by Green (2001) and Grow and Leblanc (2013); see Appendix D.

Measurement

Dependent Variables

Gast (2010) noted that the most common measurements for comparing rapidity of learning are the: (a) number of sessions, (b) number of seconds/minutes of instruction, and (c) number of error correction trials required to reach mastery criterion. Thus, the primary dependent variable was the number of sessions required to reach the mastery criteria for stimulus sets of three-array auditory-visual conditional discriminations. The mastery criterion for a stimulus set was 100% independent correct responses for three consecutive sessions. An independent, correct response was scored when the participant pointed to the S^D within 5 s of presentation of the sample stimulus without errors or prompts. If the participant touched both of the comparison stimuli in rapid succession, the researcher said, *No switching; try again* and re-started the trial; this occurred only once in bundle 1 and twice in bundle 2. An independent, incorrect response was scored when the learner did not respond within 5 s or selected an S^{Δ} within 5 s of the presentation of the sample stimulus.

The second dependent variable was the total amount of time required to meet the mastery criteria. The duration of each experimental session was recorded to calculate the total time (in seconds) required to reach mastery criteria within each condition. At the beginning of each session, the experimenter started the timer when the first auditory stimulus was issued, stopped the timer whenever Chris was engaged with a reinforcer, and re-started it at the beginning of the next trial. The timer was stopped a final time after completion of the final trial of each session (i.e., when the participant selected a response for baseline sessions or when feedback was delivered for teaching sessions).

The third dependent variable was the total number of error correction trials implemented in each condition. The experimenter used a pencil-and-paper method to tally the number of error correction trials that were required.

Treatment Fidelity

To measure treatment fidelity, the experimenter videotaped all of the sessions and scored her own implementation of at least 33% of sessions selected at random, across all phases (baseline, comparison, and maintenance) in each bundle. Treatment fidelity was scored on the data sheet that dually served as a treatment fidelity checklist created by the experimenter (See Appendices A, B and C). A checklist template was created for each of the following phases: baseline/maintenance, EC, and DOR+EC. Treatment fidelity was 100% across all sessions of each bundle with two exceptions: (a) one EC baseline session was scored at 89% and (b) one EC comparison session was scored at 89%.

Inter-Observer Agreement (IOA)

Inter-observer agreement was measured for the primary dependent variable and for treatment fidelity.

Dependent variable. Two observers, the experimenter and one research assistant (RA), independently recorded participant responses for at least 33% of sessions selected at random, across each phase for each bundle. The experimenter used behavioural skills training consisting of instructions, modeling, feedback, and rehearsal to train the RA (Sarakoff & Sturmey, 2004). The RA began collecting data for the study after meeting the performance criterion of two consecutive sessions of 100% agreement with a recorded session used for training purposes. For each trial, an agreement was scored when both observers recorded the same response on a given trial. A trial-by-trial method was be used to calculate IOA. The number of agreements was divided by the number of agreements plus disagreements, multiplied by 100, to produce the percentage of agreement. Inter-observer agreement for the dependent variable was 100% across all sessions, with two exceptions. In both cases, control comparison sessions were scored at 89% each.

Treatment fidelity. The experimenter also trained the RA to record treatment fidelity data using training procedures that were identical to those used for dependent variable IOA. The RA began collecting treatment fidelity data after meeting the performance criterion of two consecutive sessions of 100% agreement with the experimenter. An agreement was scored when both observers scored a trial as either properly implemented or improperly implemented. The trial-by-trial method and the IOA formula described previously were used to calculate treatment fidelity IOA. Inter-observer agreement for treatment fidelity was 100% across all phases and bundles.

Paired-stimulus Preference Assessment

Prior to initiating the study, a paired-stimulus preference assessment (Fisher, Piazza, Bowman, Hagopian, Owens, & Slevin, 1992) was conducted by Chris's primary instructor at the school. The top five items generated from this assessment were used as reinforcers during the comparison phase of the study. The following items were selected: bubble wrap, iPad with one of two applications (Bizzy Bear on the Farm by Nosy Crow and Letter Sounds 1 by ReadingDoctor), play-doh, and a handheld water game.

Procedure

In each session, the experimenter presented three trials of each target stimulus in a counterbalanced fashion (Grow & LeBlanc, 2013), for a total of nine trials. Across all three conditions, the experimenter first presented an auditory sample stimulus (e.g., *bem*) and immediately turned over the coloured sheet to expose the comparison stimuli. Turning over the coloured sheet served the purpose of increasing the likelihood that Chris would scan the visual array, thereby decreasing the likelihood of incorrect responding attributed to lack of attending. The participant was given a 5 s opportunity to respond.

Control

The control condition was used to test for multiple treatment interference by ensuring that responding did not consistently exceed chance levels of responding (i.e., ~33%). A token board was not used during any phase of the control condition (i.e., there was no opportunity to earn access to a reinforcer). After the auditory stimulus (i.e., spoken word) was presented, the experimenter turned over the coloured sheet to expose the comparison stimuli and the participant was given a 5 s opportunity to respond. No prompting or differential consequences were delivered for correct or incorrect responding. The control condition was conducted on a 2 to 1 (test to control) ratio.

Baseline (EC and DOR+EC)

Procedures for EC and DOR+EC baseline sessions were identical to those in the control condition.

Comparison (EC and DOR+EC)

At the beginning of each comparison session, the experimenter presented Chris with a “First/Then” token board with visual picture icons representing the items identified in the paired-choice stimulus assessment and asked, *What would you like to work for?* After Chris selected an icon, the experimenter presented the first trial. Regardless of the condition, the experimenter provided verbal praise and a token for correct independent responses on a continuous schedule of reinforcement. After five tokens were accumulated, Chris was given 60 s of access to the previously selected reinforcer. The schedule of reinforcement and token economy ratio of exchange was similar to the one used in Chris’ school environment. To ensure that Chris would have a completed token board before leaving the study room, the experimenter delivered high-probability requests and provided tokens for correct independent responses on a 3:1 ratio (VR 3). These schedules of reinforcement were consistent with Chris’ daily school programming.

Error correction. In this condition, contingent on incorrect responses, the experimenter implemented an error correction procedure identical to the independent probe procedure described by Turan et al. (2012), with the exception of an additional practice trial following the prompted trial. This error correction procedure was consistent with the one used in Chris' school programming. The error correction procedure consisted of a total of four trials:

1. Model trial: The experimenter repeated the sample stimulus and simultaneously delivered a controlling prompt (i.e., gesture).
2. Practice trial: The experimenter re-presented the original trial (i.e., delivered the sample auditory stimulus again without any prompts).
3. Distractor trial: The experimenter presented a distractor trial (i.e., a high probability request). This trial always consisted of a personal question within the child's repertoire (e.g., *What's your mom's name?, How old are you?, What school do you go to?,* etc.) If Chris responded incorrectly to the distractor trial, the experimenter provided a correct response and issued another distractor trial.
4. Repeat original trial: The experimenter represented the original trial.

During the error correction procedure, the experimenter provided verbal praise for correct responding only, on each of the four trials with the exception of the distractor trial, for which verbal feedback was provided in a neutral tone (e.g., *That's right, Yep, Okay,* etc.).

DOR + error correction. In this condition, the same procedures as those in the EC condition were implemented, with one exception: prior to the conditional discrimination trial, a DOR trial was implemented. For example, when the experimenter said, *say* ____ (e.g., *din),* Chris was required to repeat the auditory sample stimulus (i.e., *din*). No feedback was provided after the repetition. The experimenter then repeated the auditory sample stimulus again and turned over the coloured sheet to expose the comparison stimuli. When the mastery criterion was met, the DOR was removed to check if correct responding would maintain.

Best Treatment (EC and DOR+EC)

When the mastery criterion was met in either the EC or DOR+EC condition, the condition associated with mastery was implemented with the other training set, unless that set scored 100% within one additional comparison session.

Maintenance

Chris was not exposed to any of the study stimuli during the maintenance phase, except during experimental trials. Procedures for maintenance sessions were identical to those in the control condition, except that the colours associated with each condition were in place. The first set of maintenance probes was collected between 6 to 8 days after a stimulus set met the mastery criterion; this varied because of scheduling constraints. A second set of probes was conducted for the EC and DOR+EC sets in bundles 1 and 2, between 10-24 days after the mastery criterion was met for each of these bundles. Second maintenance probes were not conducted for bundle 3 because of time constraints.

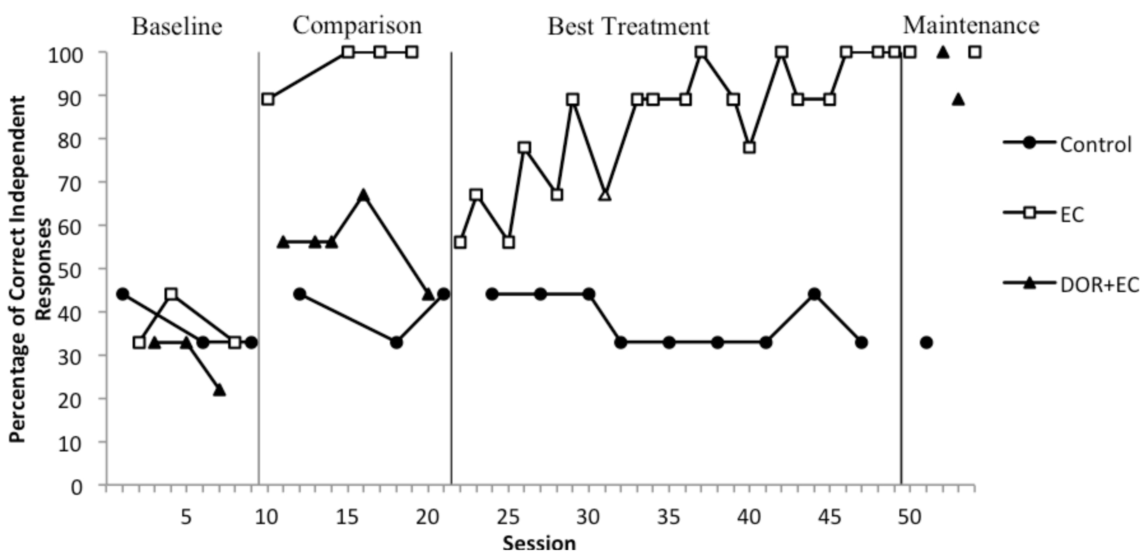
CHAPTER 3: RESULTS

The research question in this study was: Does the addition of a DOR to an error correction procedure result in more rapid learning of auditory to visual conditional discriminations in comparison to an error correction procedure alone for a child with ASD? It was not possible to formulate a hypothesis, as no previous studies have compared a DOR+EC procedure to an EC procedure alone for teaching auditory to visual conditional discriminations. Overall, across three stimulus bundles, the results showed no clear difference between DOR+EC and EC alone. In the sections that follow, a summary of the results for each dependent variable will be explained.

Number of Sessions to Mastery

Figure 6 shows the percentage of correct independent responses for bundle 1.

Figure 6. Percentage of correct independent responses across baseline, comparison, best treatment, and maintenance phases for bundle 1

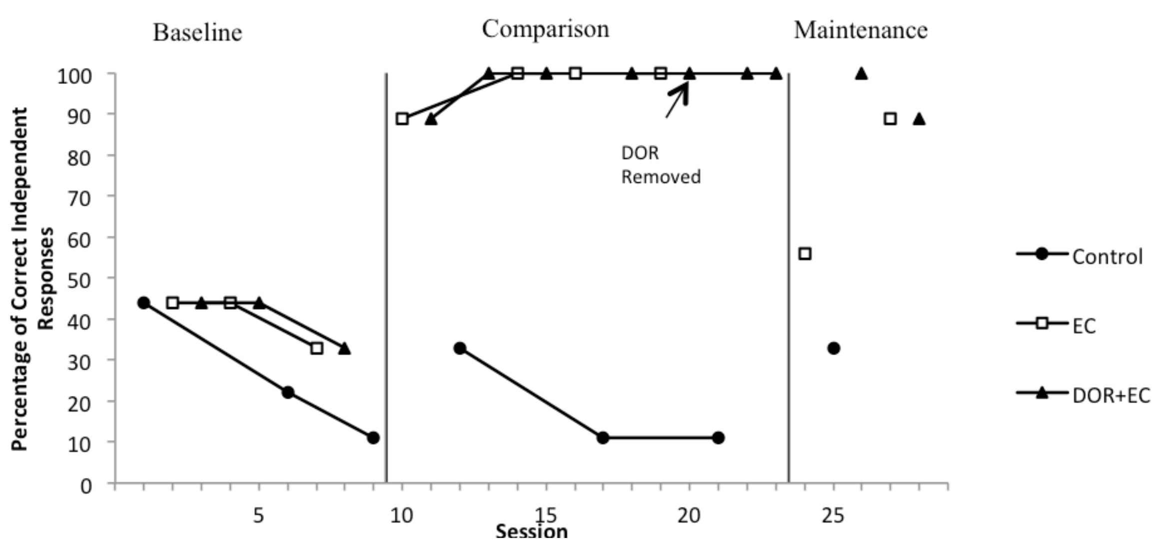


During baseline in bundle 1, Chris responded at 33% correct responding across all three conditions, with the exception of one DOR+EC session at 22% and one control and one

EC session at 44% each. During the comparison phase, there was clear separation of the data paths after the first sessions of each condition in favour of the EC condition. Chris reached 100% correct responding with EC by the second teaching session and met the mastery criterion after four sessions. A plateau for correct responding was observed in DOR+EC for the first three sessions, followed by a slight increase and then a substantial decrease during fifth session. Correct responding in the control condition remained low and stable during this phase. Following this, the best treatment (EC) was applied to this set. During the best treatment phase, a gradual, variable increasing trend was observed and 19 teaching sessions were required before reaching mastery, for a total of 24 instructional sessions altogether for the DOR+EC set. The EC set scored 100% correct during both maintenance probes, and DOR+EC scored 100% and 89%. Thus, for bundle 1, more rapid learning was clearly observed in the EC condition.

Figure 7 shows the percentage of correct independent responses for bundle 2.

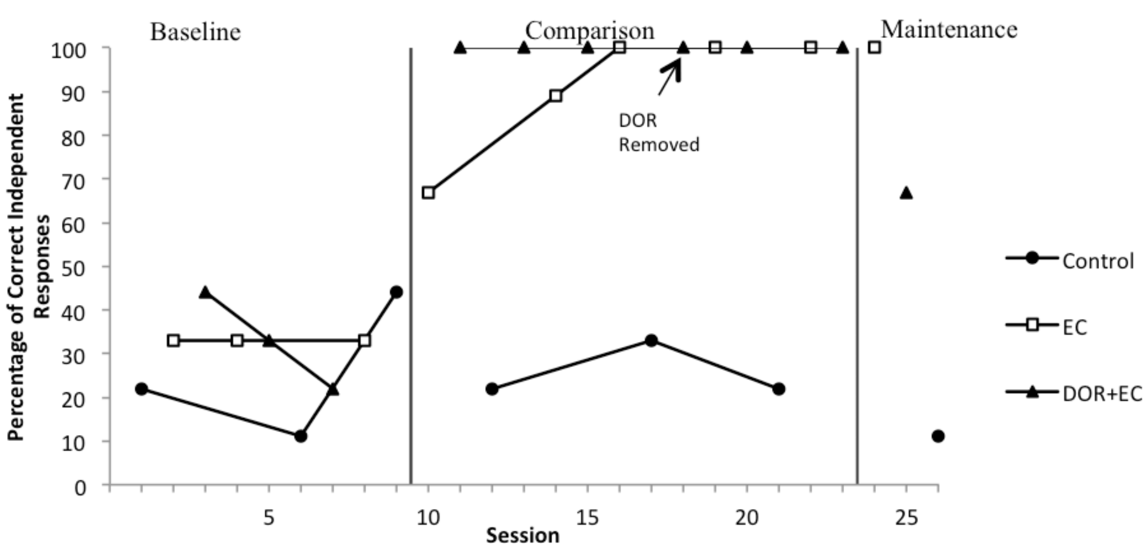
Figure 7. Percentage of correct independent responses across baseline, comparison, and maintenance phases for bundle 2



In baseline for bundle 2, a decreasing trend was observed for the control condition (from 44% to 11%). Chris responded at 44% correct across all EC and DOR+EC baseline sessions with the exception of the third session of each, which scored 33%. During the comparison phase, Chris achieved 89% correct responding on the first teaching session in both the EC and DOR+EC conditions. In both instances, he responded incorrectly on the first trial. Similarly, for both treatments, Chris reached 100% correct responding in the second teaching session and ultimately reached mastery criterion simultaneously by the fourth session. In the DOR+EC set, Chris continued to maintain 100% correct responding after removal of the DOR for three consecutive sessions, for a total of seven instructional sessions altogether. In the first set of maintenance probes, correct responding was 100% for DOR+EC and 56% for EC condition. During the second set of maintenance probes, both sets were equal at 89% correct responding. Considering all phases of bundle 2, there was no clear difference in efficiency between the two conditions.

Figure 8 shows the percentage of correct independent responses for bundle 3.

Figure 8. Percentage of correct independent responses across baseline, comparison, and maintenance phases for bundle 3



During baseline for bundle 3, a variable trend was observed in the control condition (22%, 11% and 44%); a plateau of 33% correct responding was observed in the EC condition; and a decreasing trend was observed in the DOR+EC condition (from 44% to 22%). During the comparison phase, correct responding in the control condition again remained low and stable. Coincidentally, Chris achieved 100% correct responding in the first teaching session of DOR+EC and reached mastery criterion by the third teaching session; thus, he was never exposed to the EC procedure in this condition. Similarly to bundle 2, Chris continued to maintain 100% correct responding after removal of the DOR for three consecutive sessions. The EC condition showed a steady upward trend over the first three sessions, with correct responding reaching 100% in the third session; the mastery criterion was met by session 5. During maintenance probes, EC scored 100% correct responding in comparison to 67% correct responding for DOR+EC. Overall, more rapid learning was associated with the DOR+EC condition for this bundle.

To summarize, for bundle 1, more rapid learning was associated with the EC condition, as EC met the mastery criterion within four sessions and the DOR+EC set required a total of 24 sessions (with best treatment applied) to meet the mastery criterion. For bundle 2, both treatment conditions were equal in terms of the efficiency of learning, as the mastery criterion was met simultaneously within four teaching sessions. For bundle 3, DOR+EC was associated with more rapid learning, as the mastery criterion was met within three sessions in comparison to five sessions for EC.

Number of Seconds

Table 1 displays the number of seconds of instruction for bundles 1, 2, and 3. When instructional time was used as a measure of efficiency (i.e., more rapid learning), EC consistently took less time to reach the mastery criterion across all three bundles, when compared to DOR+EC.

Table 1. Number of Seconds of Instruction for Bundles 1, 2, and 3

	Number of Seconds	
Bundle	Error Correction (EC)	Differential Observing Response plus Error Correction (DOR+EC)
1	204	1600
2	217	385
3	294	363

Number of Error Correction Procedures

Table 2 displays the number of error correction procedures for bundles 1, 2, and 3. During teaching sessions, Chris always responded correctly on the model, prompt, and repeat trial of the error correction procedure. Therefore, the error correction procedure was never delivered more than once on any given conditional discrimination trial. When the number of error correction procedures was used to measure efficiency, the results were unclear. More error corrections were required for DOR+EC in bundle 1 and an equal number were required in bundle 2. In bundle 3, only the EC condition required error correction procedures; and Chris never came in contact with the EC procedure in the DOR+EC condition.

Table 2. Number of Error Correction Procedures for Bundles 1, 2, and 3

Bundle	Number of Error Correction Procedures	
	Error Correction (EC)	Differential Observing Response plus Error Correction (DOR+EC)
1	1	48
2	1	1
3	4	0

Summary

To summarize, the results of this exploratory study showed that the addition of a DOR to an error correction procedure did not result in more rapid learning of auditory to visual conditional discriminations for Chris. Each comparative evaluation had different results. For the first stimulus bundle, more rapid learning was associated with EC. For the second stimulus bundle, no one treatment was associated with more rapid learning as acquisition each treatment occurred at the same rate. Finally, for the third stimulus bundle, more rapid learning was associated with DOR+EC.

CHAPTER 4: DISCUSSION

This study is the first to compare the addition of an auditory DOR to an error correction procedure for teaching auditory to visual conditional discriminations to an individual with ASD. Other terms used to refer to an auditory DOR have been echolalia (Charlop, 1983; Leung & Wu, 1997), repeated auditory stimulus (Grow et al., 2011), and naming (Dube & McIlvane). As noted by Dube and McIlvane (1999), an auditory DOR may not always be possible due to expressive language limitations; therefore, nonverbal DORs have been used most often to teach match-to-sample (MTS) tasks (e.g., Dube & McIlvane, 1999; Walpole et al., 2007) as well as auditory to visual conditional discriminations (Carp, Peterson, Arkel, Petursdottir, & Ingvarsson, 2012; Fisher et al., 2007). The results of this study add to the literature on the use of an auditory DOR in general and suggest that, at least in some cases, the auditory DOR does not add instructional efficiency when teaching auditory to visual conditional discriminations to individuals with ASD. Results for each of the dependent variables will be discussed in the sections that follow.

Number of Sessions to Mastery

In this study, Chris showed unique patterns of acquisition for each of the experimental comparisons. Each of the bundles will be discussed in turn.

Bundle 1

Bundle 1 was the only bundle with a best treatment phase; in this case, the EC procedures were applied to the DOR+EC set (i.e., the DOR was removed). Despite this, that set required 19 additional sessions before reaching mastery criterion. An error analysis was conducted for the DOR+EC set but no evidence of an error pattern was found. It is not clear why so many sessions were required in this condition. One possible explanation is that the

DOR teaching procedure was unfamiliar to Chris. Concurrent with the study, he was working on additional auditory to visual conditional discrimination programs as part of his IEP (e.g., he was learning receptive identification of body parts; adjectives; and objects by name, feature, function and class) and these did not include a DOR as part of the teaching procedure. Thus, he had no prior exposure to the DOR procedure before bundle 1.

Bundles 2 and 3

In both bundles 2 and 3, Chris demonstrated rapid acquisition. In bundle 2, Chris scored 89% correct independent responding in the first teaching sessions of each condition, reaching 100% correct responding in the second teaching session and ultimately reached mastery criterion for both comparative conditions simultaneously by the fourth session. In bundle 3, Chris scored 100% correct responding in the first teaching session and subsequently met the mastery criterion with the DOR+EC set by session 3, followed by the EC set meeting mastery criterion by session 5.

In bundle 2, for the first teaching session of each EC and DOR+EC set, Chris happened to err on the first trial and by chance, engaged in the correct response on both the second and third trials. Similarly, in bundle 3, it was sheer coincidence that Chris engaged in the correct response for each of the first three trials and consequently, scored 100% correct during the first teaching session of the DOR+EC set. As this result was unexpected, the RA was asked to review the videotapes for all three of these sessions to re-calculate IOA for both the dependent variable and treatment fidelity; the results of this review confirmed that IOA for all three sets was 100%.

There are three possible explanations for Chris's unexpected pattern of responding in bundles 2 and 3. The first possibility is that there was multiple treatment interference; in other words, treatments outside of the independent variable influenced the dependent variable and attributed to this unexpected pattern of responding (Gast, 2010). However, this possibility can be ruled out, as the control condition consistently remained low and stable throughout the study. If there was a threat to the study's internal validity, this would have been detected by the control condition (i.e., correct responding would also have been high).

The second possible explanation is that the pattern of stimulus presentation was predictable, so Chris was able to achieve high percentages of correct independent responding in the first treatment comparison sessions. However, as three different data sheets were generated, with the auditory stimuli and comparison visual stimuli counterbalanced within each session, this explanation can also be ruled out.

Finally, the third possible explanation is that Chris demonstrated "one-trial learning" (i.e., he learned each auditory-visual conditional discrimination by a single exposure; Deak & Toney, 2013; Trueswell, Medina, Hafri, & Gleitman, 2012). The first three trials of each session always consisted of one presentation of each of the three auditory-visual stimulus pairs (i.e., the same auditory-visual stimulus pair was never represented until the fourth trial; see Appendix D). Thus, if Chris happened to choose the correct flag on the first trial, there was a 50% chance of responding correctly on the second trial (from two unknown stimuli); and if he responded correctly on the second trial, there was a 100% chance of doing so again on the third trial, since at that point only one stimulus was unknown. This type of one-trial learning has been referred to in the literature on early language development as "fast mapping."

Fast mapping. In 1978, Carey and Bartlett conducted the first experimental demonstration of fast mapping, in which the addition of a new word to one's lexicon occurs after a single exposure (as cited in Carey, 2010). In Carey and Bartlett's early fast mapping studies, the introduction of the word "chromium" to a child's lexicon was assessed. During the first exposure, the child was asked to get *the chromium tray; not the red one, the chromium one,* when presented with two trays that only differed by colour. Between 1-10 weeks later, a second exposure of the word occurred, and at three different follow up times, the child was also tested for generalization (i.e., with a different setting and person), production and sorting, comprehension and production, and class (e.g., *Is red a colour? Is happy a colour? Is chromium a colour?,* etc.). The results showed that more than half of the children demonstrated fast mapping (i.e., the word chromium [olive green] was added to their lexicon after only a few exposures). Additionally, those who demonstrated fast mapping also knew that it was a color word (i.e., the word chromium was used synonymously with the colour green).

Fast mapping has been demonstrated with typically developing children as young as 13 months of age (Woodward, Markman, & Fitzsimmons, 1994), as well as in individuals with Down syndrome, William syndrome, hearing loss, language impairment (Gershkoff-Stowe & Hahn, 2007), and ASD (Barcus, 2011; McDuffie, Yoder, & Stone, 2006; Walton, 2013). It has been noted in the literature that the ability to fast map is positively correlated with joint attention (sometimes also referred to as gaze-following or gaze-monitoring; McDuffie et al., 2007; Walton, 2013). In typically developing children, joint attention emerges as young as 4 months of age and reaches maximal levels around 18-21 months of age, which coincides with a toddler's ability to fast map new words (Walton, 2013). Leekam, Hunniset, and Moore (1998) found that independent joint attention skills were most prevalent in children with ASD above a verbal mental age of 24 months. Within these parameters, it appears that Chris did engage in fast mapping, as he consistently scored above age equivalencies of 24 months during the communication assessment that was conducted one month prior to the start of the study.

Clinical Implications

Previous studies utilized a DOR only after slow progress in learning was identified (i.e., after identifying that an error correction procedure alone was not sufficient for teaching; Fisher et al, 2007; Grow et al., 2011). Rather than inserting the addition of a DOR to an error correction procedure after slow progress was identified, the current study was interested in the effectiveness of inserting a DOR from the outset. If the results of this study are replicated in future studies, the results suggest that inserting a DOR in addition to an error correction procedure may not be beneficial in the absence of an identified learning difficulty. Instead, a DOR procedure can continue to be used as a rescue procedure, when an error correction procedure alone is insufficient or when faulty stimulus control is evident.

Number of Seconds to Mastery

The second dependent variable to measure rapidity of learning was the number of seconds of instruction required to meet the mastery criterion. Across all three bundles, EC was consistently superior in this regard although, with the exception of bundle 1, the difference was not large (i.e., 2 minutes less in bundles 2 and 3). For Chris, an overall savings of approximately 2 minutes of instructional time would not have a significant impact on his overall progress as a learner. However, the difference might have been larger (although still quite negligible) if the mastery criterion for assessing maintenance of the DOR+EC set after removal of the DOR had been less stringent (e.g., only one session at

100% correct independent responding instead of three consecutive sessions at 100% correct responding with the DOR removed).

Number of Error Corrections to Mastery

The third dependent variable that was used to measure rapidity of learning was the number of error correction procedures required to meet the mastery criterion. For this variable, each comparative evaluation had different results. Fewer error corrections were required in EC for bundle 1; EC and DOR+EC were equal in bundle 2; and DOR+EC required fewer error corrections for bundle 3. Overall, the error correction procedure was irrelevant as a measurement of rapidity of learning, as Chris never required more than one error correction procedure on any conditional discrimination trial.

Limitations and Future Research

Future studies examining the DOR should involve multiple participants in order to enhance generalizability. A second limitation was the speed of Chris' acquisition of new auditory to visual conditional discriminations. Future research should consider the recruitment of participants who do not exhibit fast mapping and/or who have a history of overselectivity or faulty stimulus control. A third limitation was that only one specific type of error correction procedure was examined. The procedure required Chris to engage in the correct response for 3 of 4 trials (i.e., model, practice and repeat). There may have been different results if the EC procedure did not require three active responses (i.e., touching the S^D) so many times. Future research could investigate the rapidity of learning with the addition of a DOR to different error correction procedures, such as simultaneous prompting or no-no prompting (Leaf et al., 2010), most-to-least prompting or flexible error correction (Leaf et al., 2014), and delay or independent probe procedures (Turan et al., 2012).

As an auditory DOR was used, future research could also assess if the emergence of untrained tacts are more likely with the addition of a vocal response prior to the conditional discrimination trial. Recently, Delfs, Connie, Frampton, Schillingsburg, and Robinson (2014) compared the "the effects of listener training on tact emergence to the effects of tact training on the emergence of listener relations" (p. 795) and found that tact training was "more likely to produce emergent listener responding" (p. 805) than vice versa. Perhaps, the addition of an auditory DOR to listener training might change these results due to the temporal contiguity of the vocal response and manual response (i.e., selecting the S^D).

Conclusion

In conclusion, no advantage was found in this study for combining an auditory DOR with an EC procedure to teach auditory to visual conditional discriminations to one child with ASD. Researchers examining the efficacy of these and other instructional procedures should consider assessing the fast mapping ability of potential participants as part of the inclusion criteria. In addition, more research is needed to investigate the advantages and disadvantages of inserting an auditory DOR during instruction of children with ASD who struggle to learn new auditory to visual conditional discriminations.

References

Barbetta, P. M., Heron, T. E., & Heward, W. L. (1993). Effects of active student response during error correction on the acquisition maintenance and generalization of sight words by students with developmental disabilities. *Journal of Applied Behavior Analysis, 26,* 111-119. doi:10.1901/jaba.1993.26-111

Barcus, L. (2011). *Vocabulary acquisition through fast mapping in children with autism.* Retrieved from The Keep. (Paper 96.)

Carey, S. (2010). Beyond fast mapping. *Language Learning and Development, 6*(3), 184-205. doi:10.1080/15475441.2010.484379

Carp, C. L., Peterson, S. P., Arkel, A. J., Petursdottir, A. I., & Ingvarsson, E. T. (2012). A further evaluation of picture prompts during auditory-visual conditional discrimination training. *Journal of Applied Behavior Analysis, 45,* 737-751. doi: 10.1901/jaba.2012.45-737

Carrow-Woolfolk, E. (1999). *Comprehensive Assessment of Spoken Language*. Circle Pines: American Guidance Services.

Catania, C. N., Almeida, D., Liu-Constant, B., & DiGennaro-Reed, F. D. (2009). Video modeling to train staff to implement discrete-trial instruction *Journal of Applied Behavior Analysis, 42,* 387-392. doi:10.1901/jaba.2009.42-387

Charlop, M. H. (1983). The effects of echolalia on acquisition and generalization of receptive labeling in autistic children. *Journal of Applied Behavior Analysis, 16*, 111-126. doi:10.1901/jaba.1983.16-111

Conners, J., Iwata, B. A., Kahng, S., Hanley, G. P., Worsdell, A. S., & Thompson, R. H. (2000). Differential responding in the presence and absence of discriminative stimuli during multielement functional analysis. *Journal of Applied Behavior Analysis, 33,* 299-308. doi:10.1901/jaba.2000.33-299

Deak, G. O., & Toney, A. J. (2013). Young children's fast mapping and generalization of words, facts, and pictograms. *Journal of Experimental Child Psychology, 115*(2), 273-296. doi:10.1016/j.jecp.2013.02.004

Delfs, C. H., Connie, D. E., Frampton, S. E., Shillingsburg, M. A., & Robinson, H. C. (2014). Evaluation of the efficiency of listener and tact instruction for children with autism. *Journal of Applied Behavior Analysis, 47,* 793-809. doi:10.1002/jaba.166

Doughty, A. H., & Hopkins, M. (2011). Reducing stimulus overselectivity through an increased observing-response requirement. *Journal of Applied Behavior Analysis, 44,* 653-657. doi:10.1901/jaba.2011.44-653

Doughty, A. H., & Saunders, K. J. (2009). Decreasing errors in reading-related matching to sample using a delayed-sample procedure. *Journal of Applied Behavior Analysis, 42,* 717-721. doi:10.1901/jaba.2009.42-717

Dube, W. V., & McIlvane, W. J. (1999). Reduction of stimulus selectivity with nonverbal differential observing responses. *Journal of Applied Behavior Analysis, 32,* 25-34. doi:10.1901/jaba.1999.32-25

Dunn, L. M., & Dunn, L. M. (1981). *Peabody Picture Vocabulary Test-Revised.* Circle Pines, MN: American Guidance Services.

Fisher, W. W., Kodak, T., & Moore, J. W. (2007). Embedding an identity-matching task within a prompt hierarchy to facilitate acquisition of conditional discrimination in children with autism. *Journal of Applied Behavior Analysis, 40,* 489-499. doi:10.1901/jaba.2007.40-489

Fisher, W.W., Piazza, C. C., Bowman, L. G., Hagopian, L. P., Owens, J. C., & Slevin, I. (1992). A comparison of two approaches for identifying reinforcers for persons with severe and profound disabilities. *Journal of Applied Behavior Analysis, 25,* 491-498. doi:10.1901/jaba.1992.25-491

Gast, D. L. (2010). *Single subject research methodology in behavioral sciences.* New York: Routledge.

Gershkoff-Stowe, L., & Hahn, E. (2007). Fast mapping skills in developing lexicon. *Journal of Speech, Language, and Hearing Research, 50,* 682-697.

Green, G. (2001). Behavior analytic instruction for learners with autism: Advances in stimulus control technology. *Focus on Autism and Other Developmental Disorders, 16,* 72-85. doi:10.1177/108835760101600203

Grow, L. L., Carr, J. E., Kodak, T. M., Jostad, C. M., & Kisamore, A. N. (2011). A comparison of methods for teaching receptive labeling to children with autism spectrum disorders. *Journal of Applied Behavior Analysis, 44,* 475-498. doi:10.1901/jaba.2011.44-475

Grow, L. L., & LeBlanc, L. A. (2013). Teaching receptive language skills: Recommendations for instructors. *Behavior Analysis in Practice, 6,* 56-75.

Leaf, J. B., Alcalay, A., Leaf, J. A., Tsuji, K., Kassardjian, A., Dale, S., McEachin, J., Taubman, M., & Leaf, R. (2014). Comparison of most-to-least to error correction for teaching receptive labeling for two children diagnosed with autism. *Journal of Research in Special Educational Needs.* doi:10.1111/1471-3802.12067

Leaf, J. B., Sheldon, J. B., & Sherman, J. A. (2010). Comparison of simultaneous prompting and no-no prompting in two-choice discrimination learning with children with autism. *Journal of Applied Behavior Analysis, 43,* 215-228. doi:10.1901/jaba.2010.43-215

Leekam, S. R., Hunnisett, E., & Moore, C. (1998). Targets and cues: Gaze-following in children with autism. *Journal of Child Psychology and Psychiatry, 39*(7),951-962. doi:10.1111/1469-7610.00398

Leung, J-P., Wu, K-I. (1997). Teaching receptive naming of Chinese characters to children with autism by incorporating echolalia. *Journal of Applied Behavior Analysis, 30*, 59-68. doi:10.1901/jaba.1997.30-59

Lovaas, O. I., & Schreibman, L. (1971). Stimulus overselectivity of autistic children in a two stimulus situation. *Behavior Research and Therapy, 9,* 305-310.

Love, J. R., Carr, J. E., Almason, S. M., & Petursdottir, A. I. (2009). Early and intensive behavioral intervention for autism: A survey of clinical practices. *Research in Autism Spectrum Disorders, 3,* 421-428. doi:10.1016/j.rasd.2008.08.008

Mayer-Johnson, L. L. (2004). Boardmaker Plus! (Version 6) [Computer software]. Solano Beach, CA: Mayer-Johnson.

McDuffie, A., Yoder, P., & Stone, W. (2006). Fast-mapping in young children with autism spectrum disorders. *First Language, 26*(4), 421-438. doi:10.1177/0142723706067438.

McGhan, A. C., & Lerman, D. C. (2013). An assessment of error-correction procedures for learners with autism. *Journal of Applied Behavior Analysis, 46,* 626–639. doi:10.1002/jaba.65

Odom, S., Hume, K., Boyd, B., & Stabel, A. (2012). Moving beyond the intensive behavior treatment versus eclectic dichotomy: Evidence-based and individualized programs for learners with ASD. *Behavior Modification, 36,* 270-297. doi: 10.1177/0145445512444595

Ploog, B. O. (2010). Stimulus overselectivity four decades later: A review of the literature and its implications for current research in autism spectrum disorder. *Journal of Autism and Developmental Disorders, 40,* 1332-1349. doi:10.1007/s10803-010-0990-2

Reed, S. R., Stahmer, A. C., Suhrheinrich, J., & Schreibman, L. (2013). Stimulus overselectivity in typical development: Implications for teaching children with autism. *Journal of Autism and Developmental Disorders, 43,* 1249-1257. doi:10.1007/s10803-012-1658-x

Reith, S. R., Stahmer, A. C., Suhrheinrich, J., & Schreibman, L. (2015). Examination of the prevalence of stimulus overselectivity in children with ASD. *Journal of Applied Behavior Analysis, 48,* 1-14. doi:10.1002/jaba.165

Rodgers, T. A., & Iwata, B. A. (1991). An analysis of error-correction procedures during discrimination training. *Journal of Applied Behavior Analysis, 24,* 775-781. doi:10.1901/jaba.1991.24-775

Sarakoff, R. A., & Sturmey, P. (2004). The effects of behavioral skills training on staff implementation of discrete-trial teaching. *Journal of Applied Behavior Analysis, 37,* 535 – 538. doi:10.1901/jaba.2004.37-535

Schilmoeller, G. L., Schilmoeller, K.J., Etzel, B. C., & LeBlanc, J. M. (1979). Conditional discrimination after errorless and trial-and-error training. *Journal of the Experimental Analysis of Behavior, 31,* 405-420.

Sindelar, P. T., Rosenberg, M. S., & Wilson, R. J. (1985). An adapted alternating treatments design for instructional research. *Education and Treatment of Children, 8,* 67-76.

Smith, T. (2001). Discrete trial training in the treatment of autism. *Focus on Autism and Other Developmental Disabilities, 16,* 86-92. doi:10.1177/108835760101600204

Smith, T., Mruzek, D. W., Wheat, L. A., & Hughes, C. (2006). Error correction in discrimination training for children with autism. *Behavioral Interventions, 21,* 245-263. doi:10.1002/bin.223

Trueswell, J. C., Medina, T. N., Hafri, A., & Gleitman, L. R. (2012). Propose but verify: Fast mapping meets cross-situational word learning. *Cognitive Psychology, 66,* 126-156. doi:10.1016/j.cogpsych.2012.10.001

Turan, M. K., Moroz, L., & Croteau, N. P. (2012). Comparing the effectiveness of error-correction strategies in discrete trial training. *Behavior Modification, 36,* 218-234. doi:10.1177/0145445511427973

Walpole, C. W., Roscoe, E. M., & Dube, W. V. (2007). Use of a differential observing response to expand restricted stimulus control. *Journal of Applied Behavior Analysis, 40,* 707-712. doi:10.1901/jaba.2007.707-712.

Walton, K. M., & Ingersoll, B. R. (2013). Expressive and receptive fast-mapping in children with autism spectrum disorders and typical development: The influence of orienting cues. *Research in Autism Spectrum Disorders, 7,* 687-698. doi:10.1016/j.rasd.2013.02.012

Woodward, A. L., Markman, E. M., & Fitzsimmons, C. M. (1994). Rapid word learning in 13- and 18-month-olds. *Developmental Psychology, 30*(4), 553-566.

Appendix A

Procedural Fidelity Checklist: Control/Maintenance Condition 1

Session #:___________ Date:_____________ Initials:__________

Learner Behaviour	**Circle the first word the child points to without engaging in a switch responding (bolded word is the correct stimulus)** **Quiet: (/) over the Y = child remained quiet for the entire trial; or (/) over the N = did not remain quiet for the entire trial.** **Switch: (/) over the Y = child engaged in a switch response; or (/) over the N = did not engage in switch response.**
Instructor Behaviour	**Record (+) for the occurrence of an instructor behaviour.** **Record (-) for the non-occurrence of an instructor behaviour.** SD = Instructor delivers the correct instruction. Consequence = Instructor provides no programmed consequences with the exception of a switch response in which the instructor will instruct the child "no switching, try again" and repeat the trial

% of independent correct responses = ________
# of trials with switch responses = __________
% of trials with correct implementation = _______
Total duration = ________

Learner Behaviour						Instructor Behaviour	
Trial	**Session Type 1**			**Quiet**	**Switch**	**SD**	**Consequence**
1	deet	**fon**	wap	N Y	N Y		
2	fon	wap	**deet**	N Y	N Y		
3	**wap**	deet	fon	N Y	N Y		
4	**deet**	fon	wap	N Y	N Y		
5	fon	**wap**	deet	N Y	N Y		
6	wap	deet	**fon**	N Y	N Y		
7	deet	fon	**wap**	N Y	N Y		
8	**fon**	wap	deet	N Y	N Y		
9	wap	**deet**	fon	N Y	N Y		

Appendix B

Procedural Fidelity Checklist: Error Correction Condition 2

Session #:__________ Date:____________ Initials:__________

Learner Behaviour	**Circle the first word the child points to without engaging in a switch responding (bolded word is the correct stimulus)** **Quiet: (/) over the Y = child remained quiet for the entire trial; or (/) over the N = did not remain quiet for the entire trial.** **Switch: (/) over the Y = child engaged in a switch response; or (/) over the N = did not engage in switch response.**
Instructor Behaviour	**Record (+) for the occurrence of an instructor behaviour.** **Record (-) for the non-occurrence of an instructor behaviour.** **Record (n/a) = not applicable** SD = Instructor delivers the correct instruction. Consequence = If the child engages in a switch response, the instructor will instruct the child "no switching, try again" and repeat the trial M = Instructor repeats the trial with a gestural prompt. P = Instructor repeats the original trial. HPR = Instructor delivers a distractor trial. R = Instructor repeats the original trial R+ = Correct = tokens on FR1; Incorrect = neutral praise

% of independent correct responses = ________
\# of trials with switch responses = __________
\# of error correction trials = ___________
% of trials with correct implementation = _______
Total duration = ________

Learner Behaviour						Instructor Behaviour						
Trial	**Session Type 2**			**Quiet**	**Switch**	**SD**	**Consequence**	**M**	**P**	**HPR**	**R**	**R+**
1	fet	wan	**dup**	N Y	N Y							
2	**wan**	dup	fet	N Y	N Y							
3	dup	**fet**	wan	N Y	N Y							
4	fet	**wan**	dup	N Y	N Y							
5	wan	dup	**fet**	N Y	N Y							
6	**dup**	fet	wan	N Y	N Y							
7	**fet**	wan	dup	N Y	N Y							
8	wan	**dup**	fet	N Y	N Y							
9	dup	fet	**wan**	N Y	N Y							

Appendix C

Procedural Fidelity Checklist: DOR plus Error Correction Condition 3

Session #:___________ Date:_____________ Initials:__________

Learner Behaviour	**Circle the first word the child points to without engaging in a switch responding (bolded word is the correct stimulus)** **DOR: (/) over the Y = child engaged in the differential observing response (DOR); or (/) over the N = did not engage in the DOR** **Quiet: (/) over the Y = child remained quiet for the remainder of trial; or (/) over the N = child not remain quiet for the remainder of trial.** **Switch: (/) over the Y = child engaged in a switch response; or (/) over the N = did not engage in switch response.**
Instructor Behaviour	**Record (+) for the occurrence of an instructor behaviour.** **Record (-) for the non-occurrence of an instructor behaviour.** **Record (n/a) = not applicable** DOR = Instructor delivers DOR trial SD = Instructor delivers the correct instruction. Consequence = If the child engages in a switch response, the instructor will instruct the child "no switching, try again" and repeat the trial M = Instructor repeats the trial with a gestural prompt. P = Instructor repeats the original trial. HPR = Instructor delivers a distractor trial. R = Instructor repeats the original trial R+ = Correct = tokens on FR1; Incorrect = neutral praise;

Current
% of independent correct responses = ________
# of trials with switch responses = __________
# of error correction trials = ___________
% of trials with correct implementation = _______
Total duration = ________

Learner Behaviour							Instructor Behaviour							
Trial	**DOR**	**Session Type 3**			**Quiet**	**Switch**	**DOR**	**SD**	**Consequence**	**M**	**P**	**HPR**	**R**	**R+**
1	N Y	**woot**	din	fap	N Y	N Y	N Y							
2	N Y	din	**fap**	woot	N Y	N Y	N Y							
3	N Y	fap	woot	**din**	N Y	N Y	N Y							
4	N Y	woot	din	**fap**	N Y	N Y	N Y							
5	N Y	**din**	fap	woot	N Y	N Y	N Y							
6	N Y	fap	**woot**	din	N Y	N Y	N Y							
7	N Y	woot	**din**	fap	N Y	N Y	N Y							
8	N Y	din	fap	**woot**	N Y	N Y	N Y							
9	N Y	**fap**	woot	din	N Y	N Y	N Y							

Appendix D

Trial	Version 1		
1	A	**B**	C
2	B	C	**A**
3	**C**	A	B
4	**A**	B	C
5	B	**C**	A
6	C	A	**B**
7	A	B	**C**
8	**B**	C	A
9	C	**A**	B

Trial	Version 2		
1	B	C	**A**
2	**C**	A	B
3	A	**B**	C
4	B	**C**	A
5	C	A	**B**
6	**A**	B	C
7	**B**	C	A
8	C	**A**	B
9	A	B	**C**

Trial	Version 3		
1	**C**	A	B
2	A	**B**	C
3	B	C	**A**
4	C	A	**B**
5	**A**	B	C
6	B	**C**	A
7	C	**A**	B
8	A	B	**C**
9	**B**	C	A