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Implementing an Abbreviated Assessment to Compare Error-Correction Procedures for Teaching Intraverbal Behavior to Children

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by

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Abstract

Title: Implementing an Abbreviated Assessment to Compare Error-Correction Procedures for Teaching Intraverbal Behavior to Children

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Young children with Autism (ASD) often have difficulty responding appropriately to questions asked by their peers, parents, or teachers. Teaching intraverbal behavior using Discrete Trial Instruction (DTI) has shown effective results with the use of specific stimulus-transfer procedures (e.g., vocal, textual, or pictures). Previous research has suggested using an abbreviated assessment for error correction procedures as a tool to determine the most effective and efficient procedures when teaching children. In addition, such tools have been shown to not only be effective at predicting a child's most effective error-correction, but also in less time, allowing practitioners to make data-based decisions and individualize programming across learners. The present study seeks to add and extend to the current literature on error correction assessments for teaching intraverbal behavior (i.e., answering questions). The three experimental conditions included vocal modeling, single response repetition, multiple-response repetition, compared with a control condition. Results showed correspondence between the abbreviated assessment and validation assessment for 1 of 3 participants. Findings suggest that a brief assessment may be useful for practitioners when trying to find the most effective and efficient error-correction procedure.

Keywords: error-correction, intraverbal behavior, stimulus-transfer procedures

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Dedication

I dedicate this thesis to all of my friends and family who've supported me throughout my academic journey. Specifically, my parents Catherine and Charles, my sister Allie, brother-in-law, Chris, my nephew Charlie. You mean the world to me.

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Implementing an Abbreviated Assessment to Compare Error-Correction Procedures for Teaching

Intraverbal Behavior to Children

The Diagnostic and Statistical Manual for Mental Disorders-Fifth Edition (DSM-5, 2013) classifies Autism Spectrum Disorder (ASD) as a complex developmental and neurological disorder affecting the functioning of the brain. As of April 2018, the Centers for Disease Control and Prevention estimates one in 59 children is diagnosed with ASD annually in the United States, with occurrences three to four times more common in males than females. Parents often notice their child not engaging in typical behaviors as early as 18 months (e.g., not being easily soothed by their mother, not making eye contact, or lack of babbling), and current research suggests that children can be diagnosed reliably at the age of two (Moore & Goodson, 2003). When compared to typically developing peers, children with ASD range from mild to severe deficits in their ability to learn, socialize, and play. Specifically, children diagnosed with ASD often lack communication skills, which results in problem behavior, such as disruptive or repetitive behaviors (e.g., vocal or motor stereotypy; Singer, 2009). Problematic and stereotypic behaviors interfere with the child's progress in learning academic and daily living skills.

When applying behavioral interventions and teaching strategies in and out of the classroom, children with ASD perform similarly to typically developing peers and minimize barriers that commonly occur without treatment (Lovaas, 1987).

In this paper, I will discuss the impact of Early Intensive Behavior Intervention instruction on children with ASD. I will provide an analysis of commonly used procedures to teach verbal behavior when implementing Discrete Trial Instruction. I will present an overview on the verbal operants, focusing on the intraverbal operant, as defined by Skinner (1957). I will then discuss current research on teaching intraverbals to children with ASD, emphasizing various levels of instruction, from prompting methods, to current error correction procedures commonly used throughout the literature. Lastly, I will address the importance of researchers and practitioners continuing to make data based decisions by focusing on assessment strategies that may allow practitioners and those in applied settings to incorporate more efficient and effective teaching strategies. By doing so, practitioners may produce better outcomes for learners.

Early Intensive Behavior Intervention

Within the field of Applied Behavior Analysis (ABA), many children diagnosed with ASD receive therapeutic services known as Early Intensive Behavior Intervention (EIBI; Lovaas, 1987). ABA involves a systematic application of interventions targeted to increase or decrease behaviors of social significance (Baer, Wolf, & Risley, 1968). Children between the ages of two to six with a developmental delay or diagnosis of ASD may be eligible to receive EIBI services as part of an individualized education plan guaranteed under the Individuals with Disabilities Education Act (U.S. Department of Education, 2004), private insurance benefits, federal initiatives such as the Medicaid Waiver program, or other sources. EIBI services focus on individualizing and targeting specific goals for the child to improve his or her functioning in areas such as functional communication skills, decreasing problem behavior, and feeding services, using scientifically validated interventions. The outcomes for such services mitigate the barriers of the child's developmental delays or diagnosis while simultaneously teaching new and age-appropriate skills (Reichow & Wolery, 2009).

In a seminal study, Lovaas (1987), suggested children who received EIBI services for 40 hr per week by trained therapists, achieved higher gains when compared to children who received 10 hr or less per week, or who received treatment as usual after two years. His results indicated 47% of the EIBI group who received 40 hr per week performed at comparable academic levels to typically developing peers. As a result, the author reported that children with ASD who received EIBI demonstrated "recovery," or were indistinguishable from their typically developing peers 15 years post-study. Many of the children in the EIBI group integrated to mainstream education settings. Since Lovaas's study, researchers have extended the research comparing the effects of EIBI services to alternative treatments, resulting in mixed outcomes for participants (Birnbrauer & Leach, 1993; Smith, Eikeseth, Klevstrand, & Lovaas, 1997; Smith, Groen, & Wynn, 2000; Sallows & Graupner, 2005; Cohen, Amerine-Dickens, & Smith, 2006 Eikeseth, Smith,, Jahr, & Eldevik, 2007). However, the findings suggest the best results occurred when children received more hours per week in services with therapists who were trained on the UCLA model, and who received services for longer periods of time (Reichow & Wolery, 2008).

When a child receives EIBI services, he or she typically encounters two primary methods of teaching known as Discrete Trial Training and Natural Environment Teaching. Specifically, Discrete Trial Instruction (DTI) involves repetitive trial blocks that occur at a rapid pace to improve fluent performance. Each of these methods is described more thoroughly below. Practitioners typically implement this teaching method when providing EIBI services to help children acquire the skills they may not otherwise gain in a typical learning environment.

Discrete Trial Instruction

DTI increases the child's learning opportunities while simultaneously increasing the child's motivation to learn using a structured, teacher-directed procedure. With early learners, the style of teaching focuses on adding novel behaviors to the child's repertoire from simple verbal and nonverbal skills such as answering questions, imitating actions, matching sample stimuli to targets, and identifying pictures or objects. Therapists also work with children to reduce problematic behavior that impedes learning, such as tantrums, aggression, or disruptions of materials. Children later progress to more advanced skills such as expanding their vocabulary to include more complex phrases and sentences, completing self-care tasks more independently, and engaging in social activities with peers (Smith, 2001).

The format of DTI involves breaking down learning opportunities into 5- to 20-s time periods, also known as discrete trials (Smith, 2001). Each session includes a clear beginning, middle, and end component, commonly referred to as a three-term contingency. The specific teaching format allows for the person directing the teaching (e.g., teacher, therapist, or parent) to present a clear antecedent (i.e., discriminative stimulus) to evoke the desired response from the child. Following a correct response, the instructor delivers a specified consequence (i.e., the reinforcer). Once the child meets a particular criterion level of performance, (e.g., at least 80 percent correct responding across three consecutive sessions), the teacher can consider the particular skill mastered (Bogin, Sullivan, Rogers, & Stabel, 2010).

Natural Environment Teaching

NET is a method of teaching that is child-directed and consists of loosely structured sessions where the reinforcers are functionally related to the responses. For example, if a child selects the activity of coloring a picture, the therapist may then teach the child to identify different color crayons, withhold crayons and increase the child's requests, or provide simple instructions such as coloring or drawing specific objects. The types of skills taught to children with ASD vary depending on the particular needs of the child, but a primary emphasis during DTI and NET instruction involves teaching verbal behavior. Since verbal behavior is often impaired in individuals with ASD, many programs emphasize a verbal behavior approach to assessment and programming as an early focus of intervention. Verbal behavior instruction, simply defined, involves teaching skills using a functional approach to language acquisition that focuses on the "purposes" of language for the speaker (Skinner, 1957). The emphasis of verbal behavior is on the effects on the listener and the environment, which differs from a traditional psycholinguistic viewpoint, whereby the learner obtains language via innate and internal processes (Skinner, 1957; Sundberg, & Sundberg, 2011) An overview of the method of teaching verbal behavior that is consistent with Skinner's analysis (1957) follows, as it forms the basis of the present investigation.

Verbal Behavior

Skinner (1957) defined verbal behavior as operant behavior, also known as learned behavior that requires a listener to reinforce the speaker's verbal behavior and primarily focuses on the speaker rather than the listener. Verbal behavior includes spoken language, sign language, picture exchanges, or any other means that a person uses to communicate under similar controlling variables (Skinner, 1957). Verbal behavior is shaped throughout a person's life through processes of differential reinforcement. For instance, during infancy and the toddler years, a child develops and begins to engage in vocal utterances, known commonly as babbling. If a parent reinforces babbling by cooing or talking back to them, over time, babbling shapes into better approximations of words and phrase (e.g., saying, "Mama" or "Dada," asking for desired items, and naming items in the child's environment). Under naturalistic circumstances, children without ASD learn to mimic, or "echo" their parents' verbal behavior, and eventually progress to forming longer sentences. Children with disabilities, such as ASD, typically require higher intensity and frequency of instruction to develop verbal behavior similar to that of their peers.

Verbal behavior plays an important role in children's development and allows them to better access their verbal community. Skinner (1957) proposed categories of verbal behavior that he referred to as verbal operants, which he described based on the type of verbal responses and functions produced from the response. Placing each verbal operant into different categories provides an organized teaching structure to help increase a child's communication and language. Regarding initial verbal behavior, Skinner identified clear distinctions between five elementary verbal operants—echoics, mands, tacts, textual and intraverbals. For purposes of this investigation, I will only focus on the echoic, mand, tact, and intraverbal operants.

Echoic. The echoic is a type of verbal operant that is taught at the very beginning of a child's life. An echoic occurs when the speaker repeats the verbal behavior of another speaker, and similar to the mand, has point-to-point correspondence (Skinner, 1957). An example of an echoic is when a mother says, "mama", and the child repeats, "mama." The echoic is socially reinforced in a manner similar to the tact. Therefore, in the prior example of the child repeating "mama," the mother might provide verbal praise, e.g., "That's right. Good job saying, 'mama.'" The ability to echo words is a key developmental step when learning language and increases the child's verbal repertoire by expanding opportunities to transfer echoics to mands, tacts, or intraverbals (Lovas, 1987; Sundberg & Partington, 1998).

Mand. A mand involves a speaker's requests for something he or she wants or needs, and has point-to-point correspondence, meaning the mand specifies its own reinforcer. A mand is evoked in the presence of a perceived state of need by the individual, for instance, deprivation or satiation, and has value-altering and behavior-altering effects. Motivating operations involve variables in the person's environment that alter or change the person's behavior by increasing or decreasing the value of an item or event, and the behavior required to obtain it (Michael, 1993). In one example of a motivating operation to access an item, a child has been deprived of liquid for some period of time (motivating operation), requests a drink from a listener (mand), and the listener provides a drink. If the future probability of the child manding for a drink under conditions of feeling thirsty increases, we say the mand is reinforced by the listener (Skinner, 1957). Other examples of motivating operations exist to terminate aversive conditions, e.g., a child manding to "go" after playing in the hot sun, which results in increases in manding, "go" in the future, if his mother reinforces the mand by walking into the shade with him.

Manding behavior comprises the first step of communicating one's wants or needs to others. For instance, in the earliest stages of development, babies cry to receive a diaper change, food, sleep, or to be held. As they grow, typically developing children learn to replace crying with simple one- or two-word requests followed by longer sentences. In contrast, children with ASD without interventions that target development of functional language may continue to cry or engage in other types of problem behavior (e.g., aggression, tantrums, or self-injurious behavior) to access preferences or avoid aversive situations.

Tact. The tact is a verbal operant that requires specific stimulus control and is reinforced and maintained socially, typically by generalized condition reinforcers, such as verbal praise, high fives, or tokens. Simply stated, a tact occurs when a speaker names or identifies an item (e.g., food, drink, toy, object) in the presence of that item. For example, if a child says, "dog" upon seeing a picture of a dog in a book, the teacher or parent reinforces the child's (speaker's) labeling of the dog by saying, "that's right, it is a dog!" Teaching a child to label and identify nouns is a critical learning development for children and is one for the foundations for language comprehension (Ingvarsson, 2016). Tacting allows parents and other listeners to learn specific information about a child's observations in their environment. Acquiring a tacting repertoire is an important academic skill for children, and leads to the development of other verbal operants, such as intraverbal and textual responses (Sundberg & Sundberg, 2011).

Intraverbal. The intraverbal operant occurs when a verbal stimulus evokes a verbal response. This verbal operant differs from others in that it is evoked by another verbal stimulus and the response does not have point-to-point correspondence like echoics or mands (Eikeseth & Smith, 2013; Skinner, 1957). Intraverbal behavior often begins with simple chains of verbal stimuli typically consisting of fill-in-the-blank phrases or songs (e.g., Twinkle, Twinkle, Little Star, saying “3” in the presence of “1, 2…”). As the child develops, their verbal behavior increases in complexity being able to answer questions (Sundberg & Michael, 2001). For example, when a teacher asks, “What color is the sky?” and the child responds, “blue” the question specifies an answer, making this intraverbal behavior, regardless if the answer is correct or not. According to Sundberg and Partington (1998), a child should acquire and maintain a variety of mand, tact, echoic, imitation, and matching-to-sample repertoires prior to formally teaching intraverbals in order for the child to acquire a functional verbal repertoire and the ability to comprehend and further develop simple and complex discriminations in order to be effective members of their verbal community.

The intraverbal operant is essential to learn because it impacts areas of academic and social behavior for children. Over time, children need to develop a verbal repertoire that enables them to make friends, follow and learn social rules within their verbal community, write, read, count, problem solve and adhere to simple safety rules (Sundberg & Michael, 2001). Children diagnosed with developmental disorders and ASD often have impaired intraverbal repertoires that can lead to serious consequences therefore needing specific teaching in order for this operant to emerge.

To assist practitioners with assessing intraverbal skills, Poon and Butler (1972) created a modified version of the Intraverbal Gesture subtest of the Parsons Language Sample (PLS) (Spradlin, 1963b). Participants included typically developing 30 five-year-olds, 31 six-year-olds, and 28 seven-year-olds for each child's interrelationships of gestural, verbal, and bimodal (verbal and gestural) skills in order to determine normal and abnormal expressive language development in children. Experimenters asked each child 24 questions that required either a verbal or gestural response. The results indicated that gestural responses occurred the most frequently amongst five-year olds and decreased significantly from five to seven years. The use of verbal and bimodal responses (e.g., gestural and verbal) increased from five to seven years. During this study, the researchers determined that age had a significant main effect across all three age groups, suggesting that as a child increases in age, so too does their complexity with language. The researchers found that "What" questions (e.g., "What do you do with a….?") evoked more verbal responses across all three age groups than other types of questions (e.g., "how," "can," "when,"). The authors noted that the majority of questions involved "What" questions, and therefore, patterns of verbal behavior required further investigation using a counterbalanced approach. One important finding from this research, is that the authors documented increases in complexity from gestural to verbal to bimodal responses in young children without disabilities, and hence, the presence or absence of similar types of responses in each age group may assist practitioners with identifying delays in children's intraverbal behavior.

Acquiring intraverbal behavior is difficult not only for children with developmental delays or ASD, but also children without developmental delays. In a study by Partington and Bailey (1993), four preschool age children, between the ages of four and four-and-a-half were unable to answer questions correctly despite having a strong tacting repertoire (i.e., labeling pictures correctly). Based on these initial findings, experimenters investigated whether the children's tacting and intraverbal responses functioned as separate verbal operants. Using a multiple probe design, the experimenters tested eight children divided into two groups. The dependent variables included pre-and post-training scores of the Verbal Fluency subtest of the McCarthy Scales of Children's Abilities (McCarthy, 1970). Based on pre-training scores, four of the eight children were placed into the training group due to receiving lower scores on the intraverbal section of the test. The remaining four children were placed into a control group and received no training. Prior to intraverbal training, the children were each asked four questions and did not receive any consequences by the experimenter (e.g., "What are some fruits? What are some toys? What are some pieces of furniture?"). Responses were recorded to determine appropriate responses regarding common objects found around different environments that would be used in training sessions.

Using 20 picture cards from the Peabody Picture Vocabulary Test (Dunn & Dunn, 2007), experimenters assessed each child's tacting repertoire. At the start of each intraverbal training session, the experimenters asked each child to tact 20 pictures. If the child emitted a correct response, the experimenter provided praise and edibles. Incorrect responses were trained until the child was able to emit a correct response using an echoic prompt. Tact training was terminated once the child was able to tact 95% or more of the picture cards for two consecutive sessions. Intraverbal training consisted of verbal stimulus prompts (i.e., "tell me another one") and a stimulus-transfer procedure if the child was unable to emit five independent responses through for the picture cards they had successfully tacted previously. Results indicated that only one of the four children following tact training was successful at responding to intraverbal questions prior to intraverbal training. The results also suggested that even though a child could tact different items or things (e.g., food, toys, or people) in their environment, the skill may not generalize without additional independent teaching and through the use of the stimulus-transfer procedure. Thus, these findings support the earlier literature that discussed the independence of the verbal operants, that tacting and intraverbal behaviors are distinct and separate verbal operants, and should be treated as such (Skinner, 1957; Partington & Baily, 1993).

Sundberg and Sundberg (2011) replicated and extended results of Poon and Butler (1972) by comparing 39 typically developing children to 71 children diagnosed with ASD. Interestingly, the researchers found all of the children made similar errors at each developmental level when responding to intraverbal questions, regardless of their diagnosis. Their research supports the argument for specifically teaching intraverbal skills to all children in order for them to acquire a functional communicative repertoire.

Even though some children develop intraverbal behavior independently or with little instruction, communication and language deficits commonly continue to occur in children with ASD without proper intervention. Due to these deficits, it is extremely important to extend research on how to implement effective teaching skills. Without the ability to communicate effectively, children may struggle with building friendships, participating in group activities or sports, expressing their emotions to their loved ones, and functioning as independently as possible. Academically, children may fall behind by not being able to organize and categorize, take turns in conversations, answer questions or complete fill-in-the-blank tasks. Children with ASD with weak intraverbal skills may also engage in rote, irrelevant, or nonfunctional language that limits their social and academic opportunities. When investigators compared empirically validated research on the publications of different verbal operants, the intraverbal operant was the third most investigated verbal operant falling behind mands and tacts with 97 publications suggesting the need for more research when investigating the intraverbal operant (Petursdottir & Devine, 2017)

Current Research on Intraverbal Behavior

Two recent reviews of the literature on verbal behavior in the past 10 years documented an increase in publications on verbal behavior, and specifically, the intraverbal operant (Aguirre, Valentino, & LeBlanc, 2017; Pettursdottir & Devine, 2017). To date, the majority of research on the intraverbal emphasizes transfer of stimulus control, prompting, fading, and error correction. It is critical to continue researching intraverbal repertoires and the different components needed for a child to acquire communication skills to help children navigate the complex demands of social and academic life (Sundberg & Michael, 2001).

The current research on intraverbal behavior focuses primarily on teaching children an intraverbal repertoire by implementing transfer of stimulus control procedures initially proposed by Skinner (1957) (Barbera & Kubina, 2005; Finkel & Williams, 2006; Ingvarsson & Hollobaugh, 2011; Vedora, Meunier, & Mackay 2009). The transfer of stimulus control is a common procedure used in applied behavior analysis (Sundberg & Partington, 1998) that many practitioners and behavior analysts implement when teaching verbal operants (e.g., echoics, tacts, mands, intraverbals).

Transferring stimulus control, broadly, involves using prompt fading and prompt delay to teach an individual to respond in the presence of relevant discriminative stimuli. Teaching mands, echoics, and tacts often aids the child in acquiring intraverbal repertoires through the transfer of stimulus control. For example, when a teacher asks a child, "What color is the sky?" the teacher may immediately show a blue card to the child, evoking the correct response, "blue." This example is a common tact-to-intraverbal stimulus transfer procedure. Through the use of progressive-time-delay fading procedures(McClannahan & Krantz, 1997;Walker, 2008; Coon & Miguel, 2012;Kodak, Fuchtman, & Paden, 2012), the therapist may wait for a specified amount of time prior to showing the child the color card. After successive trials, the child may begin to respond correctly without the additional stimulus of the blue card under the control of the intraverbal question and the original discriminative stimulus, "What color is the sky?".

In a study by Braam and Poling (1983) the authors implemented a delayed prompting procedure to transfer stimulus control from pictures to signed responses in two 17-year-old children with hearing and language impairments. In a second experiment, the participants demonstrated effective transfer from pictures to sign language responses without errors. In a third experiment, the authors taught participants to respond when conditional discriminations were required, where instructions included two components. A conditional discrimination in the intraverbal relation includes verbal responding under the control of two stimuli, for instance, asking a child, “tell me a *fruit* that is *yellow*,” whereby both conditions must be satisfied to emit a correct response, e.g., “banana.”

Commonly used procedure amongst practitioners to teach intraverbals is echoic-to-intraverbal-transfer. (Finkel & Williams, 2002). In the echoic-to-intraverbal transfer procedure, the experimenter teaches intraverbals directly using a verbal stimulus. The teacher asks the specific question, “What fruit do you eat?” The teacher then follows with the verbal stimulus (i.e., the echoic stimulus, or response to the question), also referred to as an echoic prompt and states the correct response (e.g., apple, banana). When the child repeats the correct response, he or she accesses preferred items such as edibles, tangibles, or physical praise.

During teaching, the process of fading an echoic stimulus differs for every learner, but perhaps the most commonly used procedure is progressive time delay (McClannahan & Krantz, 1997;Walker, 2008; Coon & Miguel, 2012;Kodak, Fuchtman, & Paden, 2012). Progressive time delay procedures involve teaching a novel target through the process of gradually fading the length of time between a controlling prompt to providing the correct response, (e.g., increasing from 0 s, to 2 s, to 5 s), to a natural prompt (e.g., an instruction) when the child correctly responds. Teaching typically begins at 0 s delay to prompt the learner to emit only correct responses and gain access to reinforcement (Walker, 2008). Beginning at 0 s allows the child to contact reinforcement immediately for correct responding and decreases the chance of emitting errors.

Previous researchers found it difficult to fade an echoic prompt completely, meaning the the programmed antecedent failed to exert control over the desired response. (McClannahan & Krantz, 1997). The researchers also found that because the participant was unable to respond to the intraverbal target, the likelihood of generalization occurring decreased in addition to the participants' independent responses. Currently, at least three published studies compared the use of different prompting procedures within a transfer-of-control procedure for teaching intraverbals (Finkel & Williams, 2002; Ingvarsson & Hollobaugh, 2011; Vedora, Meunier, & Mackay 2009.

Two of the three studies compared instructional effectiveness of the use of textual prompt procedures (i.e., printed texts) to echoic prompt procedures (Finkel &Williams, 2002; Vedora, Meunier, & MacKay 2009). Both studies found the use of textual prompts aided participants with achieving mastery criteria for the intraverbal targets faster when compared to the echoic prompts. In an experiment with a multiple baseline design, Finkel and Williams (2002) taught one six-year-old child with ASD to respond to multi-word phrases by systematically fading out one word or phrase at a time depending on the teaching phase. The participant was described as someone who had above-average sight-reading skills, thus making him a good candidate for the use of textual prompts.

In a similar study of echoic versus textual prompts to evoke intraverbal responses, Vedora, Meunier, and MacKay (2009) studied two seven-year-old boys with ASD who could follow simple instructions, speak in three-to-four-word sentences and had previously learned 50 to 100 sight words prior to starting the study. Using an adapted altering treatment design (Sindelar, Rosenberg, & Wilson, 1985) the authors compared the use of textual and echoic prompting procedures when teaching children to respond to intraverbal responses. With the implementation of progressive-time-delay procedures, the data suggested that textual prompts were more effective than echoic prompts for teaching children with ASD to respond to intraverbal responses.

To compare the efficiency of picture and vocal prompts when teaching intraverbal behavior (i.e., question-answering) Ingvarrson and Hollobaugh (2011) taught three, 4-year-old boys with ASD to answer questions. Using an adapted alternating treatment design (Sindelar, Rosenberg, & Wilson, 1985) the investigators taught the participants to correctly respond to five questions in each of the two conditions, picture prompts (i.e., tact to intraverbal transfer), or vocal prompts (i.e., echoic to intraverbal transfer), while implementing a constant prompt delay of 5 s or 0 s. The experimenters used 5-s constant prompt delays during training probe trials and 0-s constant prompt delays during error correction. During error correction, instructors provided the correct vocal response or presented a picture stimulus card and remained silent. The results showed acquisition in both conditions but all three participants achieved mastery quicker in the picture prompt condition as compared to the vocal prompt condition. During a generalization probe test, all three participants also answered four or five correct responses in each condition suggesting that either prompting procedure was effective at promoting prompt generalization, and furthermore, that optimal teaching procedures may be idiosyncratic for each learner.

Children diagnosed with ASD or whose primary language is other than English, may not contact a sufficient amount of answers to questions naturally from peers or adults on a daily basis, causing them to respond incorrectly (Ingvarsson, Tiger, and Stephenson, 2007). To investigate this socially valid problem, Ingvarsson, Tiger, and Stephenson (2007) taught four pre-school age boys to respond, “I don’t know,” and “I don't know, please tell me” responses to novel questions. The researchers used a multiple baseline design across responses and implemented vocal models as stimulus-transfer procedures. The results found that all four participants acquired the skill of responding with, “I don't know,” responses, but an unintended consequence of this procedure occurred, in that three of the four children began to respond “I don’t know” to previously known questions. When the authors added training on a phrase, “I don't know, please tell me,” participants needed additional reinforcement contingencies to achieve desired effects. The authors suggested that students may have responded with the “I don’t know” phrase as a less effortful, generalized escape or avoidance response. The researchers suggested taking response effort into consideration when teaching children with ASD intraverbal responses, specifically when responses become more complex (i.e., requiring more than one word).

Among the current research on teaching intraverbal behavior, a few limitations emerge when comparing the different prompt modalities, due to most children being exposed to a specific teaching procedure prior to the research experiment, and therefore developing a learning history with a specific teaching procedure (Coon & Miguel, 2012). Although comparing the efficacy of prompting procedures is important, each method of teaching carries potential benefits as well as limitations. Practitioners may determine that certain stimulus-transfer procedures are insufficient for teaching correct intraverbal responses. For instance, some responses require a person to say a numerical reply making a tact-to-intraverbal transfer procedure ineffective (e.g., a person’s phone number. A textual prompt will only be effective if the child is able to read. Furthermore, although the implementation of vocal prompts is relatively easy and requires no additional materials, children who engage in echolalia, or self-echoic behavior may only repeat the questions rather than provide a response (Valentine, Shillingsburg, Conine, & Powell, 2012).

Much of the research in ABA on teaching correct intraverbal responding has involved consequence-based procedures, such as the implementation of positive reinforcement. An understudied area of research has been focused on decreasing the amount of errors children emit when learning novel skills (Worsdell, Iwata, Dozier, Johnson, Neidert, & Thomason, 2005). What may be more effective at teaching children intravebral responses other than comparing the different prompt modalities, is focusing on how teachers and practitioners effectively choose and implement error-correction procedures due to children's learning behavior varying from one to another.

Error Correction

Previous research has demonstrated the effectiveness of implementing multiple error-correction procedures when comparing different prompt modalities. Evidence suggests children often show idiosyncratic results of which method is most efficient (Carroll, Joachim, St. Peter, & Robinson, 2015; Kodak et al., 2016; Rodgers & Iwata, 1991; Smith, Mruzek, Wheat, & Hughes, 2006; Worsdell et al., 2005). Although error correction is commonly used amongst practitioners when teaching children with ASD, the complexities of how and when to implement such procedures has produced limited research in our current field. Rodgers and Iwata

(1991) identified four different strategies of error correction procedures: (a) no response to errors, (b) postponement of the next trial, (c) remedial trials, and (d) presentation of discrete events. Although important, their research did not run a comparative analysis of the four different error correction conditions identified, providing little evidence of each conditions effectiveness and needing further extensions of the researchers' study.

Few studies have compared different modalities of correcting a child's incorrect responses (Barbetta, Heward, & Bradley, 1993; Barbetta, Heron, & Heward, 1993; Barbetta, Heward, Bradley, & Miller, 1994; Worsdell, Iwata, Dozier, Johnson, Neidert, & Thomason, 2005; McGhan & Lerman, 2013; Carroll, Joachim, St. Peter, & Robinson, 2015). Earlier research compared different error-correction procedures when teaching students with developmental disabilities how to read sight words. (Barbetta, Heward, & Bradley, 1993; Barbetta, Heron, & Heward, 1993; Barbetta, Heward, Bradley, & Miller, 1994).

Barbetta, Heward, and Bradly (1993) compared whole-word error-correction (e.g., the teacher responded to an error by using the complete word and having the student repeat it) to phonetic-prompt error correction (e.g., the teacher responded to an error by using the first sound of the word, such as "t" for "toast"). The results indicated that the whole-word error correction condition resulted in better efficacy for all five students due to the student having to repeat the correct response (vocal model) back to the teacher (Barbetta, Heward, & Bradley, 1993). Following this study, Barbetta, Heron and Heward (1993) used the same comparative analysis procedures as the previous research (Barbetta, Heward, & Bradley, 1993) by implementing the whole-word error correction condition but varied if the student was required to repeat the correct response the experimenter provided or simply "pay attention" as the experimenter modeled the correct response. The results indicated that for all students the acquisition rate maintained when the students repeated the correct response, known as the active student response *(*Barbetta, Heron, & Heward, 1993).

Barbetta, Heward, Bradley, and Miller (1994) extended the previous two studies by using two experimental conditions to teach sight words to student. The first included one condition in which the experimenters implemented immediate active student responding (ASR), and a second condition with delayed ASR. An example of ASR included the teacher correcting the student's error with the statement, "No, this word is ____. What word?" During the delayed condition, the experimenter waited until all target words were completed and then reviewed the words that were incorrect, remaining consistent with the same procedures as the immediate condition (Barbetta, Heward, Bradley, & Miller, 1994). For all students, immediate error correction of ASR resulted in better performance than for the delayed condition. From these three studies it can be determined when teaching children sight words, error correction should be direct, immediate, and end with the student emitting the correct response.

Worsdell, et al. (2005) extended the research on error correction procedures in intraverbal responding by teaching sight words to 11 adults with developmental disabilities. The authors implemented two different error-correction conditions: single response and multiple-response. Similar to Barbetta, Heward, Bradley, and Miller, (1994), the single-response (SR) error-correction condition consisted of the experimenter using a vocal-model of the correct word, with emphasis on how to pronounce it, followed by the student repeating the correct response using ASR. The multiple-response error-correction condition produced the same repetition procedure as in the single-response condition, except that instead of the participant responding one time correctly, the participant repeated the word (correct response) five times in the presence of the sight word. The multiple-response repetition procedure is often referred to as directed rehearsal. Results indicated that both error correction procedures produced correct responding in all participants; however, the multiple-response procedure was superior in that it resulted in more cumulative words mastered, more words correctly read per session, and higher retention for maintaining the words.

Due to the impracticalities of a teacher providing error-correction every time a child errs, Barbetta, Heward, Bradley, and Miller, (1994) examined error correction on an intermittent schedule. Since the multiple-response condition resulted in better responding than the single response condition, the experimenters evaluated both continuous error-correction (i.e., correcting every incorrect response) and discontinuous error correction (i.e., only correcting an average of every three incorrect responses while ignoring incorrect answers falling in between the corrected responses). The continuous error-correction condition showed the best results for all participants, aligning with past research that error correction should occur on a continuous schedule in order to make higher gains when teaching children (Barbetta, Heward, Bradley, & Miller, 1994).

Smith, Mruzek, Wheat, and Hughes (2006) compared three procedures for correcting errors during DTI for six children with ASD between the ages of three to seven. Using a match-to-sample procedure, participants matched words to correct pictures. The three conditions used included: (a) no feedback, the instructor proceeds to the next trial, (b) error statement condition, the instructor says, “No,” or (c) modeling condition, the instructor demonstrates the correct response and says, “this is matching.” The researchers found idiosyncratic results across participants, but each participant reached mastery criterion quicker in one of the three conditions. As a limitation to this study, the authors stated that providing vocal feedback following an error (e.g., saying “no, that's not correct”) potentially represents an aversive stimulus to some students who do not receive reinforcement and may increase emotional responding (McGhan & Lerman, 2013).

McGhan and Lerman (2013) suggest that when practitioners or teachers randomly choose a specific error-correction condition without implementing an assessment or making data-based decisions, the outcomes for children acquiring new skills may be less effective than those that did. Following the idiosyncratic findings of previous research, McGhan and Lerman (2013) created and developed an error-correction assessment to identify the most appropriate error-correction method and maximize learning during DTI for individual leaners. Incorporating such an assessment would allow practitioners to easily identify specific error-correction procedures for each of their learners, individualizing and delivering the most efficient and effective teaching procedures. The purpose of the study was to determine the least intrusive, most effective procedure. Participants included five boys diagnosed with ASD between the ages of three to six. The experimenters included four conditions that were commonly used in clinical settings: (a) vocal feedback, (b) modeling, (c) active student responding, and (d) directed rehearsal. The researchers measured trials-to-criterion and correct responses. In the vocal feedback condition, when a participant emitted an incorrect response, the experimenter stated, “no that is not ___” and ended the trial. In the modeling condition, the experimenter represented the SD following the child’s error and then immediately touched the correct stimulus card followed by the statement, "this is ___." In the active student response condition (ASR), following the child's error the experimenter stated, "this is ___" in addition to an immediate gesture prompt towards the SD. The experimenter then re-presented the SD and waited 5 s for a correct response. If the child emitted no response or incorrectly responded, the experimenter physically prompted the child to select the correct stimulus card. In the DR condition, the procedures continued as before during the ASR condition, except that the experimenter repeated the procedure until the participant emitted the correct response three consecutive times. All five participants were taught arbitrary listener responding targets of which the researcher's discriminative stimulus was, "Touch______."

Once each participant completed the assessment, the experimenters implemented a validation phase comparing the least intrusive and most efficient procedure to a more intrusive and a less intrusive procedure. This comparison repeated three times with novel targets for each participant to confirm the assessment outcomes in 11 out of 14 tests. The results of the assessment produced effective findings suggesting that there may be benefits to running students through the procedures. Interestingly, four out of the five participants acquired the targets in the fewest amount of trials in the model condition, which is inconsistent with previous research (e.g., Barbetta et al., 1993). The ability to effectively identify which error condition procedure produces quicker acquisition while simultaneously using the least intrusive method will decrease teaching time and show a possible decrease in problem behavior. This also favors the idea that teachers and practitioners should individualize their teaching procedures, including error-correction procedures, instead of implementing the same procedure across all of their students.

Carroll, Joachim, St. Peter and Robinson (2015) extended McGhan and Lerman's (2013) research by comparing error correction procedures commonly used by practitioners and behavior analysts working in applied settings when implementing DTI to children diagnosed with developmental disabilities. In addition, the researchers took additional measures to assess the efficiency of each error-correction procedure. The assessment compared four error-correction procedure: (a) single response, (b) remove and re-present, (c) re-present until independent, and (d) multiple-response repetition while teaching five children diagnosed with Attention Deficit Hyperactivity Disorder (ADHD) ages six to seven. Similar to previous research, the target responses included reading sight words for three of the participants, expressive identification of features for one participant, and expressive identification of functions of items for the final participant.

The control condition was identical to a baseline condition in which the researcher pointed to the card and said, "read the card" without providing the correct word or differential reinforcement. Single response repetition also known as ASR (e.g., Barbetta et al., 1993; McGhan & Lerman, 2013) was used in the second condition, during which a researcher presented a vocal model following the child's incorrect response. The researcher then represented the original instruction, "read the card."

To reduce prompt dependency, once the participant correctly responded to the initial instruction on 50% or more of the trials for two consecutive sessions, the researcher only provided praise and access to a preferred item for unprompted correct responses. Following this condition, the researcher began the "remove and re-present" condition. During this condition, following a child's error, the researcher removed the stimulus and looked away from the participant for 2 s. The researcher then represented the instruction immediately and modeled the correct response. The researcher provided neutral praise for the correct response following the error correction procedure and removal of the stimulus card. The researcher then ended the trial if the participant continued to err.

In the third condition, the experimenter represented the instruction until the participant responded independently. Following the child's incorrect response, the researcher represented the SD followed by the vocal model and then represented the original instruction. This continued until the child independently responded correctly. The fourth error-correction procedure condition is commonly referred to as multiple-response repetition or directed rehearsal (e.g., Barbetta et al., 1993). This condition is similar to ASR except the participant has to respond correctly for five consecutive times.

The results indicated three participants mastered their targets in the fewest number of sessions in the represent- until- independent condition. One participant mastered the target stimuli from the remove and re-present condition in the least amount of training and the final participant acquired the target stimuli in the least amount of training time in the single- response- condition. Consistent with previous research, the most efficient error-correction procedure varied across participants showing idiosyncratic results during skill acquisition in DTI.

To address limitations in previous research, Kodak, Cambell, Bergmann, LeBlanc, Kurtz-Nelson, Cariveau, Haq, Zemantic, and Mahon (2016) replicated and extended McGhan and Lerman (2013) and Carroll et al. (2015) using an alternating treatment deign (Sindelar, Rosenberg, & Wilson, 1985), by comparing five error-correction procedures commonly used in practice when teaching children with ASD that differed in the level of intrusiveness. The researchers also measured the participants' echoic behavior when responding to the investigators model of the correct response in order to observe if such a response influenced the efficacy of a specific error-correction procedure. In addition, Kodak et al. (2016) included a social validity measure that previous research had not included to identify the participant's preference of error-correction procedure.

Five children (1 girl, and 4 boys) with ASD participated in the study. The participants were between four to 10 years of age and were receiving EIBI services or special education services in their local school districts. Dependent measures included correct and incorrect responses, prompted responses, echoic behavior, number of exposures to stimuli per condition, session duration, number of sessions to mastery, and the participant's selection of which condition they preferred.

Prior to the assessment, participants completed a pretest which consisted of the experimenter presenting three probe trials for each stimulus. The experimenter did not reinforce any consequences for correct or incorrect responses and those targets to which the participant had no correct responses were selected and assigned to one of the conditions. The experimenter assigned 10 sight words for two participants in each condition, five sight words for 1 participant and three sight words and preposition tacts for two participants. The numbers of targets selected were based on each participant's current skill- acquisition programs. The participants each completed an MSWO preference assessment (Carr, Nicolson, & Higbee, 2000) as well as a color preference assessment (Heal & Hanley, 2007). All teaching sessions included nine or 10 trials per participant, and were conducted between five and 12 times per day, two to five days a week. The mastery criterion was two consecutive session of independent correct responding at or above 89% for nine-trial sessions or 90% for 10-trial sessions.

Baseline consisted of interspersing mastered tasks with the taught targets. If correct responding occurred during the mastered tasks praise and access to a high-preferred item for 20 s was provided. Following baseline, participants were exposed to five different treatment conditions; (a) differential reinforcement, (b) demonstration, (c) prompt delay, (d) single response repetition, and (e) multiple response repetition. The researchers chose the first two conditions to provide procedures that previous literature would determine as less intrusive (e.g., McGhan & Lerman, 2013).

During the differential reinforcement condition, the researchers followed the same protocol as baseline but changed the consequence of correct or incorrect responses. For example, if the participant responded correctly, they were given praise from the experimenter with access to 20 s of a high preferred item. If they provided and incorrect response the stimuli presented was removed and the next trial was initiated.

In the demonstration condition, similar to past research labeled as vocal model (e.g., Carrol et al. 2015), the procedures were identical to the differential reinforcement condition, with the exception of the researcher demonstrating the correct response following an incorrect response while looking away from the participant. This condition was to track whether the participant echoed the correct response when it was provided.

Kodak and colleagues (2016) then chose two conditions during which procedures are commonly implemented in DTI with learners diagnosed with ASD. Referred to as the prompt delay condition and the single response repetition condition. In the prompt delay condition, procedures were identical to the differential reinforcement procedure with the addition of the experimenter waiting up to 5 s for a prompted correct response, followed by praise and access to a high preferred item for 20 s. Once the participant responded correctly to the prompted correct response, the participant only accessed praise and their high preferred item for independent correct responses. In the single response condition, procedures were identical to the prompt-delay condition and previous research (e.g., Carroll et al., 2015). When the participant responded incorrectly, the experimenter would then re-present the Sd following an immediate vocal model of the correct response. In the final condition, referred to as multiple response repetition, the procedures were identical to the previous condition, single response repetition, with the addition of representing the trial three times following the participant's incorrect response.

The results of the assessment indicated that all treatment conditions were effective across participants except the differential reinforcement condition did not lead to mastery for any of the participants. Out of the five conditions, the demonstration condition scored as the one or second to one as the most efficient treatment condition for four out of the five participants. The researchers found for four out of the five participants during the demonstration condition, the participants echoed the experimenter's correct response with a mean of 79% of echoic behavior per sessions. For one of the participants, the instructors observed a mean score as little as 7% echoic behavior per session providing a possible explanation as to why the demonstration condition did not rank in their top two of effective and efficient interventions.

Kodak et al. (2015) extended the previous research on assessment-based academic interventions by measuring the efficacy and efficiency of their implementation for practitioners. Although their mean duration for the assessment varied from previous research due to the inclusion of additional teaching per treatment conditions compared to previous assessments, (e.g., McGhan & Lerman, 2013) all assessments have been proven to be effective in identifying best teaching modalities for students. The results for the social validity measures showed four of the five participants having a clear preference for one intervention, with only one having a preference for the most efficient intervention. This is an important measure to consider for practitioners when determining teaching procedures for their students. Previous research included observations of participants engaging in negative vocalizations for particular conditions (Carroll et al., 2015) suggesting that a child showing preference for one condition over others, may lead to a decrease in problem behavior and an increase in compliance behavior.

However, without the implementation of assessment-based academic interventions practitioners would not be able to determine such preferences of their clients nor make data based decisions that could ultimately improve outcomes for the child. Although previous studies have developed effective assessment-based interventions, it raises the question of practicality of the implementation of such assessments for practitioners to use. One may argue that an assessment that takes over 1,000 trials or multiple hours to run may not be effective nor practical for those working in applied settings. Therefore, the use of such assessments although needed, may be punishing for practitioners to implement.

To address these concerns, Carroll, Owsiany, and Cheatham (2018) developed an abbreviated assessment to identify effective and efficient error-correction procedures while teaching children in DTI without requiring the participant to reach mastery of taught targets. By collecting a sample of the participants correct and incorrect responses, the researchers believed such measured would produce and predict the most efficient error-correction procedure.

Based on the assessment of previous research (McGhan & Lerman, 2013; Carroll et al., 2015; Kodak et al., 2016), Carroll et al. (2018) found the error-correction procedure associated with the highest frequency of correct responses during the first five training sessions resulted in the most or second to most efficient error-correction interventions for all participants. By creating an abbreviated assessment for error-correction procedures that evaluated the predictive validity, the authors would then be able to create an assessment that would be easily implemented for behavior analysts in applied settings, specifically targeting the concern mentioned above of lengthy duration time.

Four children (two girls, two boys) between the ages of three and five participated in the study (Carroll et al. 2018). Three of the four were diagnosed with ASD while one was diagnosed with a global developmental delay. For two of the four participants, the target responses were reading sight words. One participant's target response was matching associated pictures in a two-card array, and the fourth participant's target response was labeling functions of items. Data were collected on correct responses, prompted responses, and errors during teaching in each of the five conditions. An adapted alternating treatments design (Sindelar, Rosenberg, & Wilson, 1985) was used to compare up to five error-correction conditions during the abbreviated and validations assessments. Three targets were identified and assigned to each condition for the abbreviated and validation assessments.

Much like previous research, (e.g., Carroll et al., 2015), an echoic assessment was conducted for target responses that required a vocal response for two participants. An echoic assessment was conducted to determine specific teaching targets, and to exclude words that the participant had difficulty articulating or echoed inconsistently. The same number of syllables were also selected for all targets assigned to teaching conditions. Targets were also chosen based on their stimulus properties (e.g., sound overlap) or size, shape, and color for those stimuli with visual properties for the other two participants. A color preference assessment was also conducted for each participant resulting in moderately preferred colors assigned to specific conditions to make each condition more discriminable.

Sessions consisted of 12 trials with each target stimuli being presented four or six times depending on the participant. In each condition, a constant prompt-delay procedure was implemented starting with 0-s prompt delay. This resulted in the experimenter presenting the stimuli and immediately delivering the correct response. Once the participant engaged in correct prompted responses for two consecutive sessions, at 92% or above, the prompt increased to 2 s and then to 5 s allowing the opportunity of the participant to engage in correct responding. Participants were provided access to high-preferred edibles or tangible for 25 s if correct responding occurred at or above the specific prompt procedure. If the participant responded incorrectly, the experimenter's response was dependent on the particular error-correction condition the participant was being taught.

Two baseline sessions were conducted to establish that each participant had not acquired that target response and that the data represented at or below chance levels. The participant then alternated between treatment conditions: (a) no error correction (differential reinforcement only), (b) model, (c) single response repetition, (d) re-present until independent, and (e) multiple-response repetition.

In the (a) no-error correction condition, if the participant did not respond correctly, the researcher ended the trial. During this condition, no error-correction trials were run. In the (b) model condition, if the participant engaged in an incorrect response or did not respond within the prompt delay, the experimenter would then provide a vocal model of the correct response and the trial would be finished without requiring the participant to repeat the correct response. For the participant being taught matching, the experimenter would model the correct response by saying, "Match like this," and then demonstrate the correct response. In the (c) single response repetition condition, once the participant engaged in an incorrect response, the therapist would then provide a vocal model requiring the participant to echo the correct response within 2 s. If the participant did not respond correctly after the corrected response, the experimenter would end the trial. For the participants that were required to match stimuli during this condition, the experimenter would physically guide the participant to place the correct picture to its match. The experimenter then re-presented the initial instruction, “Match, “and wait for the participant to respond. Neutral praise for correct responding was provided to the participants following correct response after the error-correction and the trail would be completed. In the (d) re-present until independent, the experimenters followed the same procedure for the previous condition except for one step. Following the incorrect response, the instructor would provide the vocal model with the correct response and the participant was required to respond independently. Once the participant responded correctly independent the trial was completed or until a total of 10 error-correction trials were run. In the final condition referred to as (e) multiple response without repetition, the procedures were identical to the (c) single response repetition accept the participant was required to respond to the echoic prompt following the original instruction five consecutive times or a total of 10 trials were presented.

Following the abbreviated assessment, the experimenters replicated their procedures in two or three validation assessments with the addition of the participants required to reach mastery criterion for one or more error-correction condition. The purpose of the validation assessments were to test the predictive validity of the abbreviated assessment. The researchers also implemented an early-termination criterion for all participants if target responses in one condition were still in training after mastery of another set of target responses.

The results showed high correspondence between the abbreviated assessments and the validation assessment for two out of the four participants and only partial correspondence for the other two participants. For two of the participants, the procedures that were predicted to be the most efficient error-correction procedure during the abbreviated assessment matched for both of the validation assessments. For one of the participants, the results were similar to the first two participants except during their second validation assessment, the participant acquired the skills taught with the procedure that predicted to be her second most efficient error correction procedure shown in the abbreviated assessment. The final participant's results were less consistent with the previous three findings in that the procedures that were predicted to be most efficient in the abbreviated assessment was found to be the second most efficient procedure in two out three validation assessments. It should be noted that the final participant had engaged in aggression during the multiple response repetition condition and therefore the treatment condition was removed in the final and third validation assessment.

Implementing the abbreviated error-correction assessment (Carroll et al. (2018) may be effective and practical for some practitioners and teachers working in applied settings. On average, the abbreviated assessment required 2.6 hours to complete compared to previous studies that averaged 8 hours of training time due to participants required to achieve their predetermined mastery criterion (Carroll et al., 2015). In comparison, the validation assessments took an average of 5.7 hours for all participants to complete, nearly doubling the amount it took during the abbreviated assessment. This suggests that the implementation of an abbreviated assessment may be a practical tool in applied settings that may aid to practitioners making data based decisions and quickly identifying potential error correction procedures that are effective and efficient.

The current literature suggests that research should be conducted to evaluate the effects of conducting an error correction assessment prior to implementing teaching correct intraverbal responding. Furthermore, it is important to assess whether an abbreviated error- correction assessment is practical to conduct in clinical settings. Thus, to test the hypothesis that error correction procedures can be extended to additional verbal operants when teaching through DTI, and to extend on the current research, the purpose of this proposed investigation was to compare the effects of three error correction procedures on the acquisition of intraverbal targets using Carroll et al. (2018) abbreviated assessment.

Specific Aims

The purpose of this study was to evaluate the effects of implementing an abbreviated assessment to compare the effects of three error correction procedures: (a) vocal model, (b) single response repetition, and (c) multiple response repetition on the acquisition of intraverbal targets. The intervention was implemented with three children diagnosed with ASD. The goal of the assessment was to determine if one error-correction procedure produced quicker acquisition and decreased problematic behaviors for each participant in both the abbreviated assessment and validation assessment and assess if the assessment would be efficient and effective for practitioners to implement.

Method

Participants, Setting, Materials

Participants were recruited from a children's hospital-based EIBI program. This study included three students, who ranged from two to eight years old. Colin was a 2-year-old Hispanic male who was receiving 12 hours a week of EIBI services with a diagnosis of ASD for over one year. His verbal behavior-milestone assessment and placement program (VB-Mapp;Sundberg,2008) score was 66.5. Colin's problem behavior was flopping out of his chair. Paul was a 7-year-old Caucasian male who was receiving 25 hours a week of ABA therapy since the age of 2, and was home-schooled, with a diagnosis of ASD. His VB-Mapp score was 138. Paul's problem behavior was aggression and negative vocalizations. Brian was an 8-year old Asian American male who was receiving 6 hours a week of ABA therapy for over a year and was home-schooled with a diagnosis of ASD. His VB-Mapp score was 114. Brian's problem behavior was screaming.

Sessions were conducted in therapy rooms in the hospital. Each room contained one table, three chairs, task materials, data collection materials, and a video camera. All sessions were videotaped for inter-observer scoring of IOA and procedural integrity with consent of parent's or legal guardians. There were two trained staff; one instructing the participant and taking primary data and one taking additional data for interobserver agreement either in vivo or from the video recording.

Participants were taught nine intraverbal targets in the abbreviated assessment and nine intraverbal targets in the validation assessment. In order to participate, each participant was required to sit for 5 min with little or no disruptive behavior, (e.g., self-injurious behaviors, aggression). In addition, all of the participants required to follow simple instructions and respond with a vocal response to the intraverbal question asked by the experimenter prior to beginning the study.

Measurement

During teaching, data were collected on: (a) correct responses, defined as responding to a predetermined vocal response within the allotted prompt-delay; (b) prompted responses, defined as providing the correct vocal response following the instructors vocal model within the allotted prompt-delay; (c) errors, defined as responding with an incorrect vocal response; and (d) error correction trials, defined as the experimenter providing the correct error correction for the specified condition.

During the abbreviated validation assessment, the experimenter measured the cumulative frequency of trials with correct and incorrect (error) responses in each error-correction procedure condition. Experimenters also measured the cumulative frequency of error-correction trials for all treatment conditions, this included every time the researcher implemented a vocal model of the correct response. Each error correction procedure was scored 1 to 3 (1 being low and 3 being high) for each of the dependent measures. The procedure that resulted in the highest frequency of correct responses received a 3, followed by 2 for the second highest and 1 for the lowest. The same scoring system was implemented for the amount of errors and error-correction trials except that 3 was assigned to the condition with the lowest amount of errors or error-correction trials followed by 2 with the second lowest and 1 being given to the highest amount of errors or error-correction trials.

The experimenters calculated the total percentage of points acquired for each procedure by adding the total number of points each procedure received and divided that by the total amount of points available for that procedure. They then multiplied that result by 100.

During the validation assessment, the experimenters converted each dependent measure to a percentage of trials by dividing the total number of trials in a session and multiplied that by 100.

Secondary dependent measures were the total number of trials including error-correction trials, sessions, and the total amount of training time (minutes) in each condition before the participants reach a predetermined mastery criterion. Additionally, any instances of problem behavior were cored (e.g., whining, negative vocalizations, etc) and predetermined by the participant's behavior protocol.

Inter-observer Agreement and Treatment Integrity

Inter-observer agreement (IOA) data were collected for a minimum of 33% of all sessions. An independent observer collected data at the same time as the primary observer or scored data from video recordings. Data were compared from the primary and secondary observers on trial-by-trial data. IOA scores were calculated by trial by trial agreements in session, divided by total trials, and multiplying by 100 to convert the result to a percentage. For Colin and Paul, mean IOA was 100% in the abbreviated assessment and 100% in the validation assessment. For Brian, the mean IOA was 100% in the abbreviated assessment and 88% in the validation assessment.

Treatment integrity data were collected for a minimum of 33% of sessions. An independent observer collected data at the same time with the primary observer or from a video recording, recording on whether: (a) the researcher set up the correct materials, (b) conducted a preference assessment, (c) provided correct instruction to the participant, (d) provided 25-s with a preferred tangibles to the participant for each correct response, (e) collected if that participant engaged in any problem behavior and (f) implemented the correct error-correction procedure. Observers scored the implementation of each trial as correct (100% accuracy) or incorrect (less than 100% accuracy). Procedural integrity was calculated by taking the number of trials implemented correctly, dividing by the total number of trials in a session, and multiplying that by 100. Treatment integrity for all sessions observed of Colin was 85%. For both Paul and Brian, treatment integrity for all observed sessions was 100%.

Design

An adapted alternating treatment design (ATD; Barlow & Hayes, 1979) was used to compare acquisition of target stimuli across three error-correction conditions during the abbreviated assessment and validation assessment. This design consisted of a baseline phase followed by a treatment phase with three treatments (a) vocal model, (b) single response repetition, and (c) multiple-response repetition presented in an alternating, counterbalanced order to compare their effects. In the alternating treatment design, experimental control was demonstrated through prediction and replication (Sindelar, Rosenberg, & Wilson, 1985). The alternating treatment design allowed for direct comparisons between the three interventions. Implementing an ATD was useful when the dependent variables are equal in difficulty to acquire. For example, in the current research, all targets selected in each condition were selected based on the participant's ability to correctly pronounce or articulate the word based on the results from the Early Echoic Skills Assessment (Sundberg, 2008). Each target contained the same number of words (e.g., rain, grapes; three). Target questions for each condition were fill-in-the-blank for Colin and "wh-" questions (e.g., who, what, when, or where) for Paul and Brian in order to control for difficulty across each condition. The ATD was chosen for the current study due to its ability to avoid extended baseline conditions, or the need for reversal or withdrawal of treatment due to the participant not being able to unlearn what had been taught directly. Allowing comparisons between two or more treatments rapidly in a single subject design also mitigated potential sequencing effects (Sindelar, Rosenberg, & Wilson, 1985).

Pre-Assessments

Preference Assessment. Prior to each session, a free-operant preference assessment (Roane, Vollmer, Ringdahl, & Marcus, 1998) was conducted to identify high-preferred items for each participant. Each participant was brought into a treatment room where a minimum of five different tangible items (e.g., play-doh, iPad, action figures) were set up and were then told to, "Go play". The researcher then started the timer for 5 min and tracked the duration of each item the participant engaged with. The item the participant engaged in the longest amount of duration with was then used during teaching sessions.

Echoic Assessment. Prior to beginning the study, the experimenter conducted an echoic assessment to identify words that the participant may have difficulty articulating or echo inconsistently. The Early Echoic Skills Assessment (EESA) by Barbara Esch (2008), a subtest of the VB-MAPP (Sundberg, 2008), was used for all three participants. Colin scored a 55.5 out of 100 points with difficulties articulating words in group three with three syllable combinations. Paul and Brian scored a perfect score (100/100) and did not have any difficulty with articulation or with a specific number of syllables. Based on these scores, the experimenter determined teaching targets for each of the participants. Words that sounded too similar to other target words being used, or that were difficult for the participant to pronounce were omitted for potential targets. For example, Colin struggled with correctly saying words that began with the letter "p." Due to this, the researcher did not use any words as a teaching target that started with the letter "p."

General Procedure

The first phase of the study included an abbreviated assessment followed by the second phase referred to as the validation assessment. The purpose of the abbreviated assessment was to conduct a brief assessment that compared common error-correction procedures to identify one or more that may be the most efficient and effective procedure. The purpose of the validation assessment was to test the predictive validity of the abbreviated assessment. During phase 1, the experimenters conducted a brief comparison of error-correction procedures that identified one or two error correction procedures associated with the highest frequency of correct responses followed by the lowest frequency of errors and error-correction trials. During this phase, each participant was exposed to a control condition, and three different error-correction procedures: (a) vocal model, (b) single response repetition, and (c) multiple-response repetition.

All participants were taught using a constant prompt-time delay (Carroll, et al. 2018) procedure in all three conditions. At the beginning of training, the researcher used a 0-s prompt delay or wait time. For example, the researcher provided the verbal discriminative stimulus and immediately provided the correct prompt (picture and echoic) between the instruction and before the child had an opportunity to respond. After two consecutive sessions of the participant responding to the correct prompt, the researchers faded prompts to 2 s for two consecutive sessions, followed by 5 s for two consecutive sessions, allowing the participant the opportunity to respond independently. From the results of the pre-assessments, the experimenter selected three targets for each condition totaling 12 targets for the abbreviated assessment and 12 targets for the validation assessment. In each session, the experimenter presented the teaching targets a total of four times by randomizing them prior to session, with no more than one target being presented two times in a row.

Each session included 12 instructional trials total, mixing 3 targets, presented 4 times each. Each target word was presented in a random order an equal number of times per session with no more than two consecutive trials for the same target. Conditions were presented randomly for each participant using a random number generator.

Based on the results of the color preference assessment, researchers incorporated contextual stimuli of the same color (e.g., red, blue, or green) depending on the condition being run, and counterbalanced across participants.

Implementing contextual stimuli in each condition increased the discriminability between each condition for the participant. For example, prior to beginning session, the experimenter placed a blue stimulus card on the table with the specified teaching targets. The participant was then instructed to identify the color vocally and was given the instruction to touch the color. The experimenter provided a simple statement such as, "We are in the red condition. Red means vocal model." When the specific condition finished, the experimenter then switched the color stimuli cards to the assigned condition (e.g., red placemat card with multiple response repetition). Colin and Brian did not have a color preference so the experimenter assigned yellow, orange, red, and blue for the specific teaching conditions. Paul had a preference for the colors black and green and vocally stated he did not like the color purple. These three colors were not used and therefore, like the other two participants, the experimenter chose yellow, orange, red, and blue to represent the specific conditions.

Phase 1: Abbreviated Assessment

Baseline. As a result of the pre-assessments, novel targets were selected and presented to the participant. Across each set of targets, a minimum of three baseline points per treatment conditions were acquired without increasing or decreasing trends according to visual inspection prior to implementing any of the treatment conditions (Sidman, 1960). The participant did not receive any reinforcement, prompting or error-correction procedures during baseline.

Control. In the control condition, the experimenter conducted sessions using the same procedures used in baseline. The purpose of this condition was to monitor each of the participants' correct responding in the absence of teaching.

Vocal Model. In the Vocal Model (VM) condition, the experimenter provided the initial instruction (i.e., "Moo says the ___") followed by a picture and echoic prompt using constant-time-delay fading procedures. If the child responded correctly, the experimenter allowed access to a preferred tangible for 25 s. If the child did not emit a response within 5 s or emitted an incorrect response, the experimenter provided a vocal model and picture of the correct response (e.g., "Moo says the cow"). The experimenter considered the vocal model as an error-correction trial but did not require the participant to echo the correct response. If the participant did echo the correct response the experimenter did not provide any differential consequences. Error correction trials were scored each time the experimenter modeled the correct response following an error or no response.

Single-Response Repetition. In the Single Response Repetition (SRR) condition, (Barbetta et al., 1993; McGhan & Lerman, 2013) the experimenter provided the initial instruction (e.g.,"Tweet-tweet says the ___") followed by a picture and echoic prompt using constant- time-delay fading procedures. If the child responded correctly, the experimenter allowed access to a preferred tangible for 25 s. If the child did not emit a response within the specific prompt condition, or emitted an incorrect response, the experimenter used a vocal model of the correct response (e.g., "Tweet-tweet says the ____ ") accompanied with a picture and echoic prompt based on the current prompt level in teaching. If the participant responded correctly after the vocal model was presented (e.g., "bird") the experimenter delivered praise but withhold a preferred tangible. If the participant did not emit a response or responded incorrectly after the vocal model was delivered, the trial ended and the experimenter presented the next trial after a 25 s inter-trial interval (ITI). Error correction trials were scored each time the experimenter modeled the correct response following an error or no response.

Multiple-Response Repetition. In the Multiple Response Repetition (MRR) condition, the experimenter provided the initial instruction (e.g., "Oink says the ___"). If the child responded correctly, the experimenter allowed access to the preferred tangible for 25 s. If the child did not emit a response within 5 s or emitted the incorrect response, the experimenter then said the correct response (e.g., "Oink says the pig") accompanied by a picture and echoic prompt of the correct response, "pig." The experimenter repeated this procedure until the participant echoed the correct response a total of five times consecutively or until a total of 10 error-correction trials were presented without five correct consecutive responses. The experimenter provided brief praise when the participant responded correctly during error-correction. The experimenter scored a minimum of five error-correction trials following every trial with an error or no response.

The experimenters terminated the abbreviated assessment once a participant responded correctly during 90% or more trials for one training session, or when the experimenter conducted 60 trials in each condition. Following this, the experimenters moved on to phase 2. The participant was not required to acquire mastery of the novel targets during the abbreviated assessment.

Phase 2: Validation Assessment

The validation assessment was conducted using the same procedures as in the abbreviated assessment with the addition of conducting sessions until a participant acquired the pre-determined mastery criterion for target responses trained in one or more error-correction procedures. Mastery criterion for each participant was 80% or higher across three sessions. An early termination criterion was also implemented in this phase. For example, if the target responses in one error correction condition remained in training while another target set has been acquired by the participant meeting mastery criterion, the experimenter stopped running additional sessions for that condition. A condition was terminated early if a participant engaged in problem behavior on 75% or higher of trials.

Results

Colin

The results for Colin are depicted in Figures 1-7. Colin engaged in the highest frequency of correct responses in the multiple response repetition condition and it was associated with the second lowest frequency of error trials. He engaged in the lowest frequency of errors and error- correction trials during the vocal model condition. Colin did not engage in any problem behavior (i.e., flopping out of the chair) during the control condition and the multiple response repetition condition. He engaged in one instance of flopping out of his chair in both the vocal model condition and the single response repetition condition. The total duration of teaching time took 41 min and 10 s in the vocal model condition followed by single response condition with a total time of 42 min and multiple response repetition condition with 44 min. The control condition took 16 min. Teaching time did not include the total amount of time spent during reinforcement or time after the child errored (i.e., 25 s in teaching conditions and 10 s in control condition) In all 3 teaching conditions, Colin spent 25 min playing with his preferred toy (e.g., animals, iPad, play-doh) or time spent before representing the next trial if Colin had errored. In total, the abbreviated assessment including baseline, took 3 hours and 19 minutes to run. The results of Colin's abbreviated assessment suggested that the vocal model condition (88% of points) would be the most efficient error-correction procedure followed by the multiple response repetition condition (66% of points). The results of Colin's validation assessment are depicted though Figures 5-7. Colin's validation assessment was not consistent with the abbreviated assessment. Colin mastered the targets in the multiple response repetition condition and the single response repetition condition in the fewest number of sessions (i.e., 6 sessions). However, he mastered the targets in fewest trials which included independent trials, prompted trials, error trials, and error- correction trials totaling to 77 trials total. Colin did not reach mastery in the vocal model condition due to reaching mastery criterion in the other two conditions prior. Colin did however, engage in higher frequency of problem behavior during the single response repetition in the validation assessment followed by the vocal model condition. Colin did not engage in any problem behavior in the control condition and multiple response condition, consistent with the abbreviated assessment. The total duration of teaching time took 44 min and 37 s in the single response repetition condition, followed by the vocal model condition with 45 min and 17 s, and multiple response repetition condition with 45 min and 27 s. The control condition took a total of 17 min and 3 s.

Like the abbreviated assessment, teaching time did not include the total amount of time spent during reinforcement or time after the child errored (i.e., 25 s). In all three teaching conditions, Colin spent 30 min playing with his preferred toy (e.g., animals, iPad, play-doh) or time spent before representing the next trial if Colin had errored. In total, the validation assessment including baseline, took 3 hr and 10 min to run. For both assessments, it took researchers 6 hrs and 29 min.

Paul

Figures 8 through 14 show the results for Paul. Paul engaged in the highest frequency of correct responses, the lowest frequency of error trials and error-correction trials in the vocal model condition. He engaged in the second highest frequency of correct responses and the second lowest frequency of error-trials in the multiple response repetition condition. Paul engaged in the highest frequency of problem behavior trials (e.g., screaming, aggression) during the multiple response repetition condition and the lowest frequency of problem behavior trials in the vocal model condition with 1 trial. Paul engaged in 4 trials of problem behavior in the single response repetition condition. Paul did not engage in any problem behavior during the control condition.

The total duration of teaching time took 29 min and 20 s in the vocal model condition followed by single response condition with a total time of 30 min and 33 seconds, multiple response repetition condition with 33 min and 51 s. The control condition took 16 min. Teaching time did not include the total amount of time spent during reinforcement or time after the child errored (i.e., 25 s in teaching conditions and 10 s in control condition) In all 3 teaching conditions, Paul spent 20 min playing with his preferred toy (i.e., iPad) or time spent before representing the next trial if Paul had errored. In total, the abbreviated assessment including baseline, took 2 hours and 34 minutes to run. The results of Paul's abbreviated assessment suggested that the vocal model condition (100% of points) would be the most efficient error-correction procedure followed by the single response repetition condition (55% of points).

The results of Paul's validation assessment were not consistent with the abbreviated assessment. Paul only mastered the taught targets in the multiple response repetition condition in a total of 5 sessions. The researchers terminated the assessment once mastery criterion was met. Paul did however, engage in higher frequency of problem behavior during the control condition with a frequency of 18 trials followed by the multiple response repetition condition and vocal model condition with a frequency of 10 trials in each of those conditions, with the fewest amount of frequency of problem behavior trials in the single response condition with a total of 3 trials.

Like the abbreviated assessment, teaching time did not include the total amount of time spent during reinforcement or time after the child errored (i.e., 25 s). In all 3 teaching conditions, Paul spent 25 min playing with his preferred toy (i.e., iPad) or time spent before representing the next trial if Paul had errored. In total, the validation assessment, including baseline, took 3 hr and 3 min to run. For both assessments, it took researchers 6 hrs and 6 min.

For both Colin and Paul, their results are consistent with current research (Caroll et. al. 2018) regarding the effectiveness of the implementation of using an abbreviated assessment. In Carroll et. al (2018) study, the results indicated that for two out of the four participants, the abbreviated assessment was not conclusive, even with the additional validation assessments. Similar to these findings, the current study's results were similar in that two out of the three participants were inconsistent with their abbreviated assessment. This suggests the abbreviated assessment may not be effective for all learners.

Brian

The results for Brian are depicted in Figures 15 through 21. Brian engaged in the highest frequency of correct responses in the single response with the lowest frequency of error trials and error-correction trials in the single response repetition condition and the vocal model condition. Brian did not engage in any problem behavior (i.e., screaming) during the multiple response repetition condition. He engaged in 1 trial of screaming during the control condition, 2 trials with screaming in the vocal model condition and 5 trials of screaming during the single response repetition condition. The total duration of teaching time took 38 min and 1 s in the single response repetition condition followed by vocal model condition with a total time of 38 min and 2 s. The multiple response repetition condition took the longest with a total time of 40 min and 11 s. The control condition took 28 min. Teaching time did not include the total amount of time spent during reinforcement or time after the child errored (i.e., 25 s in teaching conditions and 10 s in control condition) In all 3 teaching conditions, Brian spent 25 min playing with his preferred toy (e.g., Disney figurines, iPad, white board and markers) or time spent before representing the next trial if Brian had errored. In total, the abbreviated assessment including baseline, took 3 hours and 25 min to run. The results of Brian's abbreviated assessment suggested that the single response repetition (100% of points) would be the most efficient error-correction procedure followed by the vocal model condition (55% of points). The results of Brian's validation assessment were consistent with the abbreviated assessment. Brian mastered the targets in the single response repetition condition and the multiple response repetition condition in the fewest number of sessions (i.e., 9 sessions). However, he mastered the targets in fewest trials which included independent trials, prompted trials, error trials, and error- correction trials totaling to 105 trials in the single response condition. Brian did not reach mastery in the vocal model condition due to reaching mastery criterion in the other two conditions prior. Brian did however, engage in higher frequency of problem behavior during the control and multiple response repetition in the validation assessment followed by the single response repetition condition. Brian did not engage in any problem behavior in the vocal model condition. The total duration of teaching time took 72 min and 18 s in the vocal model condition, followed by the single response repetition condition with 72 min and 26 s, and multiple response repetition condition with 76 min and 20 s. The control condition took a total of 28 min and 3 s.

Like the abbreviated assessment, teaching time did not include the total amount of time spent during reinforcement or time after the child errored (i.e., 25 s). In all 3 teaching conditions, Brian spent 45 min playing with his preferred toy (e.g., Disney figures, iPad, white board with markers) or time spent before representing the next trial if Brian had errored. In total, the validation assessment, including baseline, took 3 hr and 10 min to run. For both assessments, it took researchers 5 hrs and 17 min. It took researchers 8 hrs and 42 min to run both the abbreviated and validation assessments for Brian. Brian's results were consistent with previous research (Carroll et. al. 2018) in that his abbreviated assessment results were validated in the validation assessment. This suggests the effectiveness of the assessment and therefore increasing the number of participants in which the abbreviated assessment was successful for.

Discussion

The purpose of this study was to determine the most effective and efficient error-correction procedure by testing the predictive validity of an abbreviated assessment for children with ASD. The results showed a high degree of correspondence between the abbreviated assessment and the validation assessment for one of the three participants. Brian acquired the intraverbal targets taught with the highest frequency of independent responses in the single response repetition condition. The frequency of error trials and error-correction trials was a total of two in both the vocal model and single response repetition conditions. He also met mastery criterion in the fewest frequency of sessions in the single response repetition condition. Therefore, Brian earned the highest score in the single response repetition condition. In the validation assessment, Brian met mastery criterion in the fewest amount of training trials in the single response repetition condition, thus validating the abbreviated assessment. In both the abbreviated and validation assessment, Brian engaged in the highest frequency of trials of problem behavior (i.e., screaming) in the single response repetition condition. Researchers did not include problem behavior as part of the scoring criterion. Although Brian's assessments showed high correspondence between each other, practitioners should consider the frequency of problem behavior trials and may opt to choose an alternative teaching condition. For Brian, it may be suggested to implement the multiple response repetition procedure due to Brian acquiring the taught targets in both assessments. In the abbreviated assessment Brian responded with the second highest frequency of independent trials and the lowest amount of frequency trials of problem behavior in the validation assessment. Although both the vocal model condition and the multiple response condition had the same frequency of trials of problem behavior per assessment, it should be highlighted that Brian did not engage in any problem behavior during the entire validation assessment in the multiple response repetition condition. This showed to have higher social validity when choosing a condition due to the duration of that assessment (76 min and 20 s) compared to the abbreviated assessment (40 min and 11 s). Brian's problem behavior was also not high in intensity, meaning researchers did not have to intervene or stop the assessment, but ignored his screaming and continued on to the next teaching trial.

For Colin and Paul, the results of the abbreviated assessment were less consistent. For both participants, the procedure to be the most efficient and effective error-correction procedure during the abbreviated assessment was the vocal model condition. Colin did not acquire mastery in the validation assessment in the vocal model condition. He did however, acquire mastery criterion in fewest amount of teaching trials in the multiple response repetition condition, which was the condition to have the second highest percentage of points in the abbreviated assessment. Colin did not engage in any trials of problem behavior in the multiple response repetition condition for both assessments. This may be of importance to practitioners when choosing an error-correction procedure and again validates the significance of running both assessments. Like Colin, Paul's validation assessment indicated that the multiple response repetition condition would be the most effective and efficient error-correction procedure. The multiple response repetition condition was the only condition in which Paul met mastery criterion. Paul responded with the second highest frequency of independent responses in the multiple response condition in the abbreviated assessment, but due to higher frequency of error-correction trials the condition was predicted to be the last condition out of the three to implement based off of the percentage of points. Paul engaged in the highest frequency of problem behavior trials in the multiple response repetition condition followed by the control condition. Paul was sensitive to reinforcement and was not provided any tangible items during the control condition. He often would respond to the intraverbal questions asked with made up words such as "yayee", or "oogah" and would ask for the teaching stimuli cards that were used in the other three teaching conditions so that he could obtain the iPad. Thus, practitioners may opt not to implement the multiple repetition response condition due to his higher frequency of trials and problem behavior trials. They may also want to provide social praise for appropriate behaviors (e.g., sitting in his chair, speaking calmly) during the control condition for future assessments to mitigate problem behavior.

The study extends the error-correction literature by evaluating the predictive validity of the abbreviated assessment of error correction procedures. Specifically, the current study looked to decrease the total amount of time spent conducting the abbreviated assessment by implementing only one validation assessment. Like previous research (Carroll, et al. 2018) the researcher conducted a set number of teaching trials across conditions in the abbreviated assessment which included a termination criterion in order to decrease the amount of time of implementation. By doing so, we too were able to decrease the duration of time when compared to the validation assessment for all three participants averaging 2.92 hr (range, 2.34 hr to3.25 hr) in the abbreviated assessment to 3.86 hr (range, 3.10 hr 5 to17 hr) in the validation assessment, thus saving practitioners approximately 3 to 4 hr. This proved to be effective for one of the three participants.

This study also included a measure of the total amount of time it took to complete both assessments, including baseline time, reinforcement interval time, and teaching time. The time ranged from 6.1 to 8.75 hr to show a true representation of the total duration for clinical purposes and educators. The assessment may be beneficial for early learners like Colin. Implementing an abbreviated assessment may aid practitioners with finding an effective error-correction procedure saving them valuable intervention time. It may also indicate that a child may be taught with multiple procedures thus suggesting that the type of error-correction procedure is of less importance for that specific child.

In order to decrease the total amount of time of the abbreviated assessment, the current study compared only 3 error-correction procedures, vocal model, single-response repetition, and multiple response repetition. We did not include a no-error correction condition due the verbal operant (intraverbal) being taught. The researchers believed that telling a child no after responding to a question or fill-in-the blank statement would not lead to acquisition when compared to previous research who taught site words, match-to-sample targets, or listener response targets (McGhan & Lerman 2013; Kodak et al. 2016; Carroll et al. 2018). The previous research may have included this condition due to the possibility that some children may not be able to discriminate when reinforcement is available and when it is not. From the learner's point of view, failing to get a reinforcer may not be sufficient to help them understand that they responded incorrectly. The learner may perceive they are on an intermittent schedule. Thus, saying, "no" after an error serves as an extinction cue. Thus, adding a "no" (or some other extinction cue) makes the contingencies more discriminable, which speeds up learning.

However, when teaching the intraverbal operant, telling a child, "no" after an error, when they do not have the opportunity to learn the correct response, may increase problem behavior, for the child's most likely will not contact reinforcement. This study taught all three participants intraverbals; however, for Colin, investigators instructed fill-in the blank statements due to his age and VBMAPP scores, where both Paul and Brian were given WH questions.

All three participants received ABA therapy for over a year or more and had not been pre-exposed to any of the three error-correction procedures during their therapy time. This allowed researchers to control for history of exposure and able to eliminate the possibility that a child may be responding at higher rates of correct responses (Coon & Miguel, 2012).

All three participants had a history of low-to-moderate levels of problem behavior during DTI. In the current study, Colin engaged in the highest frequency of trials of problem behavior in the single response repetition condition which was shown to be the second highest percentage of points given out of the three conditions. Paul engaged in the highest frequency of trials of problem behavior in the multiple response condition which was shown to be the lowest percentage of points given out of the three condition in his abbreviated assessment and was associated with the highest frequency of error-correction trials in both assessments. This may be something to consider when looking at the dependent measure of error-correction trials for some participants, as it may be an indication that the highest frequency of problem behavior trials is associated with the highest frequency of error-correction trials. For Brian, he engaged in the highest frequency of trials of problem behavior in the single response repetition condition which was the predictive condition with the highest percentage of points in the abbreviated assessment. Although the researchers did not include problem behavior as part of the scoring criteria to determine which condition would be most efficient and effective, it may provide further insight for clinical or educational settings depending on the severity of a child's problem behavior to opt out of teaching a specific condition. In addition, if problem behavior does occur at higher frequency of trials in one condition over another, teachers or practitioners may choose another condition that may be less aversive for the child and the staff implementing the procedure. By choosing a condition with little to no problem behavior, therapists and staff may have higher levels of treatment integrity which has been shown to increase intervention effectiveness due to not having to interrupt teaching time in order to follow behavior intervention protocols (Arkoosh, Derby, Wacker, Berg, McLaughlin, & Barretto, 2007).

Considering the results of the current study and those of Carroll et. al (2018) study, the experimenter would not recommend this assessment to practitioners due to the length of time it took to implement both assessments and based off of the results. Between both studies, only 3 out of the 7 participants data showed a match between their abbreviated assessment and their validation assessment. The researcher suggests that it may be more beneficial to include problem behavior and the staff and child's preference of conditions as part of the scoring criterion. This may alter the results of the abbreviated assessment and may allow the practitioner to remove a condition before implementing the validation assessment based off the percentage of points given. By doing so, this may decrease the total duration of implementation of the assessment, and take into consideration the learner as a whole, depicting all of the variables that one my want to observe through data collection, prior to choosing the most effective and efficient teaching procedure. For validity purposes, the researcher suggests teaching all taught targets until mastered by teaching those targets in the condition that was shown to be most effective in order for the child to acquire the target and not miss out on a learning opportunity. It should also be noted that results may be idiosyncratic due to preferences or aversions to specific stimuli. Thus, for future research, it may yield more accurate data by teaching a larger number of targets across conditions when implementing the abbreviated assessment.

Implementing skill acquisition assessments into everyday practice should be a priority for current practitioners and educators. Although the assessments may be time intensive, the current assessment was able to analyze multiple dependent measures that may be beneficial to the learner and to staff implementing the procedures. For instance, Paul had higher frequency of problem behavior trials in the multiple response condition but acquired the taught targets the quickest in that condition during the validation assessment. Based off of those results, a practitioner may choose to implement or not implement this procedure by taking into consideration the aversiveness to staff due to his problem behavior. It is important to take into consideration each child's individual goals and specific outcomes and what we as educators and practitioners may do to make sure the learner is receiving the most effective and efficient teaching procedures.

There are some potential limitations to the current study. First, we did not determine if the error-correction procedure would transfer to other skill acquisition targets such as match-to-sample, listener responding, or tact targets. This may be beneficial to educators and practitioners in future investigations to run one assessment that would result in one or two effective error-correction procedures for the learner. It may be impractical and time consuming for a practitioner to implement multiple abbreviated assessments for each different skill acquisition target. Second, we only conducted one validation assessment in order to decrease the total time of the assessment which was not consistent with past research. A future investigation might involve an additional validation assessment, for two of the three participants whose abbreviated assessments were not predictive of the validation assessment. Lastly, it may be beneficial to include problem behavior as part of the scoring criterion. Although the current study collected frequency of problem behavior trials, the experimenter did not include this as a primary dependent variable as part of the scoring criterion in the abbreviated assessment. It may be possible by including problem behavior trials as part of the scoring criterion, results of the participants may differ. This meaning that the outcome of the abbreviated assessment may change when distributing points amongst four categories instead of three. By doing so, the abbreviated assessment might produce a more effective, efficient, and less aversive procedure for the learner and the practitioner to implement. Practitioners may also be inclined to withhold from running a specific condition in the validation assessment due to the participant having high frequency of problem behavior trials in the abbreviated assessment in order to reduce the total duration of the assessment. If practitioners were able to terminate running specific error-correction procedures in the validation assessment based off of the abbreviated assessment results, the assessment may become a better tool for practitioners and educators to use within their clinical practice.

Another limitation for the current study is Brian responded correctly to the intraverbal question of, "What is the capital of Massachusetts?" in the control condition during his abbreviated assessment on the last session. When the experimenter questioned his mother, his mother reported that his home-school teacher had begun to teach the map of the United States. Brian may have had access to the answer (i.e. Boston) during teaching, and thus why he answered correctly.

Future research may include teaching across multiple verbal operants in order to determine if one abbreviated assessment can produce a single error-correction procedure that is effective and efficient for one learner. For instance, it may increase the efficiency of the abbreviated assessment if a specific error-correction procedure was effective for teaching a child a tact target, listener responding target, match-to-sample target, and an intraverbal target. Additional research should assess if a yoking procedure would be as effective when compared to implementation of a standard error-correction procedure to assess the validity of running error-correction procedures. For instance, researchers may look at two groups of children, those receiving a specific error-correction procedure that was determined as most effective, to those receiving a time-delay and receiving no error-correction procedure. By doing so, researchers may be able to assess the validity of implementing error-correction procedures, and if specific procedures when compared to others, are important variables to consider.

Overall, the results of the current study suggest that conducting an abbreviated assessment may result in determining an effective and efficient error-correction procedure. The study also suggests that conducting an abbreviated assessment may be a practical tool for practitioners or educators to implement for children with ASD. In addition, one validation assessment may be enough in order to identify a specific error-correction procedure.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.

Arkoosh M.K, Derby M.K, Wacker D.P, Berg W, McLaughlin T.F, Barretto A. (2007). A descriptive evaluation of long-term treatment integrity. *Behavior Modification*, *6*, 880-95. doi:10.1177/0145445507302254

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.1993.26-11

Barbeta, P. M., Heward, W. L., & Bradley, D. M. (1993). Relative effects of direct and indirect corrective feedback on the acquisition and maintenance of sight words by students with developmental disabilities. *Journal of Applied Behavior Analysis, 26,* 99-1 10. doi:10.1901/jaba.1993.26-99

Barbeta, P. M., Heward, W. L., Bradely, D. M., & Miller, A. D. (1994). Effects of immediate and delayed error correction on the acquisition and maintenance of sight words by students with developmental disabilities. *Journal o Applied Behavior Analysis, 27,* 177-178. doi:10.1901/jaba.1994.27-177

Ben-Itzchak, E., Lahat, E., Burgin, R., & Zachor, A. D. (2008). Cognitive, behavior and intervention outcome in young children with autism. *Research in Developmental Disabilities*, *29*, 447-458. doi: 10.1016/j.ridd.2007.08.003

Bogin, J., Sullivan, L., Rogers, S., & Stabel, A. (2010). *Steps for implementation: Discrete trialtraining*. Sacramento, CA: The National Professional Development Center on Autism Spectrum Disorders, The M.I.N.D. Institute, The University of California at Davis School of Medicine, 1-9.

Carroll, R., A., Joachim, B., T., St. Peter, C., C., Robinson, N. (2015). A comparison of error-correction procedures on skill acquisition during discrete-trial-instruction. *Journal of Applied Behavior Analysis,48*, 257-273. Doi10.1002/jaba.205

Carroll R., Owsiany, J, & Cheatham , J., M. (2018) Using an abbreviated assessment to identify effective error-correction procedures for individual learners during discrete-trial instruction. *Journal of Applied Behavior Analysis, 51*, 482-501. doi:10.1002/jaba.460

Cohen, H., Amerine-Dickens, M., & Smith, T. (2006). Early intensive behavioral treatment: Replication of the UCLA model in a community setting. *Developmental and Behavioral Pediatrics*, *27*, S145-S155.

Coon, J. T., & Miguel, C. F. (2012). The role of increased exposure to transfer-of-stimulus-control procedures on the acquisition of intraverbal behavior. *Journal of Applied Behavior Analysis*, *45,* 657-666. doi:10.190/jaba.2012.45-657

Dunn, L. M., & Dunn, D. M., (2007) PPVT-4; Peabody picture vocabulary test. Minneapolis, MN.: Pearson Assessments

Eikeseth, S., Smith, T., Jahr, E., & Eldevik, S. (2007). Outcome for children with autism who began intensive behavioral treatment between ages 4 and 7: A comparison controlled study. *Behavior Modification*, *31*, 264-278. doi:10.1177/0145445506291396

Fisher, W., Piazza, C. C., Bowman, L. G., Hogopian, 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 Behavioral Analysis*, *25*, 491-498. doi:10.1901/jaba.1992.25-491

Finkel, A., S. & Williams, R., L. (2002) A comparison of textual and echoic prompts on the acquisition of intraverbal behavior in a six-year-old boy with autism. *Analysis of Verbal Behavior, 18,* 61-70. doi:10.1007/bf03392971

Ingvarsson, E. T., (2016). Tutorial: Teaching verbal behavior to children with ASD. *International Electronic Journal of Elementary Education, 2*, 433-450.

Kodak, T., Cambell, V., Bergmann, S., LeBlanc, B., Kurtz-Nelson, E., Cariveau,T, Haq, S., Zemantic, P & Mahon, J (2016). Examination of efficacious, efficient, and socially valid error-correction procedures to teach sight words and preposition to children with autism spectrum disorder. *Journal of Applied Behavior Analysis, 49*. 532-547. doi:10.1002/jaba.310

Kodak, T., Fuchtman, R., & Paden, A. (2012). A comparison of intraverbal training procedures for children with autism. *Journal of Applied Behavior Analysis, 45*, 155- 160. doi:10.1901/jaba.2012.45-155. doi:10.1901/jaba.2012.45-155

Lovaas, O. I. (1987). Behavioral treatment and normal educational and intellectual functioning in young autistic children. *Journal of Consulting and Clinical Psychology, 55*, 3-9. Doi:10.1037//0022-006X.55.1.3

Lord, C., Risi, S., DiLavore, PS., Shulman, C., Thurm, A., & Pickles, A. (2006). Autism from 2 to 9 years of age. *Arch Gen Psychiatry*, 6, 694-701. doi:10.1001/archpysc.63.6.694

Moore, V., & Goodson, S. (2003). How well does early diagnosis of autism stand the test of time? Follow-up study of children assessed for autism at age 2 and development of an early diagnostic service. *The International Journal of Research and Practice, 7*, 47-63. doi:10.1177/1362361303007001005

Michael, J. (1988). Establishing operations and the mand. *The Analysis of Verbal Behavior, 6,* 3-9. doi:10.1007/bf03392824

Partington, W. J. & Bailey, S. J. (1993). Teaching intraverbal behavior to preschool children. *The Analysis of Verbal Behavior, 11,* 9-18. doi:10.1007/978-1-4939-0401-3_16

Petursdottir, A. I., & Devine, B. (2017). *The impact of Verbal Behavior on the scholarly literature from 2005 to 2016. The Analysis of Verbal Behavior, 33(2), 212–228.* doi:10.1007/s40616-017-0089-3

Reed, P., Osborne, L. A., & Corness, M. (2007). The real-world effectiveness of early teaching interventions for children with autism spectrum disorder. *Exceptional Children*, *73*, 417-433. doi:10.1177/0014402907300402

Resetar, J. L., & Noell, G. H. (2008) Evaluating preference assessments for use in the general education population. *Journal of Applied Behavior Analysis, 41,* 447-451. doi:10.1901/jaba.2008.41-447

Roane, H. S., Vollmer, T. R., Ringdahl, J. E., & Marcus, B. A. (1998) Evalation of a brief stimulus preference assessment. Journal of Applied Behavior Analysis, 31, 605-620. doi:10.1901/jaba.1998.31-605

Sallows, G. O., & Graupner, T. D. (2005). Intensive behavioral treatment for children with autism: Four-year outcome and predictors. *American Journal on Mental Retardation, 110*, 417– 438. doi:10.1352/0895-8017(2005)110[417:IBTFCW]2.0.CO;2

Sautter, R. A., & LeBlanc, L. A. (2006). The empirical applications of Skinner's analysis of verbal behavior with humans. *The Analysis of Verbal Behavior, 22*, 35–48. doi:10.1007/bf03393025

Sidman, M. (1960). *In Tactics of scientific research: Evaluating experimental data in psychology.* Oxford, England: Basic Books.

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. Retrieved from http://www.jstor.org/stable/42898888

Singer, H. S. (2009). Motor stereotypies. *Seminars in Pediatric Neurololgy, 16,* 77–81. doi: 10.1016/j.spen.2009.03.008

Skinner, B. F. (1957). *Verbal behavior*. New York: Appleton-Century-Crofts.

Smith, T., Eikeseth, S., Klevstrand, M., & Lovaas, O. I. (1997). Intensive behavioral treatment for preschoolers with severed mental retardation and pervasive developmental disorder. *American Journal on Mental Retardation, 102*, 238–249. doi:10.1352/0895-8017(1997)102<0238:IBTFPW>2.0.CO;2

Smith, T., Groen, A. D., & Wynn, J. W. (2000). Randomized trial of intensive early intervention for children with pervasive developmental disorder. *American Journal on Mental Retardation, 105*, 269–285. doi:10.1352/0895-8017(200)105<0269:RTOIEI>2.0.CO;2

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

Stokes, T. F., & Baer, D. M. (1977). An implicit technology of generalization. *Journal of Applied Behavior Analysis, 10*, 349-367. doi:10.1901/jaba.1977.10-349

Sundberg, M. L. (2008). *VB-MAPP: Verbal behavior milestones assessment and placement* program. Concord, CA: AVB Press.

Sundberg, M. L. & Sundberg, C. A (2011). Intraverbal behavior and verbal conditional discriminations in typically developing children and children with autism. *The Analysis of Verbal Behavior, 27*, 32-43.

Sundberg, M., L. (2008). The verbal behavior milestones assessment and placement program: A language and social skills assessment program for children with autism or other developmental disabilities : Guide. Concord, CA : AVB Press.

U.S. Department of Education. Individuals with Disabilities Act. (2004). U.S. Department of Education's Individuals with Disabilities Act (IDEA). Retrieved from https://sites.ed.gov/idea/

Valentino, A. L., Shillingsburg, A. M., Conine, D. E., & Powell, N. M. (2012). Decreasing echolalia of the instruction "say"during echoic training through use of the cues-pause-point procedure. *Journal of Behavior Education, 21*, 315-328. doi:10.1007/s10864-012-9155-z

Vedora, J. & Meunier, L. (2009). Teaching intraverbal behavior to children with autism: a comparison of textual and echoic prompts. *The Analysis of Verbal Behavior*, *25*, 79-86. doi:10.1007/bf03393072

Walker, G. (2008). Constant and progressive time delay procedures for teaching children with autism: A literature review. *Journal of Autism and Developmental Disorders, 38*, 261-275. doi:10.1007/s1083-007-0390-4

Worsdell, A. S., Iwata, B. A., Dozier, C. L., Johnson, A. D., Neidert, P. L., & Thomason, J. L. (2013). Analysis of response repetition as an error-correction strategy during sight-word reading. *Journal of Applied Behavior Analysis, 38,* 511-527. doi:10.1901/jaba.205.115-04

Figures

Abbreviated Assessment
(60 Trials)

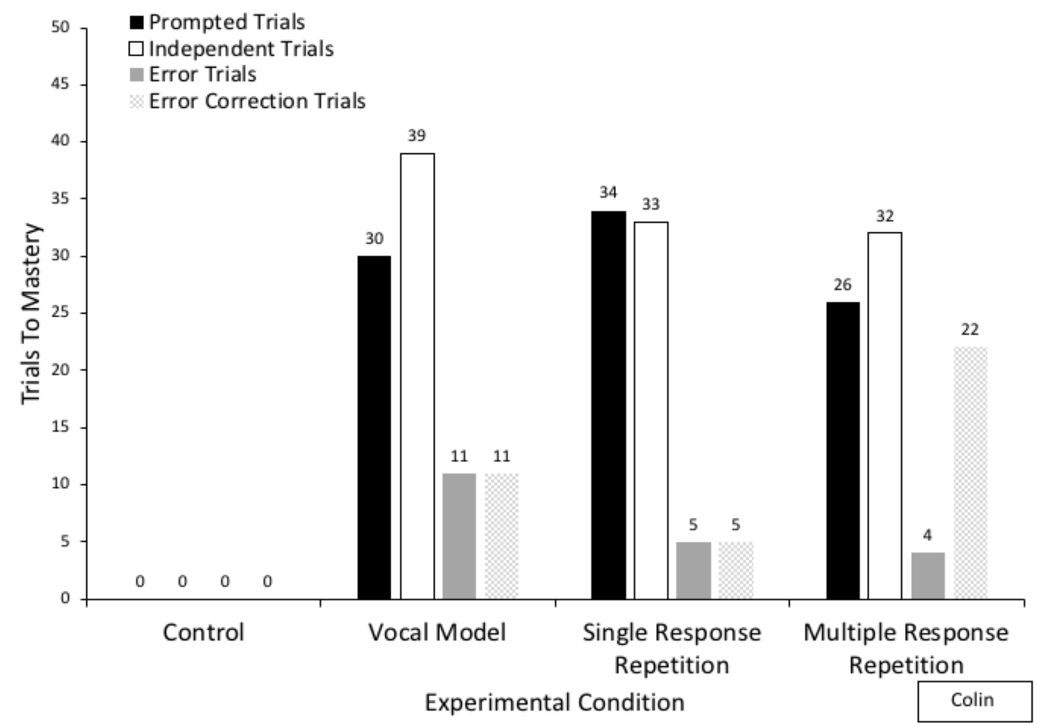

Figure 1: Figure 1 shows the cumulative frequency of correct responses, errors, and error-correction trials for Colin during the abbreviated assessment.

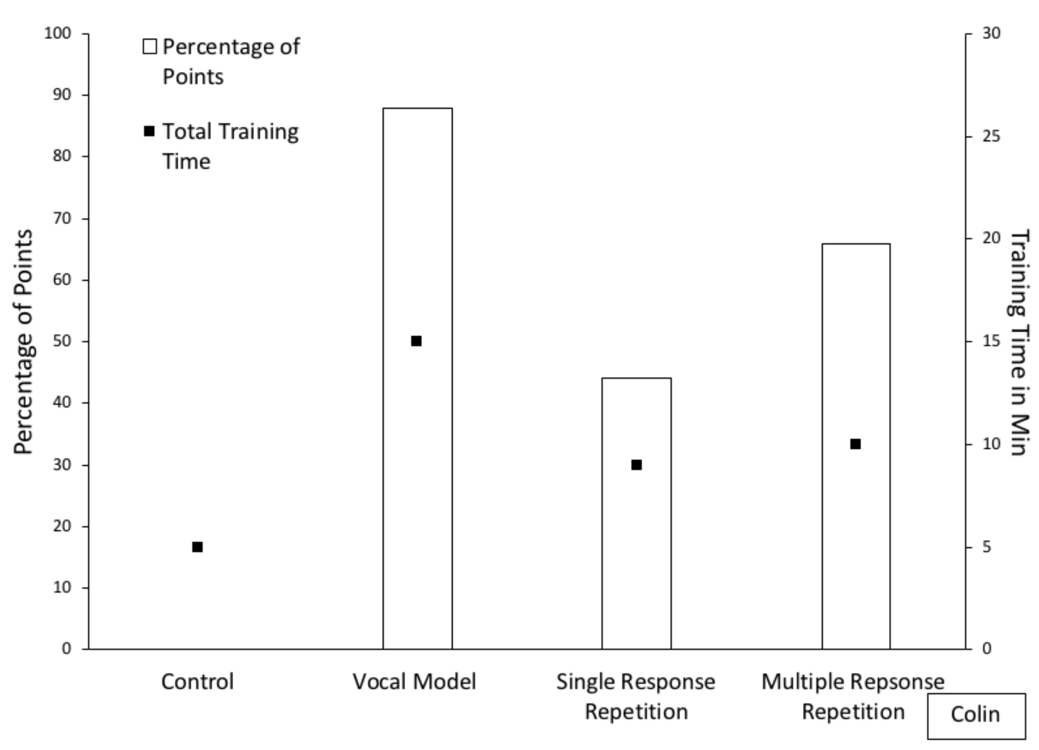

Figure 2: Figure 2 shows the percentage of points and training time for Colin during the abbreviated assessment. We did not include data from baseline sessions in the figures for the abbreviated assessment. Colin did not engage in any correct responses during baseline.

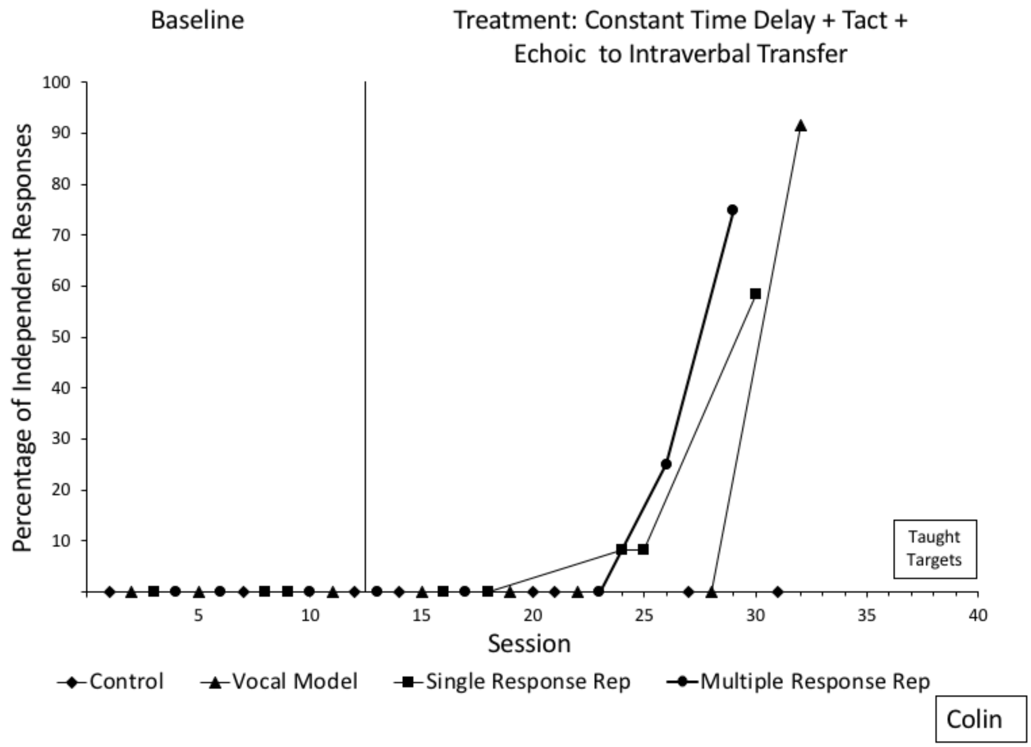

Figure 3: Figure 3 shows the percentage of correct responses for Colin during the abbreviated assessment.

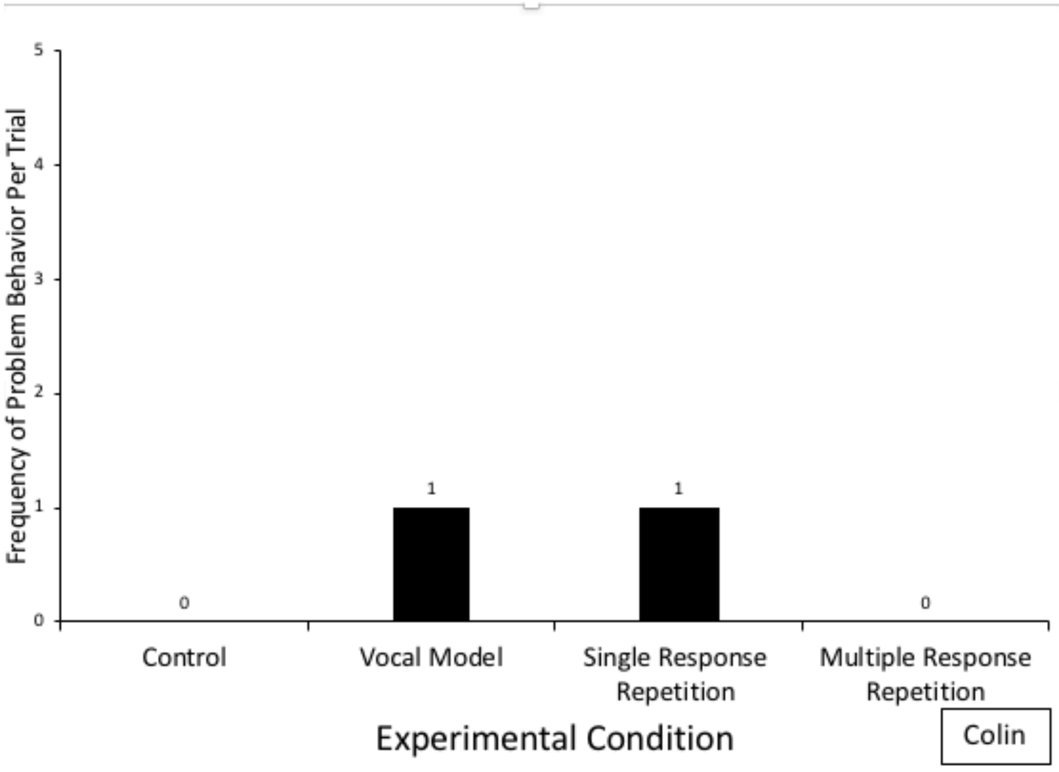

Figure 4: Figure 4 shows the frequency of problem behavior per trial for Colin in the abbreviated assessment.

Validation Assessment

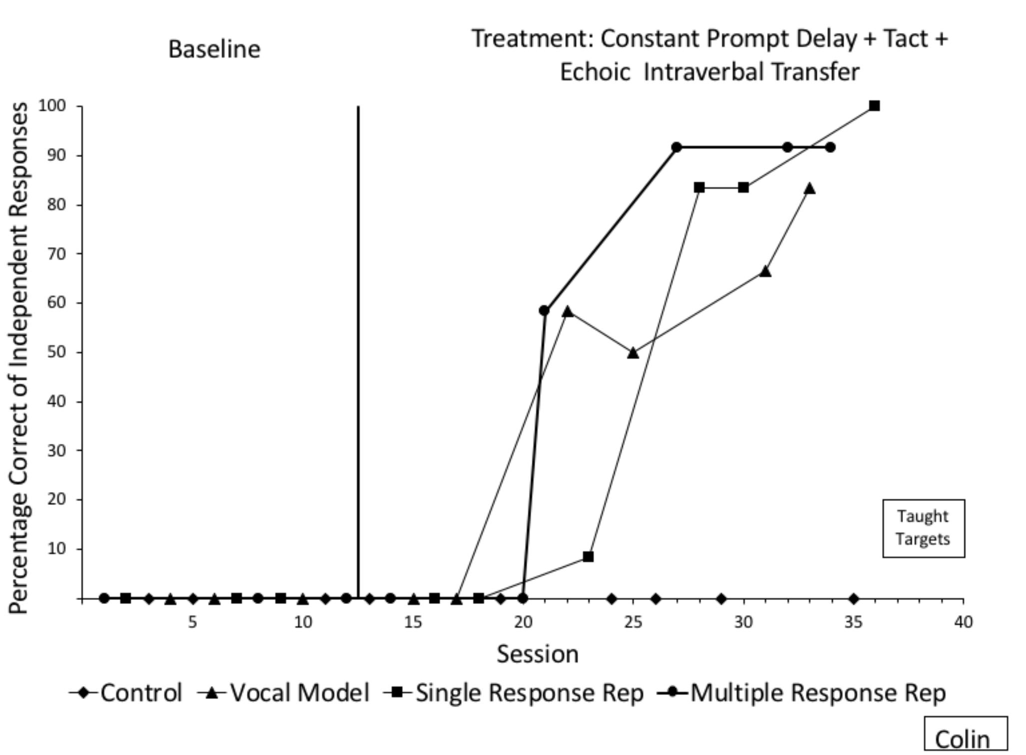

Figure 5: Figure 5 shows the percentage of correct responses of training to mastery for Colin during the validation assessments across vocal model, single-response repetition and multiple-response repetition conditions.

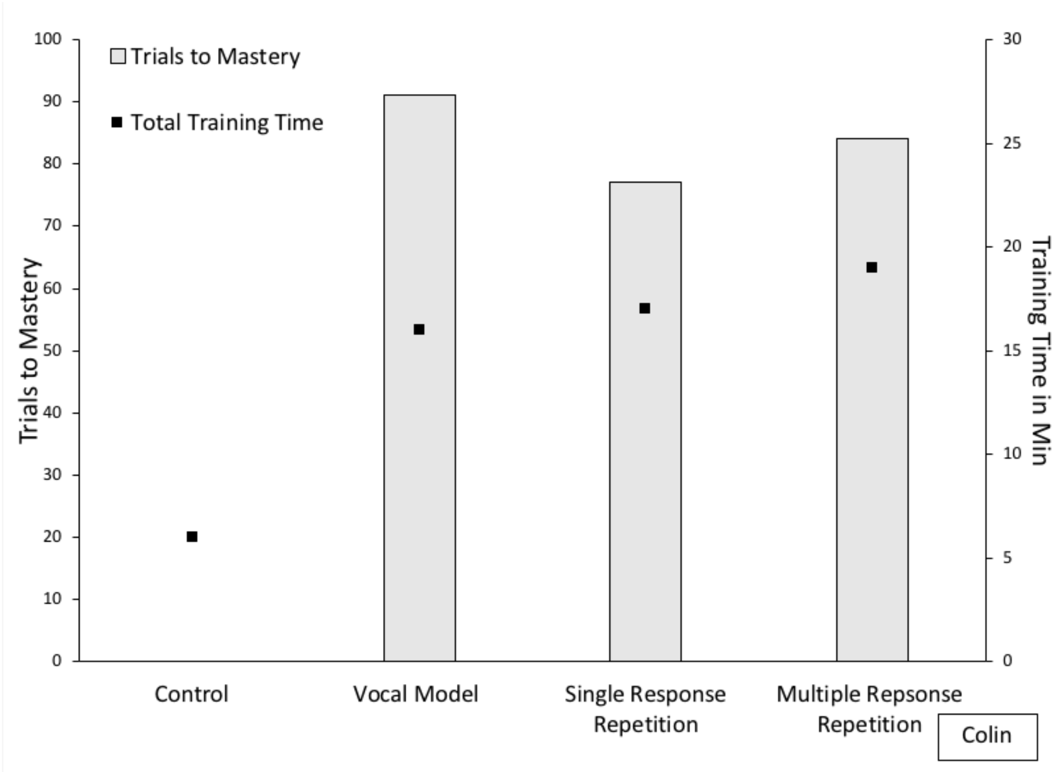

Figure 6: Figure 6 represents the frequency of training trials and duration of training to mastery for Colin during the validation assessments across vocal model, single-response repetition and multiple-response repetition conditions.

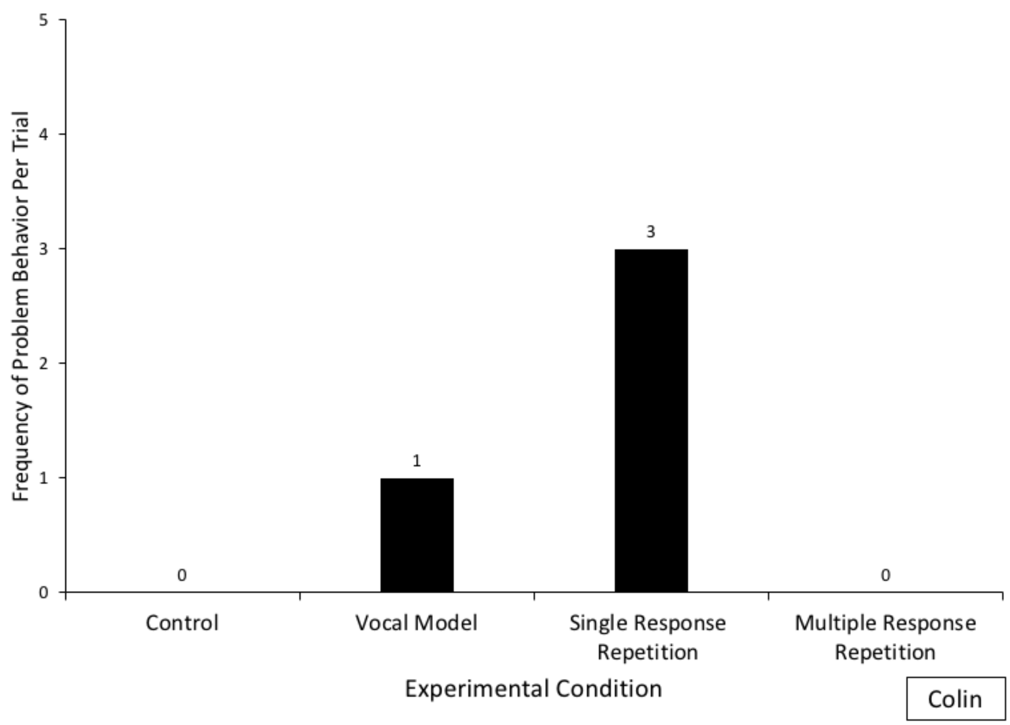

Figure 7: Figure 7 represents the cumulative frequency of problem behavior trials during the validation assessment across control, vocal model, single response repetition, and multiple response repetition conditions for Colin.

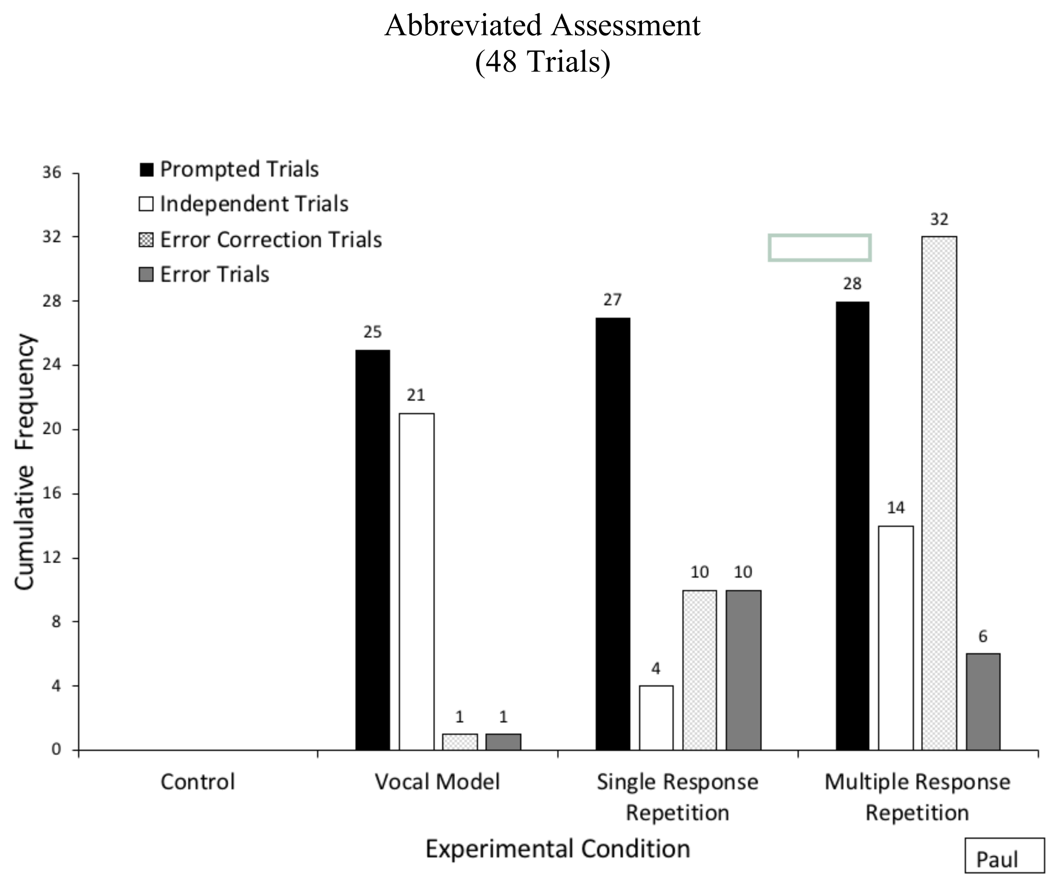

Figure 8: Figure 8 figure shows the cumulative frequency of correct responses, errors, and error-correction trials for Paul during the abbreviated assessment.

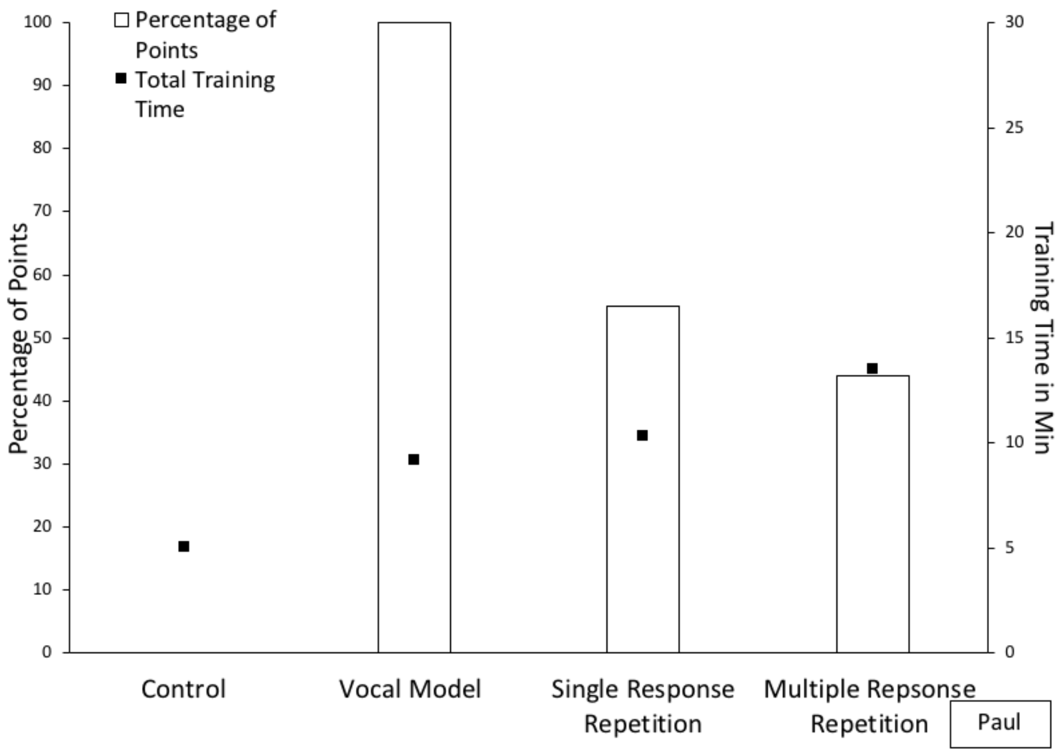

Figure 9: Figure 9 shows the percentage of points and training time for Paul during the abbreviated assessment. We did not include data from baseline sessions in the figures for the abbreviated assessment. Paul did not engage in any correct responses during baseline.

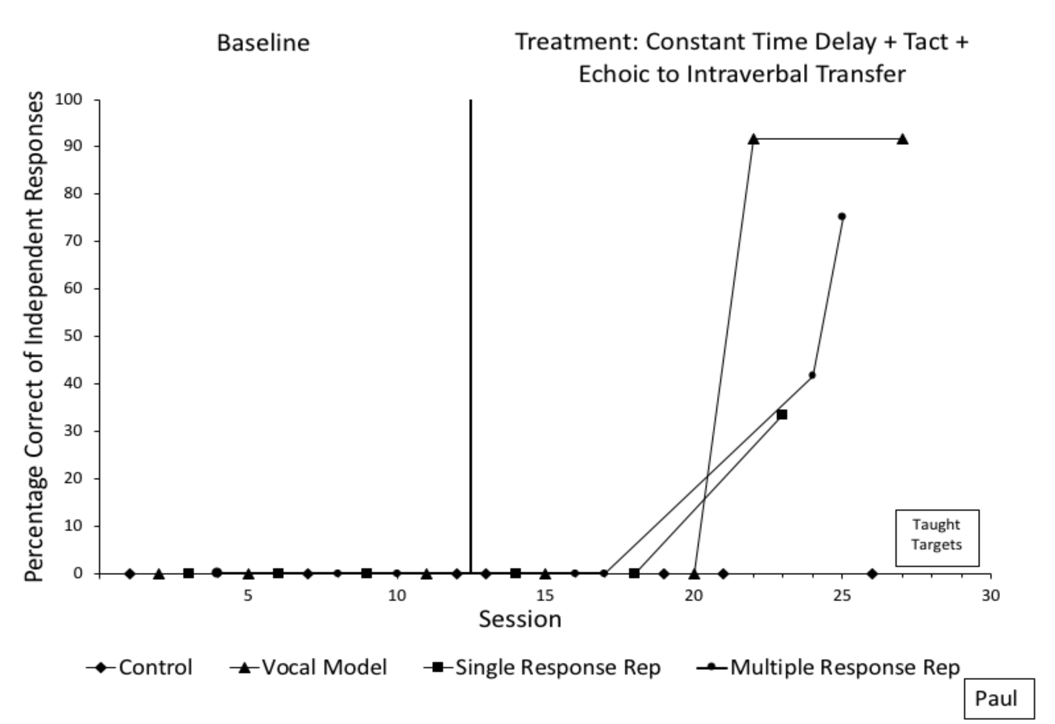

Figure 10: Figure 10 shows the percentage of correct responses for Paul during the abbreviated assessment.

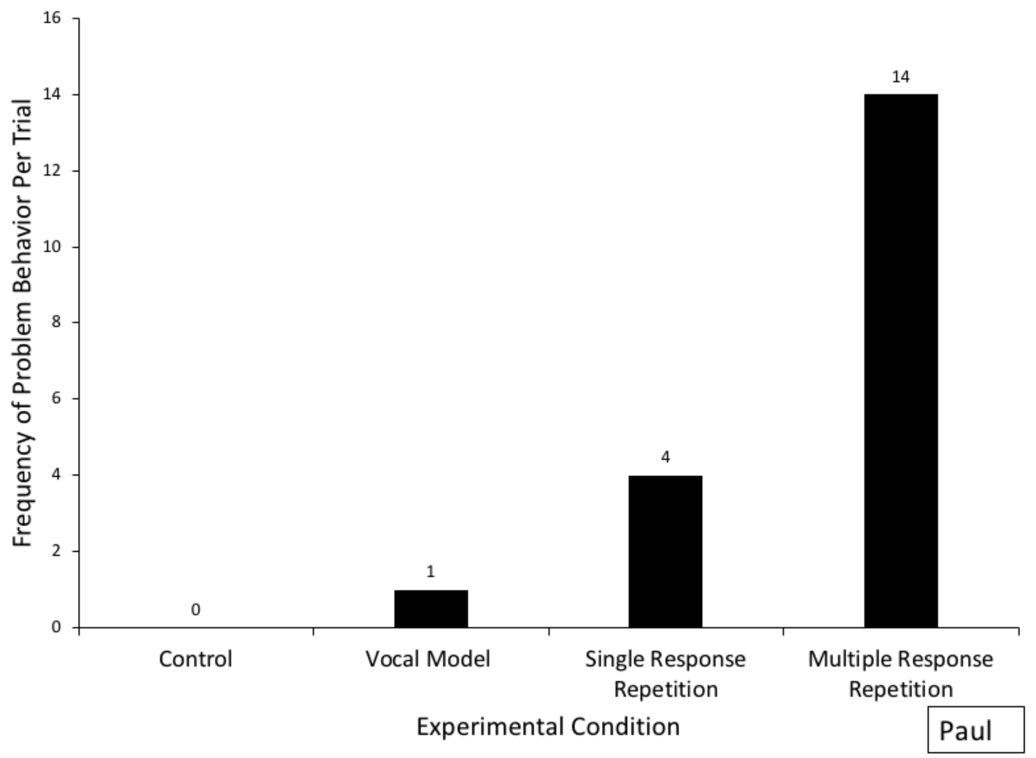

Figure 11: Figure 11 represents the cumulative frequency of problem behavior trials during the abbreviated assessment across control, vocal model, single response repetition, and multiple response repetition conditions for Paul.

Validation Assessment

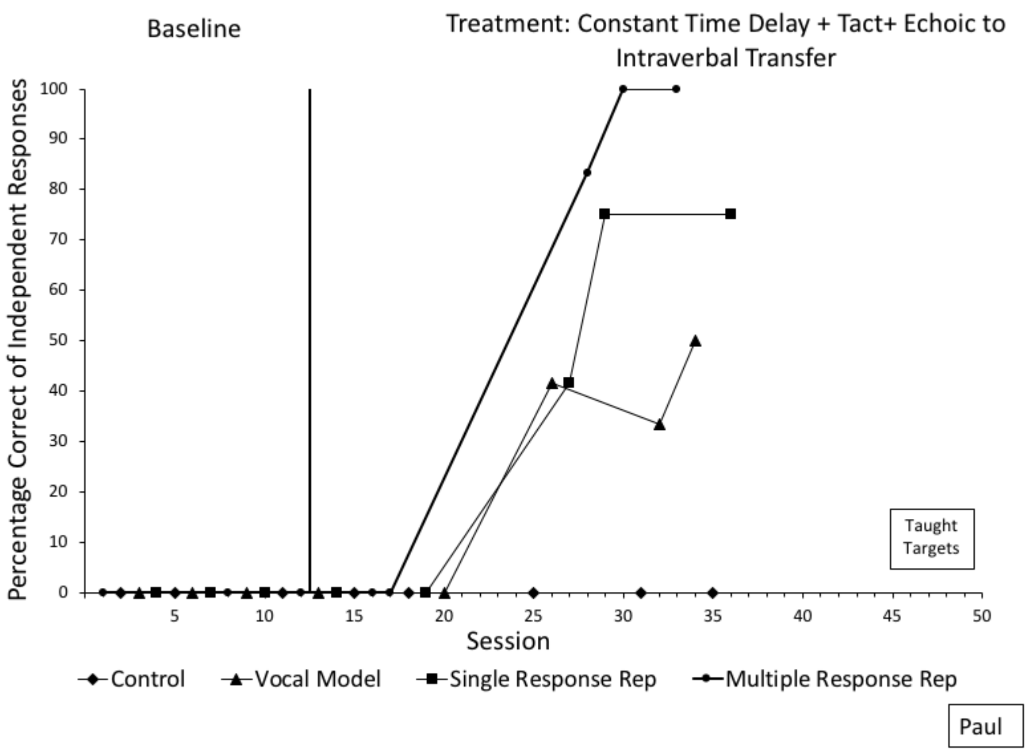

Figure 12: Figure 12 shows the percentage of correct responses of training to mastery for Paul during the validation assessments across vocal model, single-response repetition and multiple-
response repetition conditions.

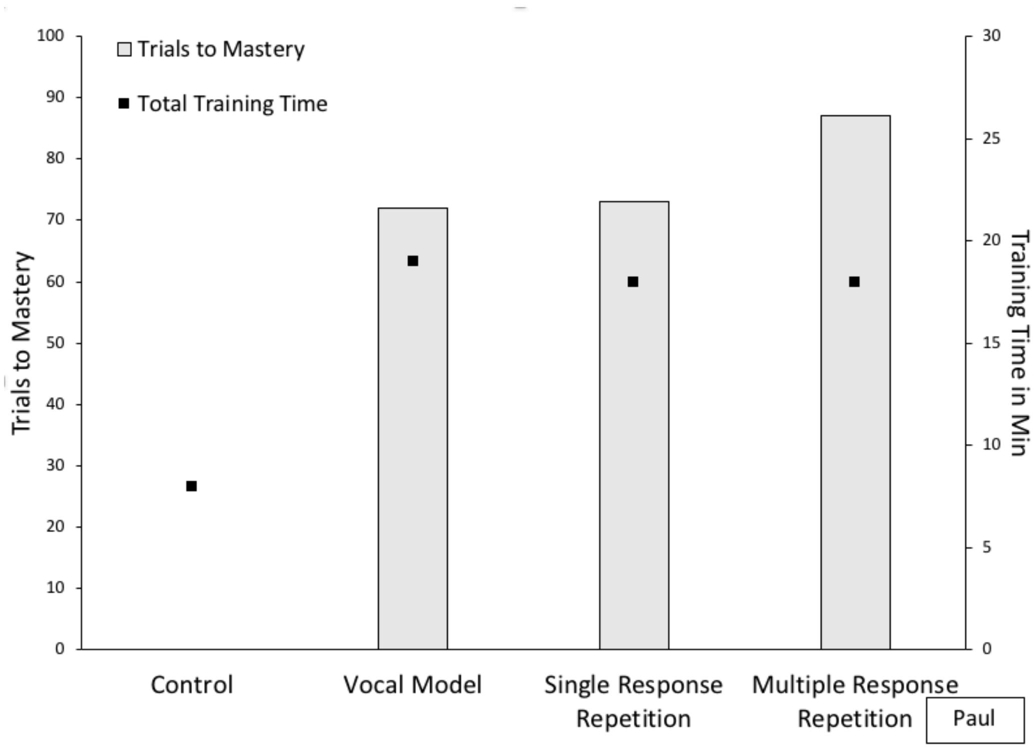

Figure 13: Figure 13 represents the frequency of training trials and duration of training to mastery for Paul during the validation assessments across vocal model, single-response repetition and multiple-response repetition conditions.

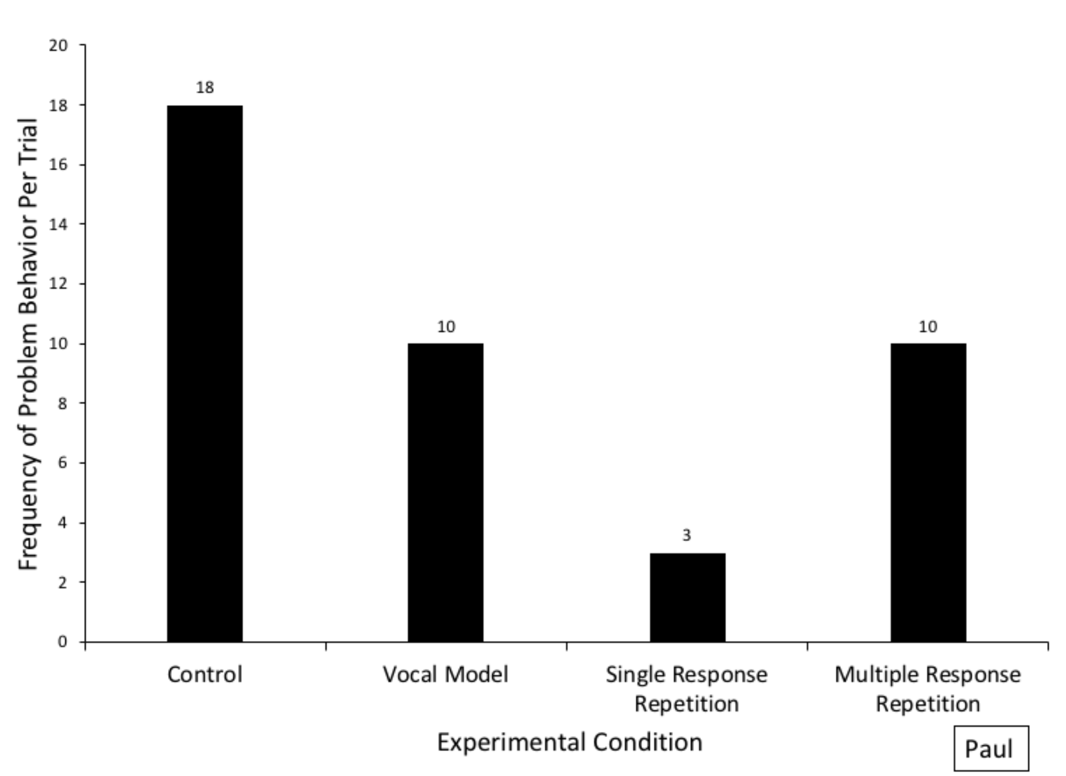

Figure 14: Figure 14 represents the cumulative frequency of problem behavior trials during the validation assessment across control, vocal model, single response repetition, and multiple response repetition conditions for Paul.

Abbreviated Assessment
(60 Trials)

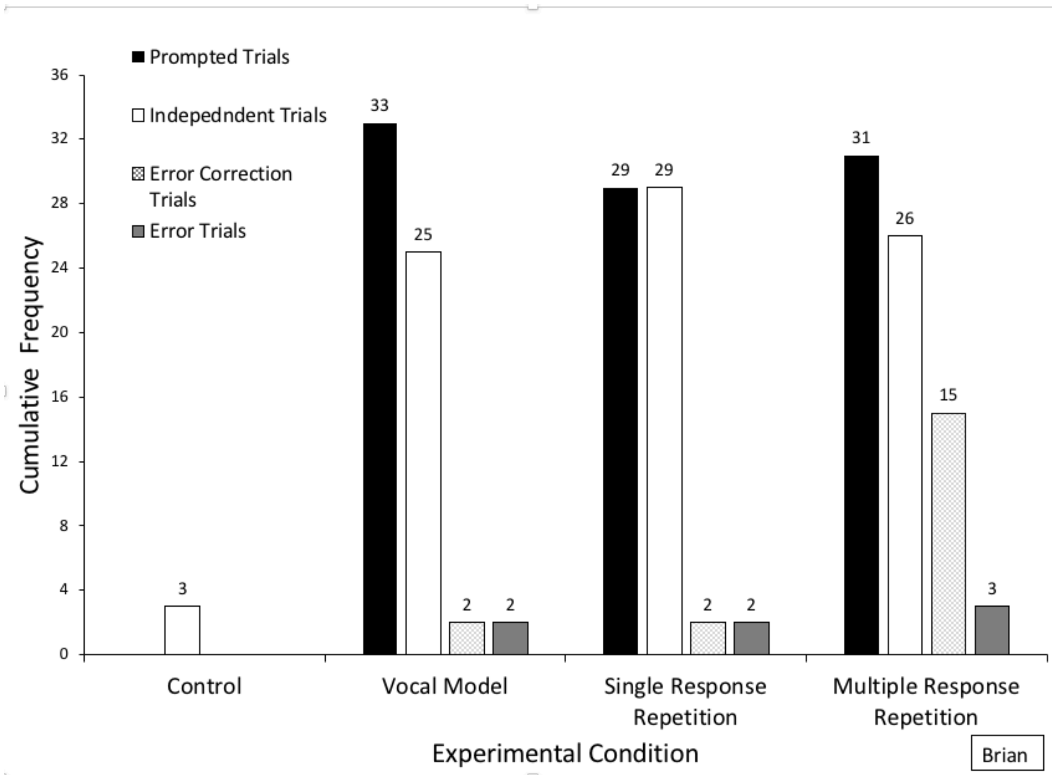

Figure 15: Figure 15 represents the cumulative frequency of correct responses, errors, and error-correction trials for Brian during the abbreviated assessment.

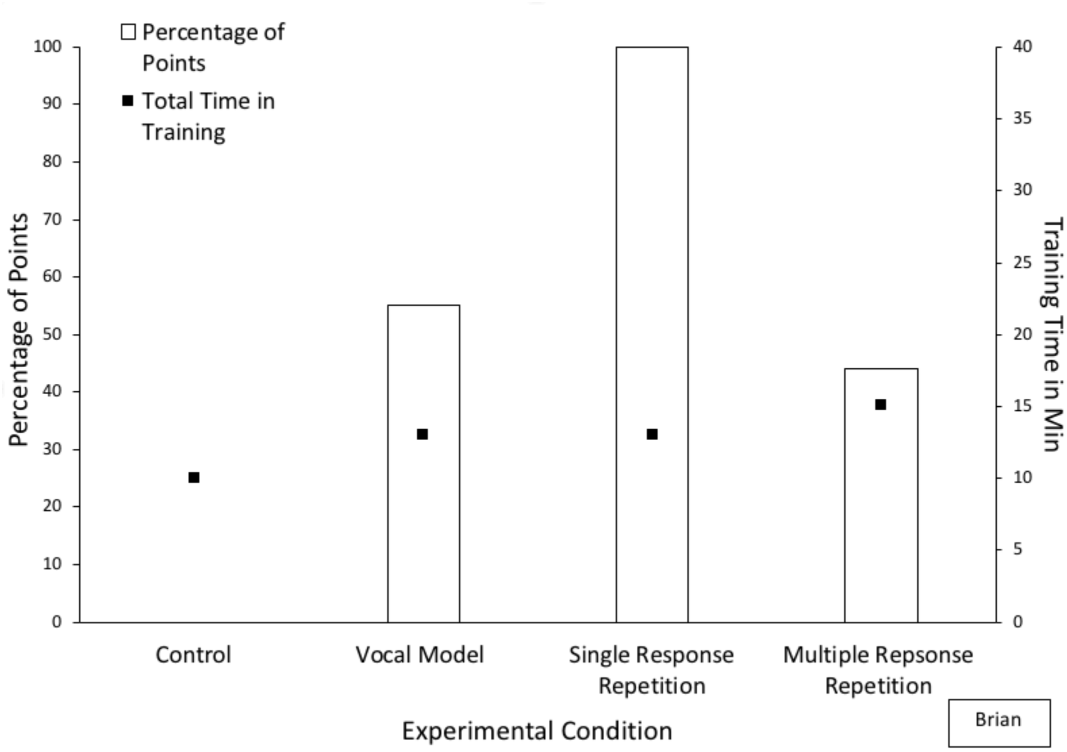

Figure 16: Figure 16 shows the percentage of points and training time for Brian during the abbreviated assessment. Data from baseline sessions was not included in the figures for the abbreviated assessment.

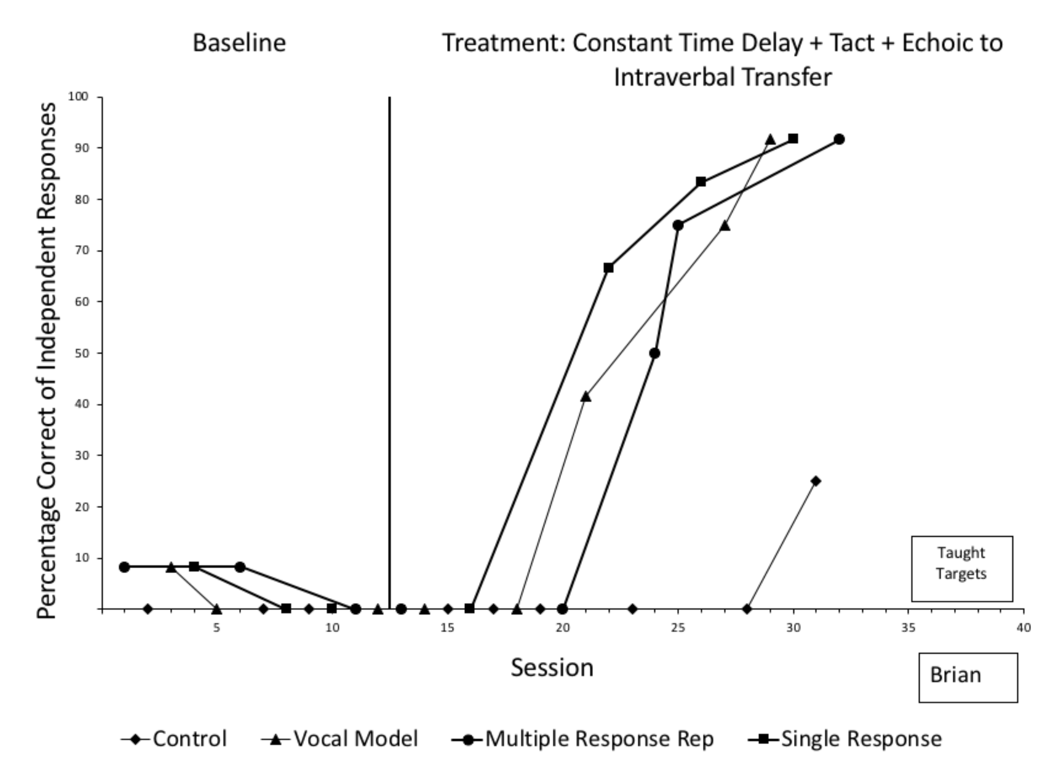

Figure 17: Figure 17 shows the percentage of correct responses for Brian during the abbreviated assessment. Brian engaged in some correct responses during baseline, however, his responding was inconsistent and dropped back down to zero levels prior to moving on to teaching conditions.

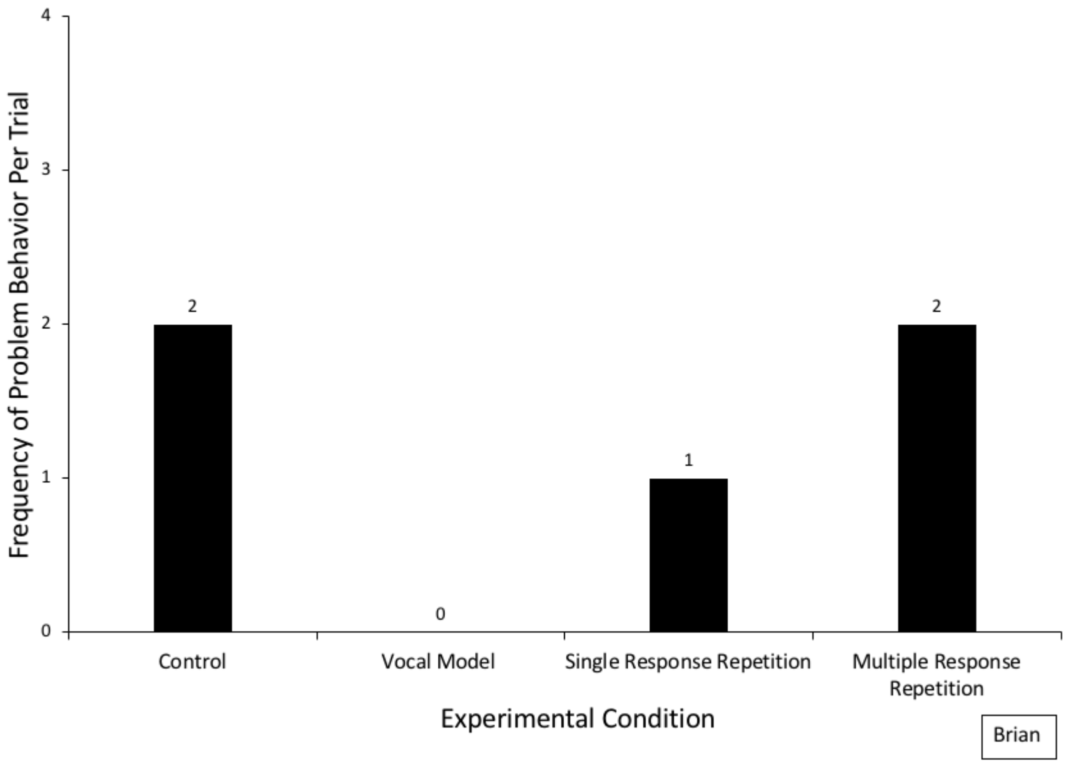

Figure 18: Figure 18 shows cumulative frequency of problem behavior trials during the abbreviated assessment across control, vocal model, single response repetition, and multiple response repetition conditions for Brian.

Validation Assessment

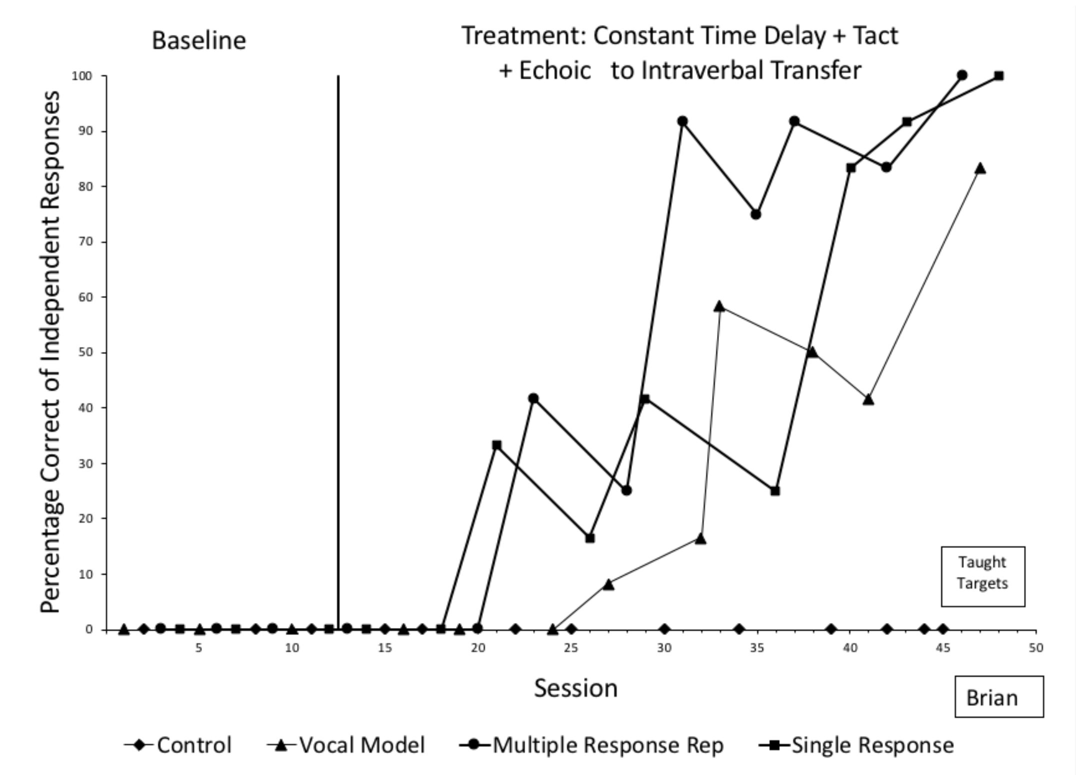

Figure 19: Figure 19 shows the percentage of correct responses of training to mastery for Brian during the validation assessments across vocal model, single-response repetition and multiple-
response repetition conditions.

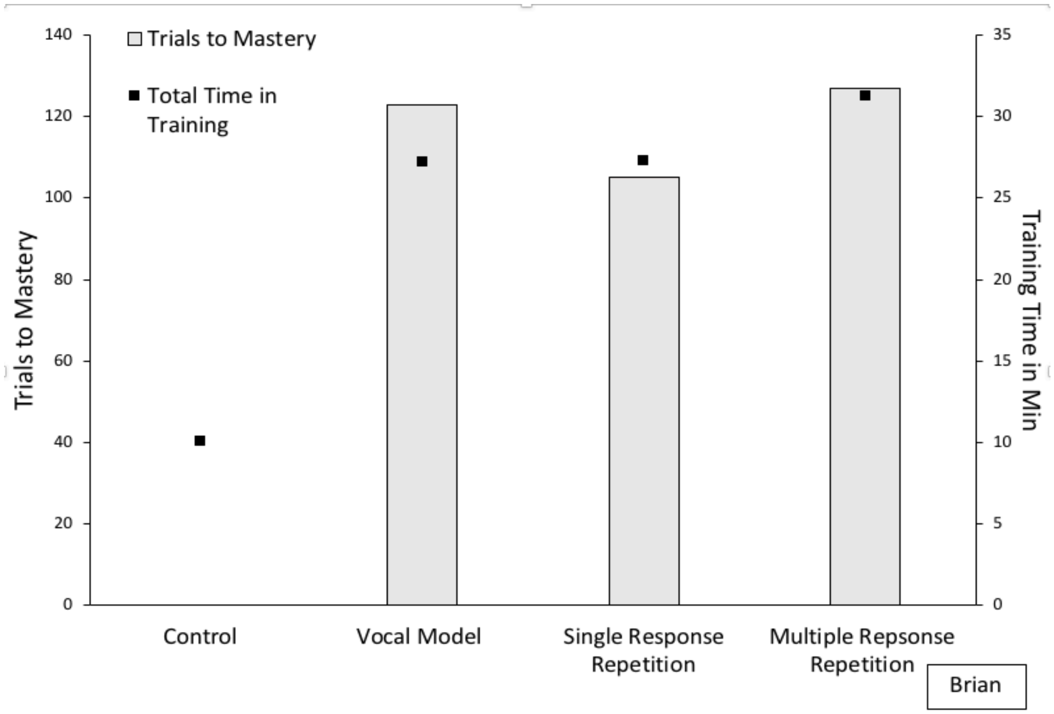

Figure 20: Figure 20 represents the frequency of training trials and duration of training to mastery for Brian during the validation assessments across vocal model, single-response repetition and multiple-response repetition conditions.

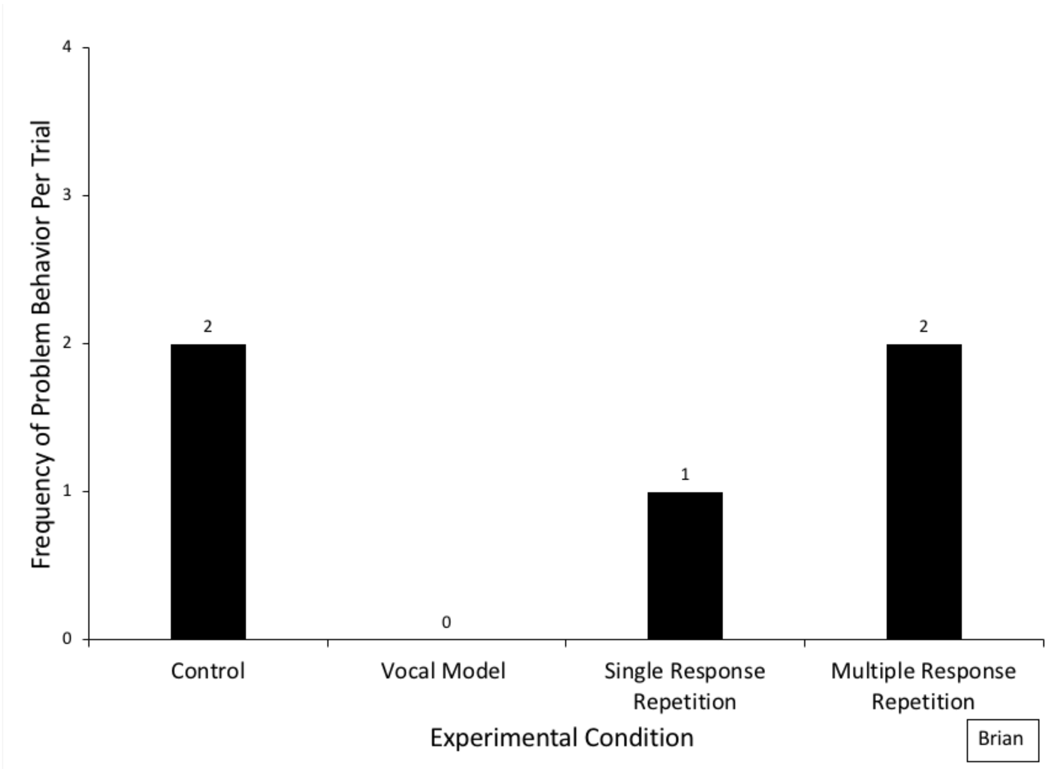

Figure 21: Figure 21 shows the cumulative frequency of problem behavior trials during the validation assessment across control, vocal model, single response repetition, and multiple response repetition conditions for Brian.