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A Further Analysis of Commission Errors during Discrete Trial Training

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by

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A Further Analysis of Commission Errors during Discrete Trial Training
a thesis by Tavy Alisa Matthews

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Abstract

Title: A Further Analysis of Commission Errors during Discrete Trial Training

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Treatment integrity has been manipulated in various ways to evaluate its impact on intervention effectiveness. Studies have compared different types of integrity failures and levels of treatment integrity in various contexts and behavioral interventions. Evaluations include differential reinforcement of alternative behavior, child compliance, and discrete trial training. However, further research is needed to establish the point at which integrity becomes detrimental to intervention effectiveness. The purpose of this study was to conduct a parametric analysis (i.e., 100%, 75%, 50%, & 25%) of treatment integrity to examine the effects of commission errors during discrete trial training. Three participants, ages 35 - 42 months diagnosed with autism spectrum disorder (ASD) were included. Using discrete trial training (DTT), participants were taught to receptively identify features of common items. Targets taught with 100% integrity (perfect implementation) yielded the fastest rates of acquisition for all participants. Low level of treatment integrity (i.e., 25%) or persistent errors produced a slower rate of acquisition.

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Dedication

I dedicate this thesis to my family and friends.

Thank you for your support throughout this journey.

Chapter I:

Introduction

The number of children diagnosed with Autism Spectrum Disorder (ASD) has increased dramatically over the last decade (Center for Disease Control and Prevention, 2010). Emerging research indicates that an increase in the prevalence may be partially contributed to a shift in the distribution of diagnosis from intellectual disability to ASD (e.g., Hansen, Schendel, & Parner, 2015). That is, while a higher number of children are being diagnosed with ASD, there is a negative correlation or a decrease in children being diagnosed with intellectual and other learning disabilities. ASD is a neurodevelopmental disorder, typically diagnosed in childhood, which consists of persistent deficits in social communication and social interaction across various contexts and includes symptoms of restricted, repetitive patterns of behavior, interests, or activities (American Psychiatric Association, 2013). Early Intensive Behavioral Intervention (EIBI), which emphasizes the use of principles derived from Applied Behavior Analysis (ABA) (Lovaas & Smith, 1989), is identified as an effective treatment for individuals diagnosed with ASD (Howard, Sparkman, Cohen, Green, & Stanislaw, 2005; Lovaas, 1987; McEachin, Smith, & Lovaas 1993; Reichow, Barton, Boyd, & Hume, 2014). ABA has been demonstrated across multiple settings, including home, school, workplace, and clinical environments. Additionally, ABA has also been implemented across a number of populations including caregivers (e.g., parent training), teachers, typically developing and children with intellectual disabilities to name a few (Bibby, Eikseth, Martin, Mudford, & Reeves, 2001; Carroll, Kodak, & Fisher, 2013; Feldman & Werner, 2002; Lewis, Sugai, & Colvin, 1998).

Applied Behavior Analysis (ABA) focuses on solving problems of social importance by using techniques derived from principles and procedures of behavior analysis (Fisher, Piazza, & Roane, 2011). These procedures are used to increase or establish new skills (skill acquisition) and decrease behavior excesses (e.g., aberrant behaviors). ABA is utilized across various settings and populations, but most notably in the area of developmental disabilities and ASD. During the 1960s, Lovaas and colleagues developed interventions based on learning principles with children diagnosed with ASD (Lovaas & Simmons, 1969; Wolf, Risley & Mees, 1964). Over time behavioral interventions have been disseminated through numerous clinical studies published in peer-reviewed journals (e.g., Eikeseth, 2009; Matson, Benavidez, Compton, Paclawskyj & Baglio, 1996; Suozzi, 2004). As a result, a range of treatment manuals and curricula have been published to guide practitioners in implementing treatment programs for children with ASD (Leaf & McEachin, 1999; Lovaas et al., 1981; Maurice, Green, & Foxx, 2001; Maurice, Green, & Luce, 1996). Behavior analytic interventions are most effective when implemented early, emphasize intensive one-to-one teaching, include parent involvement

(Anan, Warner, McGillivary, Chong, & Hines, 2008; Bibby et al., 2001; Lovaas, 1987; McEachin et al., 1993; Reinchow, 2014), integrate children with typically developing peers, and emphasize a comprehensive program that is individualized (i.e., teach a number of skills and/or reduce maladaptive behaviors based on the assessment of each child) (Eikeseth, 2009).

Early Intensive Behavioral Intervention

Prior to the 1960s, minimal evidence supported interventions to eliminate aberrant behaviors and produce lasting adaptive behaviors for children with ASD (Smith, Lovaas, & McEachin, 1993). However, mounting research from the early 1960s into the mid-1980s garnered significant empirical support for Early Intensive Behavioral Intervention and ASD. (Eldevik, Hastings, Hughes, Jahr, Eikeseth, & Cross, 2009; Lovaas, 1981, 1987; Reichow & Wolery, 2009). In this model, EIBI targeted children younger than 4 years of age and included a curriculum of 40 hours per week of one on one treatment, year round, for two or more years. The behavioral intervention also included parent training and mainstreaming into regular preschools (Lovaas, 1987; McEachin et al., 1993). Participants were compared to a control group who received a much less intensive intervention, such as a maximum of 10-hours a week of one to one behavioral treatment, and/or enrolled in special education programs (Lovaas, 1987; McEachin et al., 1993). To evaluate child outcomes, standardized measures were used, including IQ scores and educational placement status during pre and post treatment (Lovaas, 1987; Luiselli, 2008). Results showed that 47% of the experimental group achieved IQs in the normal range after treatment. In addition, approximately 90% of the experimental group achieved significant gains in educational or classroom placements, compared with minimal changes in IQ and educational placement for children in the control groups. Several years later, McEachin et al. (1993) re-evaluated the children who participated in the original study (Lovaas, 1987) to determine whether gains in IQ and educational placement had been maintained over time. Children from the experimental group continued to demonstrate higher IQ scores and were placed in less restrictive educational environments, suggesting that the gains from EIBI were maintained over time.

Current evidence supports ABA starting at a young age and as early as 18 months, demonstrating a robust change of behavior and better gains than those who start later (24–36 months or older) (Committee on Educational Interventions for Children with Autism of the National Research Council, 2001; Eldevik et al., 2009; MacDonald, Parry-Cruwys, Dupere, & Ahearn, 2014; Reichow, 2014; Reichow & Wolery, 2009). In fact, MacDonald et al. (2014) evaluated outcomes for three groups of children (i.e., 18 - 23 months, 24 - 29 months, 30 - 36 months) months receiving EIBI. Findings indicated that the biggest gains were observed for children who started treatment prior to their second birthday or the youngest treatment group (18 - 23 months).

Typically, the following components are incorporated into EIBI, (a) specific teaching methods, including discrete trial training with a 1:1 adult to child ratio in the early stages of treatment, and (b) implementation in either home, or clinical settings ranging from 20 to 40 hours per week for 1 to 4 years or more (Dawson, 1997; National Research Council, 2001; Reichow, 2014; Volkmar, Woodbury-Smith, State, & King, 1999). Once necessary skills are acquired (communication, pre-academic, social interaction) sessions are systematically transferred to more naturalistic settings such as (classrooms, community) to promote generalization and maintenance (Reichow, 2014). Overall, EIBI addresses the core deficits of ASD, with the development of an individualized treatment program based on a child's current behavioral repertoire and a functional approach is used to address challenging behaviors that interfere with learning (Reichow, 2014).

Typically, intensive treatment programs incorporate discrete trial training to teach new skills, at least initially. Specifically, discrete trial training is a widely adopted and effective method to present novel or nonacquired skills to individuals diagnosed with ASD and other related disabilities. A range of skills have been successfully taught, including: communication, pre-academic skills: listener behavior, social-emotional skills, and adaptive living skills to name a few (Downs, Downs, Johansen, & Fossum, 2007; Downs & Smith 2004; Grow, Carr, Kodak, Jostad, & Kissamore, 2011; Smith, 2001).

Discrete Trial Training

Origins of the discrete trial were derived from the experimental analysis of behavior literature, by early behaviorists including Thorndike, Watson, Pavlov, and Hull in the early 1920s. Specifically, a study conducted by Thorndike (1911) examined a behavior-consequence response with cats in a puzzle box as the apparatus. Thorndike placed the cats into the puzzle box to observe if they would engage in an 'escape' behaviors (i.e., leave the box to access food). Contingent on engaging in an escape response, a reinforcer was delivered (e.g., access to food). Several trials were repeated, where the placement of the cat in the apparatus indicated the start of the trial and leaving the box and access to reinforcement signified the end of the trial. Nonetheless, it was not until the late 1960s where the discrete trial was applied to teaching young children with ASD (Wolf et al., 1964). Discrete trials are called "discrete" because each instructional 'unit' has a clear start and a clear end (Leaf & McEachin, 1999). Each trial is initiated with an antecedent (e.g., discriminative stimulus) such as an instruction, followed by a response (child emits target response), and ends with a consequence (e.g., delivery of reinforcer or error correction). This arrangement is also referred to as a three-term contingency (Cooper, Heron, & Heward, 2007).

Using DTT, complex skills are broken down into simple units and individualized to enhance acquisition (Smith, 2001). For example, Smith (2001) identified four main components of DTT. The first component was identified as the discriminative stimulus, which cues the availability of reinforcement. For a discrimination task, this could involve the therapist presenting a vocal instruction "touch the dog" while simultaneously placing a picture of a dog, cat, and mouse on the table in front of the child. The second component is comprised of a prompt or supplemental stimulus, which is not always presented but is provided to facilitate correct responding (e.g., gesture or physical prompt by guiding the child's hand to the correct picture). The third component is the child's response, such as pointing to the picture of the dog in the array. Finally, the fourth component is the consequence or a reinforcer delivered for the correct response (Smith, 2001). The sequence is then followed by a brief inter-trial interval, usually no more than three to five seconds, to indicate the end of the trial. In clinical practice, additional trials may be interspersed from a number of learning programs, sometimes up to 20 or 30 trials in two to three minutes, equating to 1000's of trials per day. This is a critical feature of DTT within EIBI, such that multiple opportunities are presented for a child to practice until proficiency is met (Luiselli, 2008). According to Luiselli (2008), an advantage of DTT is that teachers, parents, and other professionals can easily be trained to implement procedures with a predetermined curriculum. Other advantages include a highly structured environment with predetermined instruction, prompting sequence, and programmed consequences and fairly simple data collection methods (Luiselli, 2008). Extensive evidence supports the use of DTT as an effective teaching procedure when compared to other treatment approaches such as regular special education programs, (Hall, 1997; Howard, Sparkmen, & Cohen 2005; McEachin et al., 1993; Reichow, 2014).

For example, Howard, Sparkmen, and Cohen (2005) compared three approaches to early intervention: intensive behavior intervention (IBI, aka EIBI), eclectic treatments, and special education for children with autism. Sixty-one participants were included, where 29 participants received IBI, 16 participants received eclectic treatments, and 16 participants received special education (Howard et al., 2005). During IBI, a 1:1 therapist to child ratio was provided and treatment was delivered primarily in a highly structured environment (Howard et al., 2005). Children were provided 50 – 100 learning opportunities per hour via DTT, with an average of 30 hours per week depending on age (Howard et al., 2005). DTT was the main component of the intensive behavior intervention approach. The first comparison group (i.e., control) received intensive "eclectic" treatment, which included a combination of methods, such as sensory integration therapy, PECS, & activities derived from the Treatment and Education of Autistic and Related Communication Handicapped Children (TEACCH) model. For this comparison group, the adult to child ratio was 1:1 or 1:2 with 25 – 30 hours of treatment per week (Howard et al., 2005). A second comparison group included children who were enrolled in the local special education program with a 1:6 adult to child ratio, receiving an average of 15 hours of education per week. Children in this group were exposed to educational activities that were “developmentally appropriate” to enhance their language, play, and sensory experiences (Howard et al., 2005). These treatment approaches were selected for this study due to a lack of empirical evidence supporting non-behavioral interventions such as (TEACCH). Additionally, previous studies comparing early intensive behavior analytic treatment directly with TEACCH, or any other comprehensive treatment model were selected as well (Howard et al., 2005). The participants across all three groups were evaluated using standardized tests of cognitive, language, and academic skills at intake and approximately 14 months later (Howard et al., 2005). Results showed that the intensive behavior intervention group, where DTT was the main component, produced significantly higher learning rates than the two comparison groups. For example, the IQ cognitive scores for three participants in the DTT group went from being in or near normal range (low average: 84, 89, 97) at intake to (average or above average: 122, 114, & 102) at the follow-up. In the first comparison group, no children had IQ scores in the normal range at intake; at follow-up, only two children had moved into the normal IQ range. For the second comparison group three children demonstrated increases in IQ scores from intake to follow-up; however, two children whose IQ scores were in the normal range at intake demonstrated a mild decline at follow-up (from 91 to 77 and 89 to 85) (Howard et al., 2005). Overall, these findings suggest that interventions incorporating DTT can produce effective outcomes for children diagnosed with ASD.

As previously mentioned, DTT has been demonstrated to be an effective method for teaching individuals with ASD to develop a range of skills including labeling, conditional discriminations, adaptive living, and social or play skills (e.g., Grow et al., 2011; Krantz & McClanahan, 1993; Majdalany, Wilder, Greif, Mathisen, & Saini, 2014). Specifically, a large amount of instructional time is often devoted to teaching conditional discriminations, in which the correct response in the presence of the discriminative stimulus depends on the stimulus context (Lerman, Valentino, & LeBlanc, 2016). For example, when teaching a child to discriminate among several common objects (e.g. knife, fork, and spoon) the therapist might present stimuli of each object and ask the child to "Point to spoon". In the presence of the spoon, pointing to the spoon is correct only if the auditory stimulus is, "Point to spoon". Curriculum manuals and guides recommend two methods for teaching this type of auditory-visual discrimination. In one method (the "simple-conditional method"), the stimuli are presented sequentially until mastered, in which the learner is taught to respond to one stimulus only (e.g., point to spoon). Additional stimuli (e.g., fork and knife) are successively introduced, with increasingly difficult discriminations over time until the objects are presented together and alternated during trial sets. In the "conditional-only method", the learner is taught the three stimuli (e.g., fork, knife, and spoon) simultaneously from the onset of instruction. Results of several recent studies suggest that the conditional-only method is more effective and efficient than the simple-conditional method, which has been recommended in several EIBI curriculum guides (e.g., Grow et al., 2011; Grow, Kodak, & Carr, 2014).

Treatment Integrity

It is important to note that the effectiveness of DTT depends highly on the accuracy of implementation (i.e., treatment fidelity). According to DiGennaro Reed (2011), treatment integrity refers to the consistency and accuracy of the implementation of a treatment protocol in the manner in which it was designed. Generally, treatment procedures need to be implemented with fidelity to ensure effectiveness (Lane, Bocian, MacMillian, & Gresham, 2004). Procedural fidelity or treatment integrity of DTT depends on the accurate implementation of all of its components. For example, when teaching a child to get dressed (i.e., putting on underwear, then pants) typically a task analysis is developed and followed to complete the task accurately. Treatment integrity errors, such as providing a prompt at a particular step instead of an independent opportunity, can prolong skill acquisition, lead to prompt dependency, and increase problem behaviors (i.e., faulty stimulus control; child only emits a response in the context of a prompt being provided). Treatment integrity ensures that behavior change, or the dependent variable, is reliably due to the independent variable (i.e., treatment of interest), and not to extraneous variables (Cooper, Heron, & Heward, 2007).

Treatment integrity can be assessed through a number of methods including direct observation, feedback from individuals not implementing treatment, self-monitoring, and permanent products (Lane et al., 2004). According to Gresham, Gansle, and Noell (1993), factors that influence treatment integrity include the complexity of the intervention, time required to implement the intervention, materials, number of therapists or teachers involved in the intervention, perceived and actual effectiveness, and motivation of the therapists/teachers involved. Despite the benefits of assessing treatment integrity, the assessment of the independent variable is not often conducted.

In a review by Wheeler and colleagues (2006), 60 studies from peer-reviewed behavioral journals published between the years of 1993 to 2003 were selected. The researchers identified 11 studies that operationally defined the independent variable and assessed treatment integrity. While 41 additional studies provided technological descriptions of the independent variable, those same studies failed to assess treatment integrity, or the accuracy in which the independent variable was implemented. Lastly, three studies mentioned treatment integrity within the article, but failed to provide those data or discussion for replication. Given the intent of applied research to develop and evaluate the efficacy of an intervention with an individual or group of individuals, it is necessary to understand that within such studies, adherence to the research protocol must be consistently observed across participants (Wheeler, Baggett, Foxx, & Blevins, 2006). Wheeler et al. recommended that researchers give special attention to specifying criteria, procedures, tasks, and characteristics of those involved in treatment, as well as training the experimenters, therapists, or trainers in how to carry out the intervention techniques that are central to the study (Wheeler et al., 2006).

Research assessing treatment integrity in the last five years has increased with several types of integrity errors that have been identified within various contexts. For example, errors of commission (i.e., reinforcing an incorrect response) and errors of omission (i.e., withholding reinforcement for a correct response) are two types of treatment integrity errors that can affect treatment efficacy. Additionally, integrity errors can occur within each of the components of DTT discussed by Smith (2001), including discriminative stimuli, prompt use, and reinforcement (Carroll et al., 2013). Carroll and colleagues (2013) found three common treatment integrity errors during teaching, including repeating an instruction, failure to provide a prompt when necessary, and failure to provide reinforcement for a correct response. The authors conducted a further analysis of the three common treatment integrity errors by comparing high vs. low treatment integrity conditions, 100% vs. 33% respectively. Results showed detrimental effects on teaching during the low treatment integrity condition within these types of errors. Research has also evaluated treatment integrity in the context of DRA/time-out interventions, academics, & discrete trial training (DiGennaro Reed, Reed, Baez, & Maguire, 2011; Noell, Gresham, & Gande, 2002; Northup, Fisher, Kahang, Harrell, & Kurtz, 1997; Vollmer, Roane, Ringdahl, & Marcus, 1999).

Numerous studies have been conducted evaluating treatment integrity during behavior change procedures, such as differential reinforcement of alternative behavior (DRA) (Northup et al., 1997; Vollmer et al., 1999; St. Peter Pipkin, Vollmer, & Sloman, 2010). Specifically, St. Peter Pipkin and colleagues (2010) extended Vollmer et al. (1999) research examining DRA and treatment integrity by conducting a translational model, in which, the authors evaluated the effects of commission and omission errors on DRA when providing periodic reinforcement of problem behavior and failure to reinforce appropriate behavior. Commission errors were defined in the study as delivery of a reinforcer following problem behavior, and omission errors were defined as failure to deliver an earned reinforcer. The effects of both omission and commission errors were examined within a university computer lab with undergraduate students.

Experiment 1 involved 22 undergraduate students in a computer lab interacting with a computer program design to model DRA conditions. Red and black circles were presented on the computer screen. Clicking on the colored dots (i.e., black and red) on a computer screen was analogous to engaging in problem behavior (e.g., black dot) or appropriate behavior (e.g., red dot) (St. Peter Pipkin et al., 2010). Points were delivered (i.e., reinforcers) and were programmed to be delivered on a schedule that varied for target circle and participant. Participants were assigned to four subset conditions that varied in the level of treatment integrity. Subset 1 condition sequence involved 80%, 60%, 40%, and 20% omission errors. Subset 2 was similar to subset 1, with the exception of commission errors. Subset 3 involved combined errors (i.e., commission and omission errors), and subset 4 alternated between BL, 100%, and 50% treatment integrity.

Results for subset 1 (i.e., omission errors, failure to reinforce appropriate behavior) showed that varying the level of treatment integrity did not affect levels of problem behavior and was associated with low rates of alternative behavior. During subset 2 (i.e., reinforcing problem behavior), commission errors did not become detrimental until the level of treatment integrity dropped to 40% or lower. During subset 3 (i.e., errors of commission & omission), responding matched the specific schedule of reinforcement. That is, when problem behavior had a greater than 50% chance of producing reinforcement, problem behavior occurred more frequently than appropriate behavior, and vice versa. During subset 4 (i.e., exposure to 50% integrity after baseline and after 100% integrity), for five participants a pattern was observed in which some carryover from the most recent condition, such that 50% was most effective following 100% integrity, and less so after 0% integrity. For the remaining eight participants, there were no observed carryover effects. In sum, errors of commission led to a greater detrimental effect on responding than did errors of omission at relatively low levels of treatment integrity (20% and 40%).

Experiment 2 further assessed the combined omission and commission errors (replicated subset 3) to evaluate the level of responding, including the effects of combined errors on the occurrence of problem and appropriate behavior during DRA with one child diagnosed with ASD. Resulted showed more on-task than off-task behavior during the 80% and 60% treatment integrity conditions while responding switched during the 40% and 20% treatment integrity conditions.

Experiment 3 included an adolescent diagnosed with an intellectual disability. The purpose of experiment 3 was to replicate subset 4 and evaluate sequence effects on responding during treatment integrity failures.

A 50% treatment integrity condition was used for this experiment. During this condition, 50% of aggression responses and 50% of greetings resulted in brief attention. Data were collected on aggression (physical contact between participant's open hand and the therapist's body) and greetings (i.e., saying "hi"). Results indicated differences at the 50% treatment integrity condition following DRA rather than following baseline. During integrity failures following baseline, rates of greeting remained low or near zero, and rates of aggression remain high and stable. Treatment integrity failures were more detrimental to the treatment when they followed baseline than when they followed treatment with perfect integrity. Overall, this study suggests commission errors in isolation are most detrimental when treatment integrity is below 40%. Omission errors in isolation did not have detrimental effects on treatment regardless of treatment integrity level. Taken together, these studies indicate that a combination of errors of omission and commission results in an increase of problem behaviors and a decrease in inappropriate behaviors (St. Peter Pipkin et al., 2010). It is important to note, that despite integrity failures, robust effects of DRA procedures were still illustrated.

Previous research has also examined impact of treatment integrity within skill acquisition procedures. For example, Carroll et al. (2013) evaluated the effects of treatment integrity errors on skill acquisition for children with ASD during DTT. The purpose of the first experiment was to identify common treatment integrity errors that occurred during one-on-one instruction or small group instruction observed in a typical academic classroom. The purpose of the second experiment was to evaluate the effects of the three most common treatment integrity errors observed during the first experiment. Finally, a third experiment was conducted to evaluate the differential effects of the three integrity errors on skill acquisition during DTT (Carroll et al., 2013). Results in Experiment 1 showed the three most common integrity errors implemented by therapists were repeating the instruction, failure to provide a prompt when necessary, and failure to provide reinforcement for a correct response. These three integrity errors identified in experiment were then evaluated across two levels of treatment integrity (i.e., 100% vs. 33%). During the high integrity condition, errors were not implemented and each component of the discrete trials was presented correctly (i.e., perfect implementation). The low integrity condition involved programmed integrity errors implemented for 8 of the 12 trials during each session. Results showed all participants mastered target stimuli in the high integrity condition (i.e., 100%) and 1 out of 6 participants mastered targeted stimuli in the low integrity condition (i.e., 33%).

The authors conducted a further analysis of the effects of the three common treatment integrity errors presented in experiment 2, on acquisition of target stimuli during DTT. Results showed that the lowest percentage of correct responding for skill acquisition during the low integrity condition (33%) for all three errors across all participants. Overall, the study indicated that therapists or teachers who work with children with ASD frequently implement different components of academic instruction with less than perfect integrity (Carroll et al., 2013). The results of studies 2 and 3 indicate that integrity errors decrease the effectiveness of DTT.

In another study conducted by DiGennaro Reed and colleagues (2011), the effects of commission errors during DTT were evaluated during conditional discrimination training. A commission error was defined as reinforcing an incorrect response by delivering a token or social praise. The independent variable was the level of treatment integrity associated with a percentage of commission errors (100%, 50%, 0%). The dependent variable was percentage correct during each session of conditional discrimination task. During baseline the experimenter presented three stimuli in a horizontal array on a tabletop, each depicting a nonsense shape (DiGennaro Reed et al., 2011). Subsequently, the experimenter presented the following instruction to each participant “find [shape]”. Programmed consequences were not delivered during baseline; that is a correct response did not lead to reinforcement nor did an incorrect response lead to error correction. Each session consisted of 10 consecutive trials of the same shape (i.e., referred to as massed trial format). Least to most prompting was used as an error correction procedure. During the 0% treatment integrity condition

(100% commission errors), each incorrect response was followed by a commission error. During the 50% treatment integrity condition (50% commission errors), every other incorrect response was followed by a commission error, and during the 100% treatment integrity condition (0% commission errors) there was perfect implementation. All participants demonstrated higher levels of performance during 100% treatment integrity condition. For two out of three participants, performance was low and showed no differentiation across the 100% and 50% treatment integrity conditions. However, for 1 participant differential outcomes were observed with (M = 92%) in the 100% treatment integrity condition, (M = 45%) in the 50% treatment integrity condition, and (M = 10%) in the 0% treatment integrity condition. One limitation of the study was the assignment of one shape to each integrity condition, which was not counterbalanced across participants. DiGennaro Reed and colleagues concluded acquisition may be due to specific instructional targets associated with that condition. Another potential limitation was that the pattern of errors displayed in their study were less likely to occur in applied settings.

Various studies have been conducted with parametric analyses of different levels of treatment integrity and its relation to intervention effectiveness. The measurement of treatment integrity varies across studies and settings. For example, Vollmer et al., (1999) used 100%, 75%, 50%, and 25% levels of treatment integrity to evaluate omission and commission errors during the implementation of a DRA procedure. Results showed a decrease in intervention efficacy with high occurrence of commission errors. In the St. Peter Pipkin et al. (2010) study, researchers conducted a translational model of treatment integrity, which found that commission errors were more detrimental than omission errors in both basic and clinical settings. DiGennaro Reed et al. (2011) conducted a parametric analysis of commission errors during discrete trial training indicating that low levels of treatment integrity degraded performance. Additional research is needed on treatment integrity and intervention effectiveness. More specifically, research is needed on different levels of treatment integrity failures during skill acquisition. Establishing clear criteria of integrity errors that lead to breakdown or problems with acquisition during EIBI has clear implications for training front-line therapists. Thus, the purpose of this study is to replicate and extend DiGennaro Reed et al. (2011) by conducting a parametric analysis, using 100%, 75%, 50%, % and 25% levels of integrity to examine commission errors during discrete trial training with children with developmental disabilities. Specifically, reinforcement was delivered prior to error correction, essentially reinforcing errors during teaching.

Chapter II:

Method

Participants

Participants were three boys, aged 35 – 42 months with a DSM5 diagnosis of ASD. Participants were recruited from a university-based EIBI clinic, demonstrated learner readiness skills, such as attending to a therapist, responding to standard prompting procedures (e.g. least to most, errorless teaching), and could sit at a table for two to five minutes. Individuals who engaged in high rates of problem behavior, such as self-injury, aggression, or property destruction were excluded.

Robert was 42 months of age, diagnosed with moderate to severe ASD determined by the toddler module of the Autism Diagnosis Observation Schedule (ADOS, 2nd edition)[1]. He was a level two learner as determined by the Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP; Sundberg, 2008)[2] with a score of 63, and a beginner language repertoire. He received 15 hours of services in clinic per week.

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[1] Autism Diagnosis Observation Schedule (ADOS) is a standardized, semi-structured assessment of communication, social interaction, and play (or imaginative use of materials) for individuals suspected of having autism or other pervasive developmental disorders.

[2] Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP) is a criterion assessment, skills-tracking system and curriculum guide to assess the language, learning and social skills of children with autism or other developmental disabilities.

James was 35 months of age, diagnosed with moderate to severe ASD determined by the toddler module of the ADOS (2nd edition). He was considered a level three learner determined by the VB-MAPP (2008) with a score of 13, and he demonstrated an intermediate to advanced language repertoire. He received 30 hours of services in clinic, per week.

Matthew was 42 months of age, diagnosed with moderate ASD determined by module one of the ADOS (2nd edition). He was primarily a level two learner (with some skills in level three) determined by the VB-MAPP (2008) with a score of 93, and also demonstrated an intermediate language repertoire. He received 30 hours of services in clinic per week.

Setting and Materials

All sessions were conducted at a university-based autism center in a secluded treatment room with padded walls and a one-way mirror for observation. The work space included a child-sized table, two chairs, a video camera, teaching materials. Teaching materials consisted of a two-inch three ring binder with an array of four to eight pictures displayed on each page. Edibles as identified by an MSWO were used for Robert and James; and toys for Matthew. Each session was conducted with the therapist and participant seated at the table next to or across from each other. The length of session varied depending on participant responding and included play breaks as needed.

Response Measurement

The dependent variable was the percentage of correct responses within an 8 trial block (i.e., percentage accuracy). Multiple trial blocks were conducted during daily sessions. Percentage accuracy was calculated by dividing the total number of correct responses by the number of correct plus incorrect responses and converted to a percentage for each session. A correct response was defined as responding to the therapist instruction within 5s of the delivery of the discriminative stimulus (e.g., instructions, materials). Problem behavior was also measured including negative vocalizations, disruptions, etc. Negative vocalizations were defined as a vocal utterance in the form of crying or whining for more than three seconds in duration. Disruptions were defined as an attempt to hit or swipe stimuli or tearing, breaking, or standing up at the table without permission. Data were collected by the primary investigator and additional trained graduate therapists. One to five eight trial blocks were conducted per day, with a maximum session length of 30-45 minutes.

The independent variable consisted of the predetermined level of treatment integrity, 100%, 75%, 50%, and 25%. Three out of the four levels of treatment integrity (excluding 100% treatment integrity) included implementation mistakes consisting of commission errors. A commission error was defined as reinforcing an incorrect response with a preferred item as identified by the MSWO, prior to implementing error correction.

Interobserver Agreement

Interobserver agreement (IOA) was collected by a trained independent observer for at least 40% of sessions for all participants. Observers were selected after achieving at least 90% reliability across three consecutive sessions with the principal investigator. IOA was calculated by comparing each observer's record on a trial-by-trial basis. For participant behavior, an agreement was scored when both observers scored student performance identically (i.e., as correct or incorrect). Agreement was calculated as the number of trials agreed divided by agreements plus disagreements, multiplied by 100 for each session (DiGennaro Reed et al., 2011). Inter-observer agreement ranged from 96% to 98%: Robert (97%; range 89% to 100%), Matthew (98%; range 90% to 100%), and James (96%; range 88% to 100%).

Treatment Integrity

Treatment integrity was collected by a trained observer for at least 72% of sessions across all participants. This was calculated by dividing occurrence of each treatment component by the total number of treatment components scheduled to be delivered, multiplied by 100. Treatment integrity data were collected using a checklist evaluating the following characteristics of the therapist's behavior: 1) gaining child's attention, 2) delivering correct discriminative stimulus (instruction, materials), 3) providing predetermined prompt as necessary, 4) implementing error correction, and 5) reinforcement (i.e., delivers programmed consequences as planned; including planned commission errors). Treatment integrity across session ranged from 97% to 100%: Robert (100%), Matthew (97%; range, 95% to 100%), James (98%; range, 90% to 100%).

Social Validity

A brief series of questions were developed to assess caregiver's opinions about the study, using a five-point Likert-type scale, ranging from one (not at all satisfied) to five (very satisfied). Questions included information about the acceptability of the treatment, the effectiveness of the intervention, and the feasibility of the intervention. Questionnaires were completed at the end of the study. The caregiver's score from the questionnaire average 4.5 across all participants indicating the study to be socially valid.

Experimental Design

A combined multielement and nonconcurrent multiple baseline design across participants was used to evaluate the four levels of treatment integrity (100%, 75%, 50%, 25%) on participants' performance during discrete-trial training of conditional discrimination (DiGennaro Reed et al., 2011). The reason for selecting this design was to extend and replicate the findings used by DiGennaro Reed et al. (2011). The four levels of treatment integrity were alternated randomly during treatment.

Procedure

Data were collected on the percentage of correct responding and occurrence of problem behavior for each session for each participant. Prior to each session, a multiple-stimulus-without-replacement preference assessment (MSWO) was conducted (De Leon & Iwata, 1996) to identify putative reinforcers for the session. The highest two to three preferred items were alternated during that session to avoid satiation. The MSWO was conducted prior to each session for the duration of the study. Sessions were conducted until the participant met predetermined mastery criteria for each target stimulus. Mastery criteria were defined as the participant independently emitting the correct response on at least 87.5% of trials across three consecutive sessions and emitting a correct response on the first trial. Implementing treatment integrity errors during skill acquisition may be detrimental to teaching (e.g., mastery criteria not met). In other words, since implementation mistakes were being made during teaching (i.e., commission errors) by the therapist, mastery criteria were less likely to be met. Thus, if mastery was not reached following eight consecutive sessions, data were examined to determine whether responding had remained stable or decreased so procedural changes could be implemented (Pence & St. Peter, 2015).

Prior to the study, probes were conducted for each task and exemplar. Only exemplars that the participants scored less than 25% were selected. For example, the therapist probed 10 – 30 objects (or picture cards). A minimum of three cards were placed in front of the child and the instruction "touch the one you color with" was delivered. The participants were provided four opportunities to emit the correct response. The exemplars, in which, participants scored 25% or less during the assessment were selected for the study.

Baseline

Each session consisted of multiple eight trial blocks in massed trial format. Specifically, one target stimulus was associated with each pre-determined level of treatment integrity. For example, if the target stimulus was “dog”, for eight consecutive trials the therapist presented a binder with four to eight pictures on each page in front of the child and asked the child to touch “dog”. The location of the target stimulus varied for each trial. Each trial began with the therapist obtaining the participant’s attention by saying “[Name], look here”. The experimenter then presented a binder with a minimum of four different stimuli in an array on each page and instructed the participant to “Touch or find ____”. The experimenter provided 5 seconds for the participant to respond. Programmed consequences were not delivered during baseline. That is, a response, correct or incorrect, simply produced the next trial.

Treatment

During treatment, consequence manipulation consisted of implementing discrete trial training at the four predetermined treatment integrity levels, 100%, 75%, 50%, and 25%. Each treatment integrity level was associated with one target stimulus (e.g., red vehicle-100% integrity, orange animal-75% integrity, round food-50% integrity, cold food-25% integrity; see Table 1 for a list of targets for each participant). During the 100% treatment integrity condition, the therapist implemented the trial blocks accurately for all 8 trials and did not engage in any errors (i.e., perfect implementation). During the 75% integrity condition, a commission error was implemented for 2 out of 8 trials within the trial block. During the 50% treatment integrity condition, a commission error was implemented for four out of eight trials within the trial block. Finally, during the 25% treatment integrity condition, a commission error was implemented for 6 out of 8 trials within the trial block. In other words, a reduced level of integrity was associated with providing reinforcement for incorrect responding prior to implementing the error-correction procedure. Thus, errors were reinforced according to the schedule associated with each predetermined level of treatment integrity, 100%, 75%, 50%, and 25%. Error correction was delivered using the least-intrusive prompt necessary, following delivery of preferred item. To assist with accurate delivery of the reinforcer for incorrect responses, visual prompts on the therapist's clipboard indicated which responses were followed by reinforcement (Vollmer et al., 1999). For example, during the 25% treatment integrity condition incorrect responses emitted by the participant was collected on a separate data sheet which displayed a list of incorrect responses for the treatment integrity condition. Every six out of eight incorrect responses was highlighted and followed by the implementation of a commission error. All participants received similar instructions as described in baseline. During teaching, the least intrusive prompt required to facilitate the correct response was used within the error-correction procedure. Specifically, if the participant emitted an incorrect response (i.e., selects the wrong stimulus or no response), the experimenter would provide a gestural prompt (e.g., pointing) for correct responding if pointing had been previously been used as a successful prompt in the past. A neutral statement (e.g., "that's ____ ") was delivered for prompted, correct responses. Thus, prompted correct responses were not followed by delivery of preferred items. Each session consisted of 8 consecutive trials of the one stimulus associated with that condition.

Follow up

Follow-up sessions were conducted 2 to 6 weeks after mastery was achieved. The follow-up sessions were conducted as described in baseline except there was no error correction procedure for incorrect responses and no prompts were provided. Data were collected on independent correct responses, incorrect responses, and the absence of responding.

Chapter III:

Results

Figure 1 shows the results for Robert, who met mastery (i.e., 87.5% correct responding across three consecutive sessions, first trial correct) during the 100% treatment integrity condition first. Robert then met mastery for the 25% treatment integrity condition following 112 trials, then he mastered the 75% treatment integrity condition following 152 trials, and finally he met mastery for the 50% treatment integrity condition following 198 trials (see Figure 4). At session 39, target stimuli in the 25% and 75% treatment integrity condition were moved to the 100% treatment integrity condition. Shortly after moving the target stimuli from the 25% and 75% treatment integrity condition to 100% (i.e., perfect implementation), Robert met mastery for target stimuli across both conditions. A progressive prompt delay procedure was added to the 50% treatment integrity condition at session 70 due to lack of mastery over an extensive period of time (i.e., eight consecutive sessions). Shortly after implementing the progressive prompt component, Robert met mastery criteria.

Figure 2 shows the results for James, who met mastery first during the 100% treatment integrity condition following 144 trials. James met mastery for the 25% treatment integrity following 168 trials, then he mastered the 50% treatment integrity condition following 176 trials, and finally he met mastery for the 75% treatment integrity condition following

184 trials (see Figure 4). At session 63, the 25%, 50%, and 75% treatment integrity conditions were moved to the 100% treatment integrity condition. Shortly after implementing moving target stimuli from the 25%, 50%, and 75% treatment integrity condition to the 100% treatment integrity condition, mastery criteria was met.

Figure 3 shows the results for Matthew who first met mastery during the 100% treatment integrity condition following 80 trials. Matthew met mastery for the 75% treatment integrity condition following 88 trials, then he mastered the 50% treatment integrity condition following 112 trials, and finally he met mastery for the 25% treatment integrity condition following 168 trials (see Figure 4). At session 51, the 25% treatment integrity condition was moved to the 100% treatment integrity condition, in which, after another six sessions mastery criteria was met.

Figure 5 shows the aggregated results across all three participants. During the 100% treatment integrity condition the range of trials to meet mastery was 70 - 145, during the 75% treatment integrity condition the range was 85 - 175 trials, during the 50% treatment integrity condition the range was 110 - 200 and finally during the 25% treatment integrity condition the range was 110 - 170. Also, Table 1 depicts the list of targets taught during this study within the receptive identification of common objects task.

Chapter IV:

Discussion

The purpose of the current study was to extend the findings of DiGennaro Reed et al. (2011) by conducting a further analysis of treatment integrity, incorporating commission errors during discrete trial training. Four integrity levels, 100, 75, 50, and 25 respectively, were examined to ascertain the point at which acquisition might be hindered for children receiving DTT in EIBI programs. For all participants, skill acquisition occurred most quickly, during the 100% integrity condition, or when treatment was implemented with perfect fidelity (no mistakes). Accordingly, this condition required the fewest number of trials to meet mastery across all participants. For one participant, Matthew, mastery was also met fairly quickly at the 75% treatment integrity condition. However, for two of the three participants, Robert and James, mastery was not met when integrity was reduced to 50% and 25%, respectively.

These results are consistent with those found by DiGennaro Reed et al. (2011), in that a higher level of treatment integrity (i.e., 75 – 100%) produced better performance and faster acquisition. In addition, persistently low treatment integrity (i.e., 25 – 50%) produced adverse effects (e.g., not meeting mastery criteria during the initial phase of treatment and producing slower rates of acquisition). The current study extends the procedures used by DiGennaro Reed (2011) et al. in several ways. First, two additional levels of integrity, 25%, and 75%, were added to this study. These levels were added with the need to establish a clear criterion of when breakdown in treatment integrity could become detrimental to acquisition. From a clinical standpoint, this provides trainers with information on minimum qualifications for training front line staff. Our results showed that skills can still be acquired during DTT when treatment integrity levels are as low as 75% - 50%. Another extension includes the use of target stimuli that were of clinical relevance for participants' clinical programs as opposed to arbitrary targets as selected by DiGennaro Reed et al. (2011). Targets were chosen based on a non-scored skill set from the Verbal Behavior Milestones Assessment and Placement Program (Sundberg, 2008). For Matthew and James, mastered targets were maintained over time across the four treatment integrity conditions. For Robert, the target in the 50% treatment integrity condition was the only target that did not meet maintenance criteria at follow-up. We were able to target a skill set that was once a deficit and begin to make some progress within that area. Finally, we moved target stimuli that did not meet mastery to the 100% treatment integrity condition and implemented treatment with perfect fidelity within these targets. This was especially important because it demonstrated skill acquisition can still occur despite a history of reinforcement with problematic teaching. Overall, the results found in this study supports previous research suggesting the assessment of treatment integrity is crucial whenever you are implementing a treatment protocol to ensure procedural fidelity.

There are some possible explanations for the results of the current study. James and Robert produced more variable results than Matthew. Reported by experimenters during the majority of the study James would emit the same response across all four treatment integrity conditions (i.e., overselectivity). In particular, James was observed to demonstrate a bias or respond more frequently towards one specific stimulus (i.e., dirt) across all conditions during treatment. This indicates a pattern of responding with faulty stimulus control (i.e., the response is not under the control of the discriminative stimulus) and could have contributed to James's variable results. For Robert, he met mastery during the 25% treatment integrity condition second. Anecdotally reported by the experimenter, Robert may have been exposed to the target stimulus associated with that condition outside of session, which may have contributed to the faster rate of acquisition in a condition with poor treatment integrity. Also, Robert had none to limited history with EIBI (e.g., implementation of teaching methods and procedures) prior to participating in this study. Thus, additional assistance (i.e., progressive time delay prompt) was needed to facilitate correct responding during the 50% treatment integrity condition.

There are limitations to the current study, along with directions for future research. First, trials were conducted in mass trial format which may not be the most efficacious teaching method for skill acquisition across participants (Chiara, Schuster, & Bell, 1995). Future research should evaluate additional teaching techniques, such as task interspersal, in which target stimuli are mixed within trial blocks during sessions.

Another limitation of this study was that we initially observed false positive results across participants. A false positive in this study was defined as the participant emitting an incorrect response on the first trial, and following error correction correct responding was observed for the subsequent trials within that session. While participants met initial mastery, 87.5%) for that session, the participant would continue to emit an incorrect response on the first trial of subsequent sessions. These findings suggested that percent accuracy was not a good measure when using massed trial format. As a result, the mastery criteria was altered to include both percent accuracy (87.5%) as well as the first trial of each session to be correct.

Due to the small number of participants included in the study, it is difficult to determine the conditions for which a breakdown of integrity is most problematic. Further, evaluating integrity with individuals with a range of behavioral and verbal repertoires may attribute to establishing a criterion for programming based on the level of the learner. Finally, treatment integrity errors can occur within instruction, prompting, and reinforcement during DTT. This study only examined commission errors during DTT, it would be beneficial to conduct further analyses of treatment integrity on the aforementioned areas. Also, more research is needed on omission and commission errors during DTT (e.g., evaluating the combination of commission and omission errors).

In conclusion, the current study demonstrated that high level of treatment integrity yielded better performance during acquisition for young children with diagnosed with ASD. Whereas, persistent low integrity produced adverse effects on acquisition, requiring more teaching trials. Future research should continue to evaluate this area and pursue training methods to improve treatment fidelity for clinicians who work with young children with autism.

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Appendix

Table 1

List of targets taught for Robert, James, and Matthew

Participants	**25% Integrity**	**50% Integrity**	**75% Integrity**	**100% Integrity**
Robert	"Touch the clothing" (**Shirt**)	"Touch the one you play with" (**Mr. Potato Head**)	"Touch the one you sit on" (**Couch**)	"Touch the one you color with" (**Markers**)
James	"Something with sleeves is a" (**Shirt**)	"Dig in the" (**Dirt**)	"The one with a mane is a" (**Lion**)	"Something that hops is a" (**Frog**)
Matthew	"Touch the cold Food" (**Ice Cream Bar**)	"Touch the round food" (**Cookie**)	"Touch the red vehicle" (**Fire Truck**)	"Touch the orange animal" (**Tiger**)

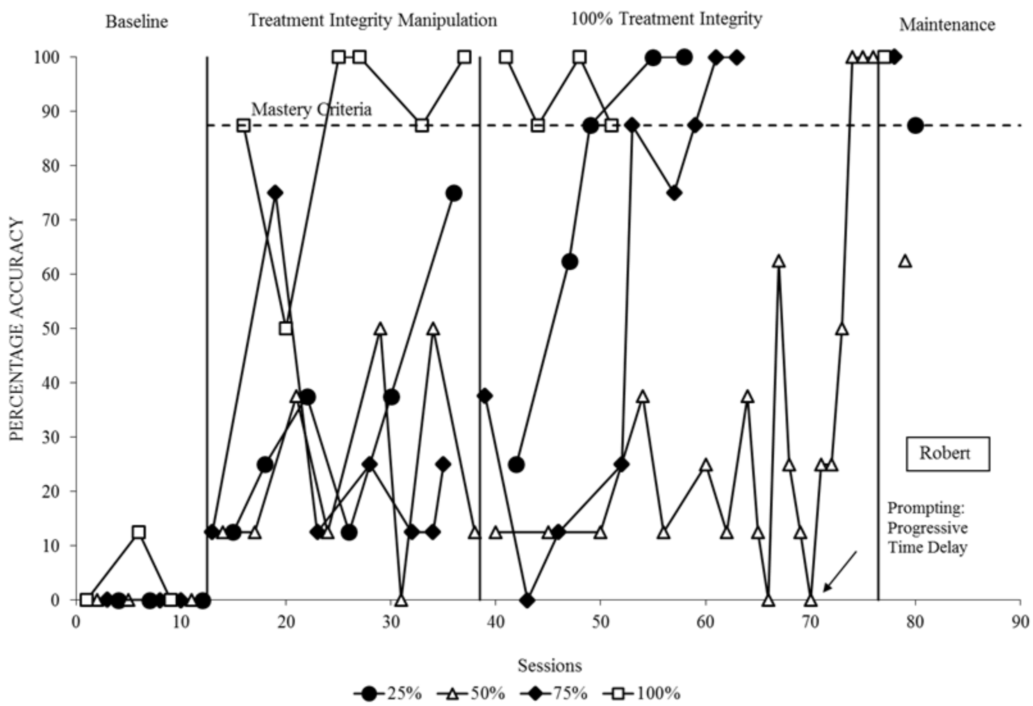

Figure 1. Percentage of correct independent responses during baseline and treatment for the 25%, 50%, 75%, 100% and extended 100% treatment integrity condition. Follow up sessions were conducted to assess maintenance of targets.

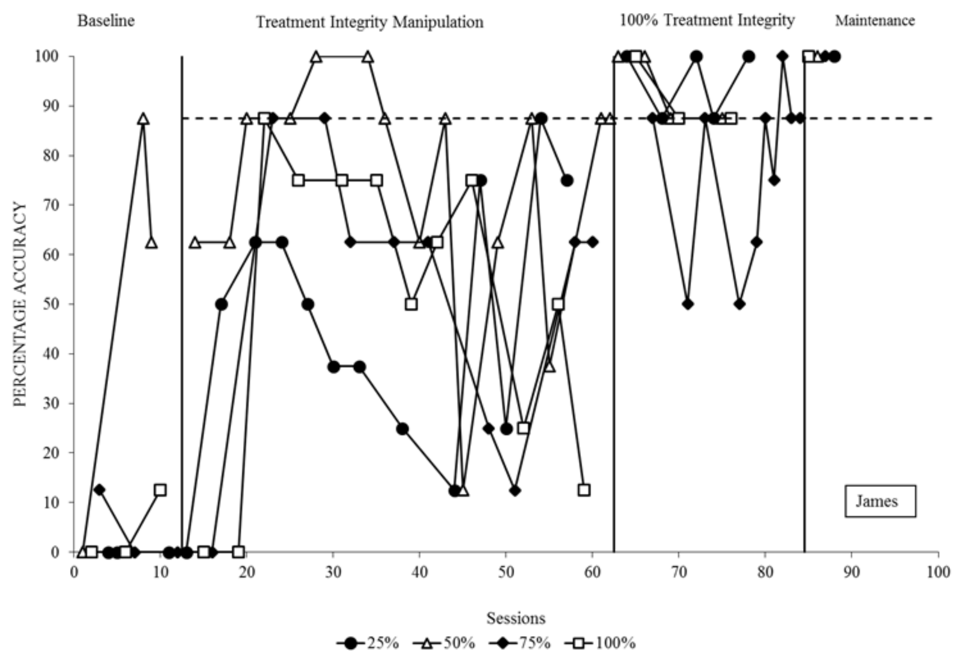

Figure 2. Percentage of correct independent responses during baseline and treatment for the 25%, 50%, 75%, 100% and extended 100% treatment integrity condition. Follow up sessions were conducted to assess maintenance of targets.

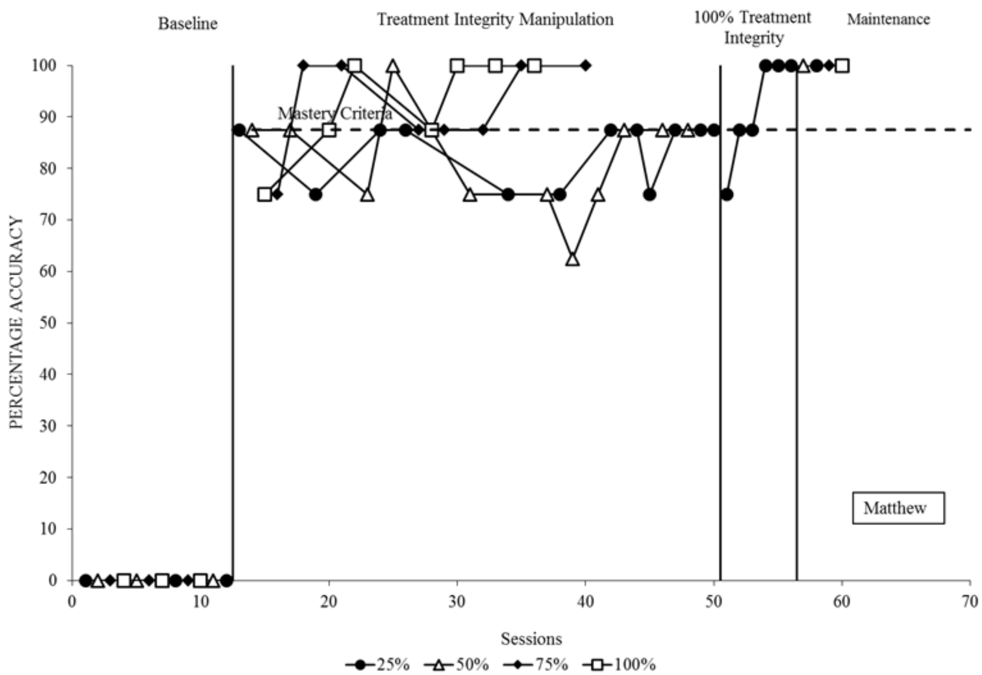

Figure 3. Percentage of correct independent responses during baseline and treatment for the 25%, 50%, 75%, 100% and extended 100% treatment integrity condition. Follow up sessions were conducted to assess maintenance of targets.

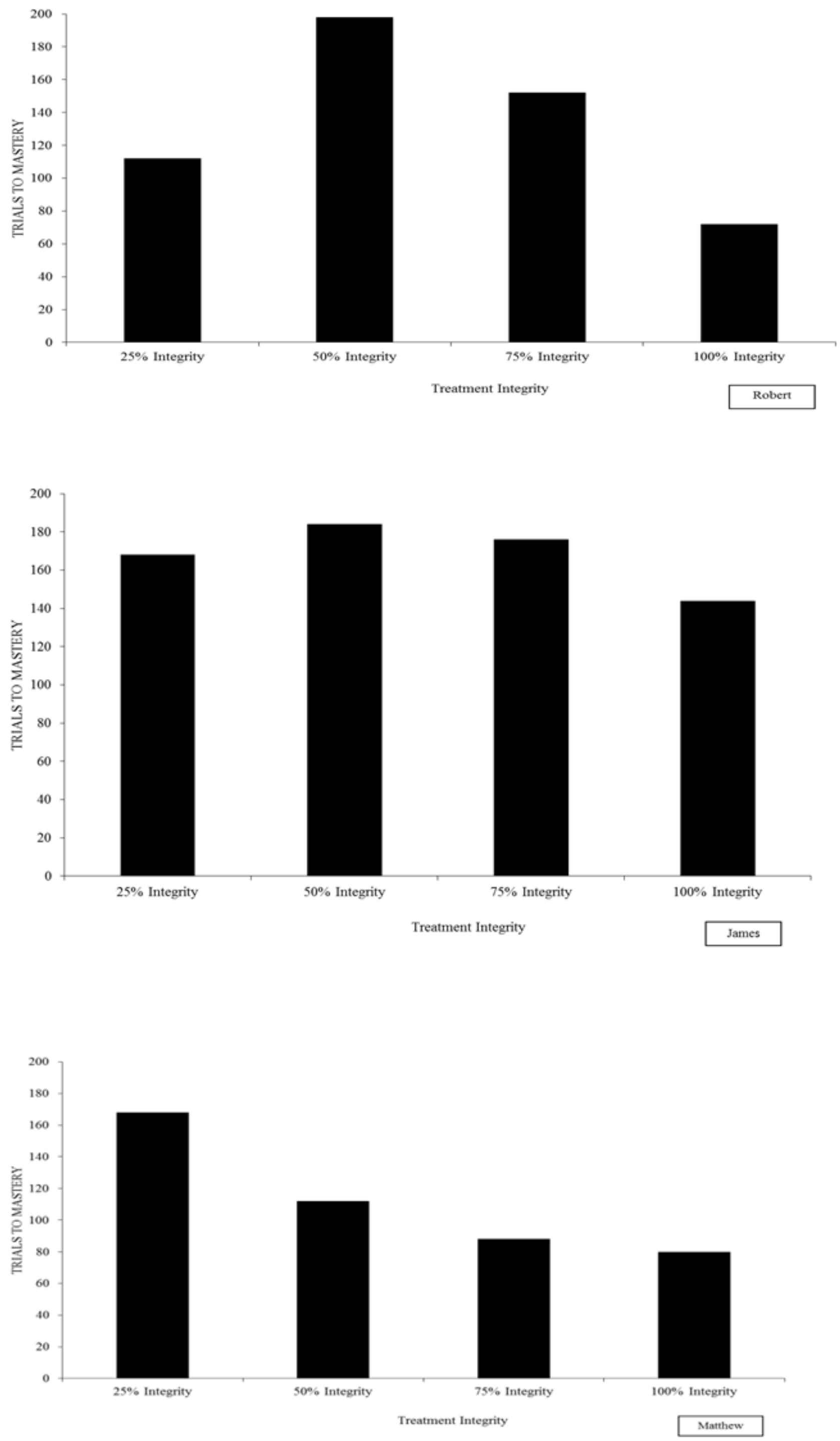

Figure 4. Trials to mastery for Robert, James, and Matthew.

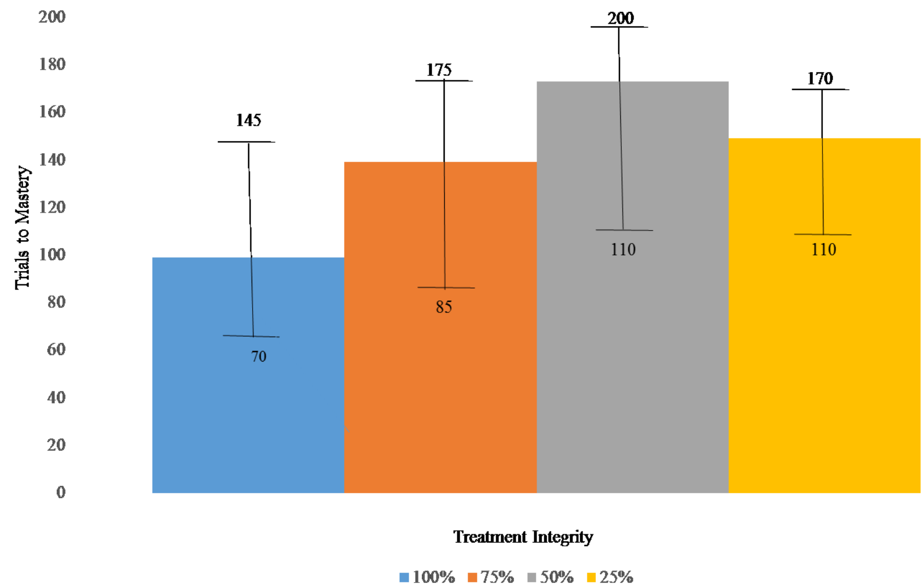

Figure 5. Aggregated results of trials to mastery across all participants for each treatment integrity condition.