FUNCTIONAL ANALYSIS OF VERBAL BEHAVIOR FOR CHILDREN WITH AUTISM SPECTRUM DISORDERS: A PARTIAL REPLICATION AND TREATMENT INVESTIGATION

by

AILA KATRINE DOMMESTRUP

(Under the Direction of Jonathan M. Campbell)

ABSTRACT

Functional and social communication impairments are common symptoms of children diagnosed with autism spectrum disorder (ASD). Improving assessment of the functional use of language within this population of children is ongoing and the clinical utility of linking intervention to specific assessment results is growing. The purpose of the two studies presented in this dissertation was to investigate these lines of research for children with ASD. The first study sought to replicate and extend use of a functional analysis methodology of verbal behavior (Lerman et al., 2005). Results suggested that this methodology is applicable to implement with children with ASD, and can be successfully completed in non-clinic setting (e.g., the participant's home). In the second study, the link between assessment results and subsequent intervention was investigated. Additionally, the sensitivity of the functional analysis of verbal behavior methodology was assessed by conducting a post-intervention assessment. Findings provided limited evidence supporting the use of assessment results to select more efficient intervention strategies. Post-intervention functional analysis results were also inconsistent but provided helpful information for future directions of this line of research. The limitations and implications of these studies are also discussed.

INDEX WORDS: Autism Spectrum Disorders, verbal behavior, functional analysis

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CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

Autism spectrum disorders (ASD) have historically been characterized by impairments in three areas: communication, social interaction, and restricted and repetitive interests and behaviors (American Psychiatric Association [APA], 2000). Recent adjustments to diagnostic criteria reflect outcomes of research reviews and clinical expertise that ASD may be better categorized using a two domain model, where communication and social interaction impairments are combined and rated on a new severity scale (APA, 2013). Current prevalence rates estimate that approximately 1 in every 50 children aged 6-17 years in the United States is affected by ASD (Blumberg et al., 2013). The statistics reflect an increase in prevalence estimates in recent years (Chakrabarti & Fombonne, 2005), with national estimates increasing from 1 in every 110 in children in 2009 to 1 in 88 in 2012 being affected (Centers for Disease Control and Prevention [CDC], 2009, 2012). Some states have reported similar prevalence rates as high as 1 in 77 children being identified with ASD (Pinborough-Zimmerman et al., 2012). With this increase in prevalence rates, as well as increases in public awareness (Blumberg et al., 2013; CDC, 2009, 2012), exploratory and confirmatory research regarding the efficacy of interventions targeting the main symptom clusters associated with a diagnosis of ASD has maintained a dominant presence in the literature.

Since Leo Kanner (1943) first described the characteristics of those children he identified as autistic, a lack of social awareness or inappropriate social behaviors has continued to be arguably the most recognizable symptom of ASD (Carter, Davis, Klin, & Volkmar, 2005).

Longitudinal and retrospective studies examining children at 2 years of age have shown that those children later diagnosed with ASD evince a lack of seeking social attention, as well as responding to social attention, compared to both typically developing peers and peers demonstrating early delays whom do not meet diagnostic criteria for ASD later in life (Lord, 1995; Osterling & Dawson, 1994). While social difficulties of individuals with ASD may be more easily recognizable, parental reports indicated that speech and language delays are the most frequently cited area of primary concern (Chawarska et al., 2007).

Long term prognosis of verbal ability varies greatly among children diagnosed with ASD (Anderson et al., 2007). In a long-term study by Anderson et al. (2007) findings indicated that children with ASD with the most severe communication impairments at age 2 years continued to have the slowest development and fewest communication skills by age 9 years, supporting the need for early language and communication interventions for this population. Another group (Pry, Petersen, & Baghdadli, 2009) found that development of expressive language in children with ASD co-varied with the child's play behavior, such that as a child's expressive language abilities increased play activity skills increased, and as expressive language decreased, play behavior decreased. Pry et al.'s (2009) findings inform the above mentioned revisions for the diagnostic criteria of ASD in the 5th Edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; APA, 2013). Rationale for this revision was based on review of the literature, clinical expertise, and discussions with experts which resulted in the argument that social and communication deficits "are inseparable and more accurately considered as a single set of symptoms with contextual and environmental specificities" (APA, 2010). Prizant and Wetherby (2005) discussed two types of communication abilities which support the DSM-5 revisions; social and functional communication are described as being interrelated and overlapping. Specifically, Prizant and Wetherby argue that increased mastery in either type of communication lends itself to improvements in the other in terms of the individual's independence and participation in their social environment and meeting their everyday adaptive needs. In addition, the National Research Council (NRC) of the National Academy of Sciences (2001) prioritized interventions targeting functional communication as an assistive prerequisite skill prior to social communication instruction when planning early educational goals.

Long before the conclusions reached in the NRC review, Skinner (1957) emphasized the importance of improving functional communication skills during language emergence. Skinner described words and language as tools or instruments an individual uses to affect their environment. Verbal behavior consists of relationships between, what Skinner refers to as, verbal operants. The four primary verbal operants Skinner describes are: (a) mands, (b) tacts, (c) intraverbals, and (d) echoics. Mands are verbal operants in which the desired reinforcement or response is specified by the speaker's verbalization. Considered to be a form of demand or command, the primary goal of the mand is to access reinforcement via the listener. For example, a child is thirsty and receives a glass of water from his mother after saying or signing, "water." A tact is under the control of a nonverbal stimulus or most specifically by the presence of an object or event which evokes a communicative response from the speaker. That is, a tact is the act of naming or labeling; for example, when a child approaches a swimming pool and says, "water." Intraverbal operants differ greatly from mands and tacts as they show "no point-to-point correspondence with the verbal stimuli which evoke them" (p. 71) and do not require the presence of an object to evoke a response. Intraverbal operants can be thought of as word associations where a given word or phrase may have several "correct" responses; however, an instructional goal would be to reinforce a particular response to establish it as the primary association for the initial stimuli. For example, teaching a child to complete the phrase "The ocean is made up of _____" with the response, "water" would be considered an example of an intraverbal operant. Echoic behavior is the fourth elementary operant and represents "the simplest case in which verbal behavior is under the control of verbal stimuli" according to Skinner (p.55). Unlike intraverbal behavior, an echoic response does have a point-to-point correspondence with the controlling stimulus. Echoic behavior is often the first method of communication education implemented by parents and teachers as it is used when teaching infants and young children the names of objects. For example, a parent says "water" and the child says "water."

What can be derived from the examples of Skinner's (1957) verbal operants is that the reason or function of a child's vocalization of the word "water" cannot be immediately determined without also examining the context in which the response was evoked. As Skinner states, "in all verbal behavior… there are three important events to be taken into account: a stimulus, a response, and a reinforcement" (p.81). A single verbal operant is only a small piece in the whole of a child's verbal repertoire, the function of which, according to Skinner, cannot be determined without extensive study and manipulation of the stimuli and reinforcements surrounding specific responses. For children with ASD especially, determining the functions of operants within their verbal repertoire may assist parents, teachers, and therapists in educational and intervention planning.

Research assessing the functions of speech in children with ASD and developmental disabilities is emerging in the literature (e.g., Kelley, Shillingsburg, Castro, Addison, & Larue, 2007; Kelley, Shillingsburg, Castro, Addison, LaRue, & Martins, 2007; LaFrance, Wilder, Normand, & Squires, 2009; Lerman et al., 2005; Normand, Severtson, & Beavers, 2008; Schieltz et al., 2010; Shillingsburg, Kelley, Roane, Kisamore, & Brown, 2009). Specifically, Lerman et al. (2005) developed a methodology for systematically manipulating stimuli and consequences to determine what function (i.e., mand, tact, intraverbal, or echoic) an utterance within a child's verbal repertoire is serving. Using behavioral research as a model (Iwata, Dorsey, Slifer, Bauman, & Richman, 1994), Lerman et al. argued that similar functional analysis methodology can be made appropriate for assessing verbal behavior. Replications and modifications to Lerman et al.'s methodology have been completed recently (Kelley, Shillingsburg, Castro, Addison, LaRue, & Martins, 2007; LaFrance et al., 2009) with consistent outcomes resulting in successful identification of the function of verbalizations for the participants. Thus far, researchers have indicated that the results of these functional analyses of verbal behavior can be used to guide treatment; however, little has been done to evaluate these suggestions.

While extensions of the functional analysis of verbal behavior into subsequent intervention has not been completed in the current literature (Plavnick & Normand, 2013), recent research has begun to investigate the importance of linking assessment to intervention for language training and instructional purposes (Bourret, Vollmer, & Rapp, 2004; Kodak, Fisher, Clements, Paden, & Dickes, 2011; Plavnick & Ferreri, 2011). Thus far, results have been promising with participants demonstrating increased levels of correct responding when instruction techniques have been matched to individual assessment results. Continued research exploring the significance of the linkage between functional analysis and language intervention is necessary.

The purposes of the proposed studies was to (a) add to the literature assessing the functions of verbal behavior, specifically with children with ASD, (b) assess whether the function of language used by children with ASD identified through functional analysis of verbal behavior methodology assists in determining the most efficient method for language instruction, and (c) evaluate the sensitivity of Lerman et al.'s functional analysis methodology in measuring the use of language taught using function-specific instruction. Study 1 used Lerman et al.'s methodology as a platform to further evaluate modifications that have been made in recent replications of the functional analysis of verbal behavior. The participants included in this study all carried a diagnosis of ASD as language deficits in this population are more likely to lead to further social and behavioral problems (APA, 2010; Dworzynski et al., 2007; Prizant & Wetherby, 2005). The purpose of Study 1 was not only to extend the literature on the efficacy of this methodology but to determine functions of verbalizations for the participants to guide intervention planning. Study 2 evaluated the results of Study 1 in terms of applicability of determining the function of speech to guide intervention in areas of weakness for individual children. The intervention in study 2 investigated the efficiency of novel word learning when instruction was provided targeting different verbal operants, including non-functional functional operants according to assessment results, which has yet to be investigated in the literature. Another novel element of this study is the second functional analysis of verbal behavior that was conducted at the conclusion of Study 2 evaluating the sensitivity of the methodology to identify newly learned, function specific, vocabulary words.

Together, these studies provide valuable information regarding the process of assessment and intervention of verbal behavior for children with ASD. Specifically, further evaluation of the appropriateness of the functional analysis methodology for use with this population and extension of the results to intervention implementation are documented and explored. The outcomes of these studies have the potential for important implications for parents, teachers, and practitioners regarding verbal language assessment and determination of appropriate instructional interventions for individual children with ASD.

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CHAPTER 2

ASSESSING THE FUNCTIONS OF EMERGING VERBAL BEHAVIOR IN CHILDREN WITH AUTISM SPECTRUM DISORDERS: A PARTIAL REPLICATION

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Abstract

Impairments in communication are core symptoms associated with autism spectrum disorders (ASD). Children with ASD with limited language capabilities are at a higher risk to develop severe social and behavioral problems due to their inability to communicate their needs and desires. Although research on the importance of communication interventions is well documented, assessment of how and why children use verbalizations already established within their repertoire is a newly developing domain in the communication literature. Functional analysis methodology developed by Lerman et al. (2005) has been successfully implemented to determine the function of verbal behavior exhibited by children with ASD and other developmental disabilities. Limitations have been noted regarding the presence of establishing operations during and the clear differentiation between certain experimental conditions. The present study sought out to replicate the findings using Lerman et al.'s methodology with children with ASD while also addressing the limitations through procedural modifications.

INDEX WORDS: Autism Spectrum Disorder, verbal behavior, functional analysis

Introduction

Autism spectrum disorders (ASD) are neurodevelopmental disorders historically characterized by impairments in communication, social interactions, and patterns of behaviors and interests (American Psychiatric Association [APA], 2000). When Leo Kanner (1943) first published his research identifying children with autism, his primary finding was that these children lacked appropriate social awareness and interaction skills. This symptom cluster continues to be the most recognizable (Carter, Davis, Klin, & Volkmar, 2005); however, delays in language development are more often the first reported concerns by parents and caregivers (Chawarska et al., 2007).

With respect to diagnosis, communication and social impairments traditionally have been thought of as separate domains; however, researchers and clinicians have recently found relationships between the two in terms of treatment planning and outcomes (Duffy & Healy, 2011; Dworzynski et al., 2007). This relationship has become solidified in the literature so much so that recent changes have been made to the diagnostic categories for autism spectrum disorder within the Diagnostic and Statistical Manual of Mental Disorders – Fifth Edition (DSM-5) including combining social and language impairments into one criteria (APA, 2013).

Specifically, the APA team charged with developing these changes for DSM-5 made the following adjustments to create a single social communication impairment criterion for diagnosis of autism spectrum disorder. To meet the social communication diagnostic domain criteria, an individual must evince all of the following:

a) Deficits in social-emotional reciprocity,

b) Deficits in nonverbal communicative behaviors used for social interaction, and

c) Deficits in developing, maintain, and understanding relationships (APA, 2013).

Individuals will also receive a severity rating on the above criteria on a 3-level scale; "requiring support," "requiring substantial support", or "requiring very substantial support."

The rationale behind these changes stems from not only the literature but clinical expertise and discussions with experts which resulted in the viewpoint that social and communication deficits "are inseparable and more accurately considered as a single set of symptoms with contextual and environmental specificities" (APA, 2010). Additionally, it was noted that deficiencies in language and communication are not unique or constant within individuals with ASD; however, when present they tend to have an effect on the social abilities of the individual (APA, 2010; Duffy & Healy, 2011; Dworzynski et al., 2007; Prizant & Wetherby, 2005). In other words, functional language deficits have been shown to relate to social functioning deficits in children with ASD (Kjelgaard & Tager-Flusberg, 2001). This relation is further described by Prizant and Wetherby (2005) who discuss overlapping types of communication; social and functional, and their order of priority when planning interventions. Prizant and Wetherby argue that the severity of language deficit impacts the ability of a person to interact socially and develop the appropriate skills to form relationships with others. Lacking in social skills, therefore, limits the individual's ability to learn from peers to increase their social and functional communication skills. According to Prizant and Wetherby, the nature of deficits should be thought of as reciprocal in that a lack of functional language affects social learning which further limits naturalistic opportunities to learn additional functional uses of language. Prizant and Wetherby reference and support recommendations provided by the National Research Council's Committee on Educational Interventions for Children with Autism (NRC, 2001) which suggest that functional spontaneous communication followed by social instruction should be the priority when determining intervention goals for young children with ASD.

Interventions targeting functional spontaneous communication for children with ASD were reviewed by Duffy and Healy (2011). The authors summarized efficacy data for various techniques included in their review and concluded that some children with ASD respond better than others but all have the potential to assist children who lack spontaneous communication. Increasing spontaneous communication may improve development of a child's social communication according to the reciprocal nature of communication proposed by Prizant and Wetherby (2005); however, theory proposed by Skinner (1957) argues that educating a child to use spontaneous language needs to focus on determining the different functions for which language is used and to keep in mind that a single verbalization has the potential to have multiple meanings in a child's verbal repertoire. Specifically, practitioners should be investigating in more detail the "how" and "why" a child uses their communication abilities as opposed to just the "when" and "where".

Skinner's Verbal Behavior

Skinner (1957) defined communication as the use of and relationships between verbal operants. Verbal operants consist of what Skinner called *mands, tacts, intraverbals, echoics, textual*, and *transcription*. For the purposes of this paper only mands, tacts, intraverbals, and echoics will be discussed in detail. Textual, or reading, and transcription, or writing, require more adaptive skills than the other operants and are rarely the target of early communicative interventions for children with ASD. All of these operants make up the tools that an individual uses as pieces of their overall verbal repertoire and represent the different kinds of behaviors that are affected by context. More specifically, depending on the presence or absence of certain stimuli in the environment, topographically similar verbal responses may be different functionally. The use of the different operants is directly impacted by the antecedent and consequent variables that are or have become associated with the expression of a particular verbal response. Thus, a child learns different situations in which a verbalization results in corresponding responses from a listener thereby forming a functional relationship between the use of language and some consequence or reinforcement.

An echoic has a point-to-point correspondence with the controlling verbal stimulus. Skinner (1957) describes the echoic as “the simplest case” (p. 55) in which a verbal operant is under this type of verbal stimulus control. Initial emergence of vocalizations may often serve an echoic function as this is how adults teach infants the names associated with objects; by stating the desired response (i.e., the stimulus) and encouraging a child to repeat it. For example, when a young child reaches for the glass in his parent’s hand, the parent may provide the verbal stimulus, “say ‘water’” which would evoke the response “water” from the child who is then reinforced with social praise for the appropriate verbalization and, perhaps, a drink from the glass of water. “We pick up a large part of our verbal repertoire by echoing the behavior of others under circumstances which eventually control the behavior non-echoically” (Skinner, 1957, p. 62). In other words, we learn a verbalization as an echoic and then generalize or receive instruction to use that same verbalization as another verbal operant.

Mands are used to elicit a response or consequence which results in the speaker acquiring a specific reinforcement from their listening audience. Similar to a command or demand, when the child’s verbalization is maintained by a mand function, the child is using their vocal response to gain access to a desired or needed object or activity. As Skinner (1957) states, a mand is “under the functional control of relevant conditions of deprivation or aversive stimulation” (p. 35) as opposed to simply the stimulus itself. There is an establishing operation (Michael, 1982) associated with some state of deprivation which motivates the child to mand with the goal of bettering their environment. Establishing operations (EOs) are included under the umbrella term of motivating operation (MO), which is a stimulus condition that can have two effects (Laraway, Snycerski, Michael, & Poling, 2003). While an EO increases the reinforcing value of an item and subsequently increases the likelihood of a child engaging in a behavior, an abolishing operation (AO) decreases the reinforcing value of an item and abates the behavior which may have been reinforced in the past. EOs are the MO associated with evoking mands, for example, a child may be participating in a physically taxing activity upon the completion of which he approaches an adult and says, “water.” The verbalization of “water” is most likely associated with the child’s thirst (i.e., the EO) after being active and deprived of water during the activity. “Water” in this situation is serving the function of a mand.

A tact, on the other hand, is directly controlled by the presence of a stimulus and not a verbal stimulus or a child’s state or environment. Skinner (1957) described a tact as “behavior which ‘makes contact with’ the physical world” (p. 81) as the verbalization is evoked due to the presence of an object within a child’s surroundings. The tact has been argued to be the most important verbal operant (Skinner, 1957) as its relationship with a stimulus also allows for the instruction of generalization or discrimination of like and unlike stimuli exemplifying a given verbalization to continue expanding a child’s vocabulary. An example of a verbalization serving the function of a tact is if on vacation a child sees the ocean and exclaims, “water” thereby labeling what is present in his immediate environment. Examples of using the ability to tact to teach generalization is an adult labeling rain, water in a dog bowl, and water coming out of a hose as “water,” whereas, teaching discrimination might include examples of juice, paint in a clear cup, or a bowl of soup all being “non-water.”

Intraverbal operants are verbal responses to verbal stimuli that “show no point-to-point correspondence” (Skinner, 1957, p. 71). Unlike mands or tacts, where the antecedent to a verbalization is either the desire for a specific reinforcement or the presence of a stimuli, the antecedent to an intraverbal is a verbal stimuli. Therefore, the entire interaction is a verbal stimulus which evokes a verbal response which is then most likely followed by verbal reinforcement. Skinner describes intraverbals as chains of responses or word associations. A common illustration of this is the reciting of the alphabet, where the verbal stimulus of “A, B, C” evokes the response “D, E, F,…”. What makes teaching intraverbals difficult is the possibility of many “correct” verbalizations associated with a particular phrase. For example, if a child is able to verbalize “water,” corresponding phrases that could be taught include, “a swimming pool is filled with ____” or “when you’re thirsty you drink _____”. However, the latter phrase could also correspond with responses, such as “milk” or “juice”, so depending on a child’s vocabulary or verbal repertoire; intraverbal instruction may be a large undertaking to ensure adequate stimuli and response options or exemplars.

What can be concluded from the examples of Skinner’s (1957) verbal operants described above is that the reason for or function of a child’s vocalization of the word “water” cannot be immediately determined without also examining the context in which the response was evoked. Context, in this instance, includes taking into account “three important events…: a stimulus, a response, and a reinforcement” (p. 81). Additionally, it is important to consider the possible role of development in the progression through the hierarchy of verbal operants as defined by Skinner. Based on these definitions, language progression is likely to follow the pattern of verbalizations first functioning as echoics, then mands, tacts, and intraverbals because of the antecedent and consequent variables associated with each (Conti-Ramsden & Durkin, 2012;

Lerman et al., 2005; Sidener et al., 2010). It has been documented that children with ASD will generally traverse developmental sequences, including language based progression, in a similar order as their typically developing peers at an early age but potentially at a slower rate (Burack & Volkmar, 1992; Sigman & Ungerer, 1984). As stated above, a single verbal operant is only a small piece of a child's communication and verbal behavior, the function of which cannot be determined without extensive study and manipulation of the stimuli and reinforcements surrounding specific responses.

Using Functional Analysis Methodology to Identify the Function of Verbal Behavior

Methods for teaching verbal and communicative behavior to children with ASD and developmental disabilities have been well documented in the literature (Ault, Gast, & Wolery, 1988; Duffy & Healy, 2011; Goldsmith, LeBlanc, & Sautter, 2007; Lovaas, 1987); however, recent research has begun investigating the importance of determining the functional use of language in developmentally delayed populations. Guided by the experimental analysis methodology developed by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994), Lerman et al. (2005) developed a similar methodology for assessing the functions of emerging vocal communication in children with developmental disabilities. The authors evaluated their methodology with four children with developmental disabilities (diagnoses included autism, cerebral palsy, visual impairment, moderate to severe intellectual disability, and severe developmental disability) who exhibited little to no functional communication but demonstrated frequent use of one or more vocal responses. Target responses were defined as serving the function of mand, tact, intraverbal, or echoic according to the verbal operant descriptions of Skinner (1957). A sequential multielement design using four test conditions, mand, tact, intraverbal, and echoic, and four control conditions, mand, tact, intraverbal, and echoic, across participants and responses was implemented. The authors measured frequency of responses during 10-min sessions for all conditions. Target responses were identified for each participant based on parent and teacher input and the identification of objects representing the target food or item to be used during sessions.

Original functional analysis of verbal behavior methodology. Lerman et al.'s (2005) original methodology assessing the functions of verbal behavior manipulated several antecedent and consequent variables associated with the target item/verbalization. To assess if the vocalization served a mand function, a participant was restricted from accessing the target object for 60 min prior to the session. Commencing each session, the therapist sat in close proximity to the participant, presented the object, and then placed it in a bag out of the participant's reach. If the participant vocalized the target response, the object was given to the child for 20 s before being returned to the bag, or in the case of edible items, removed from the participant's view. If the target response was not emitted within 20 s of the object being removed, the therapist provided the verbal prompt, "What do you want?" If the target response was not emitted after 1 min, the therapist removed the object from the bag briefly. During the mand control sessions, the participant was given access to the object for 60 min prior to the session and continued to have access to the object during the entire 10 min session. The therapist was seated across the room from the participant and did not provide consequences for any vocal responses.

During tact test sessions, the participant was allowed to interact with the object for 60 min leading up to the session and had continuous access during the session. The therapist was seated near the participant and provided brief verbal praise each time the target response was vocalized. If the participant did not emit a response after 20s, the therapist provided the verbal prompt, "What is that?" Similar to tact test sessions, the participant was given access to the object for 60 min prior to tact control sessions as well. During the session the object was removed from the room and the therapist, seated across the room, did not provide any consequences for verbalizations.

The intraverbal test condition began with the participant accessing the object for 60 min prior to the session. During the session, the object was not present and the therapist was seated next to the participant. The authors predetermined four or five fill-in-the-blank statements that targeted but did not contain the relevant response and the therapist delivered a statement every 20 s, providing brief verbal praise for correct vocalizations. Intraverbal control sessions were identical to test sessions, except that the statements being delivered were not relevant to the target response and consequences were not provided for any vocalizations.

Echoic test and control conditions were only evaluated if no clear mand, tact, or intraverbal function was identified. For both echoic test and control conditions the participant was provided access to the object for 60 min preceding the removal of the object for the sessions. During the echoic test condition the therapist was positioned near the participants and vocalized the target response every 20 s. If the participant repeated the target response, the therapist provided brief verbal praise. During the echoic control sessions the participant was positioned across the room, did not interact with the child, and did not provide consequences for verbalizations.

For each participant, the authors identified at least one function per target response (Lerman et al., 2005). The authors concluded that this methodology of experimental analysis is useful for identifying the functions of verbalizations emitted by children with developmental disabilities. They also discuss the importance these findings have in terms of guiding language intervention and training. For example, the participants whose vocalizations were identified as serving a mand function would benefit from language training targeting tacting and intraverbal skills.

Replications and extensions of the functional analysis of verbal behavior. A systematic replication of Lerman et al. (2005) was completed by Kelley et al. (2007) with a similar population of children. Four male participants with diagnoses including autism, spina bifida, seizure disorder, general language delay, and apraxia were included in the investigation. Conditions were similar to those described in Lerman et al. with the following modifications, which were suggested to be more clinically practical especially in regards to the duration of time required to complete the assessment. First, test condition session length was changed to 10 trials instead of 10 min, thus, response measurement was percentage of trials with correct responding as opposed to frequency of responses per minute. This modification also allowed the assessment to more closely resemble the type of instruction the participants had been previously exposed to in their respective instructional settings. Control session length was yoked accordingly to the corresponding test session. Second, authors conducted two test sessions for each control session. Third, periods of access to or restriction from the target object were decreased from 60 min to 5 min. Results for the four participants were as follows. Both responses for one participant did not appear to serve a mand, tact, or intraverbal function; however, he did engage in moderate levels of responding during the echoic test condition for both. The second participant had zero level responding across conditions for one response but high levels of responding for the second target supporting a tact function. For the third participant, the authors identified one response that served a tact function and one that served an echoic function. Finally, the fourth participant demonstrated three of four target responses serving clear mand and tact functions, whereas the fourth target response was less clear. This participant did not exhibit any responding during intraverbal conditions. Generally speaking, the results of Kelley et al.'s modified replication of Lerman et al.'s methodology supports the use of this technique in identifying the function of the verbal behavior of children with developmental disabilities. Additionally, Kelley et al.'s findings were similar to the findings of Lerman et al. with at least one clear function being identified for at least one target vocalization for each participant.

A second systematic replication of Lerman et al. (2005) was conducted by LaFrance, Wilder, Normand, and Squires (2009) with another group of children with developmental disabilities (diagnoses included pervasive developmental disorder not otherwise specified, microcephaly, epilepsy, global developmental delay, low facial muscle tone, autism, and congenital myopathy). LaFrance et al. maintained Lerman et al.'s original design elements including 60 min exposure to or restriction from the target object and 10 min session length. Sessions were divided into 20 s intervals and frequency of target vocalizations per interval was recorded. Methodology was identical to Lerman et al. with the exception of a minor modification to the mand test condition for two of the three participants. Concern regarding the presence of adequate stimulus control between the mand test and control sessions prompted the researchers to place the target item in sight but out of reach for these two participants, as opposed to keeping it in a bag, to strengthen the experimental control of the condition and to ensure the control of the appropriate variable (i.e., the target item).

LaFrance et al. (2009) conducted a second experiment with the same participants modifying design and condition procedures in an attempt to limit potential confounds of both. New target responses were identified for each participant and session length was shortened to 5 min. The design modification included the conditions being implemented in a multielement design versus a sequential alternation between test and control conditions, congruent with functional analysis procedures identified by Iwata et al. (1994). Procedural modifications were made to all conditions except echoic test and control sessions. For mand and tact test sessions, LaFrance et al. decreased the frequency with which the therapist was providing verbal prompts (i.e., “What do you want?” or “What is it?”, respectively). During mand test sessions the therapist no longer provided a verbal prompt, instead the participant was shown the item on a 60 s fixed interval schedule if target vocalizations did not occur. For tact sessions the therapist provided a non-verbal prompt (e.g., pointing or picking up the object) every 20 s and the verbal prompt of “What’s this?” every 60 s after a correct verbalization. Due to the inability to control for all possible responses to target intraverbal statements and that identifying all vocalizations that may be appropriately controlled by the stimulus statement would be a vast undertaking, the authors removed the intraverbal test and control conditions from this experiment. Referring to traditional functional analysis (Iwata et al., 1994) as well as the literature on repetitive and stereotypical behavior often exhibited by children with autism and developmental disabilities, the authors added a new condition referred to as the automatic test condition. In this condition, the participant was given access to the target object for 60 min preceding the session before all materials were removed from the room and the participant was left alone for the entirety of the session. Frequency of target vocalizations per 20 s interval was coded via videotape.

Results of LaFrance et al.’s second experiment are as follows. The first participant exhibited high and stable rates of responding during the tact and echoic test sessions, low and stable responding during the mand test sessions and near zero levels rates of responding during the automatic test sessions. The second participant showed similar patterns of responding with the highest frequency of responding during the echoic condition, followed by relatively high levels of vocalizations during tact test sessions, low levels during mand test sessions, and no vocalizations during automatic test sessions. The third participant also demonstrated the highest responding during the echoic session with slightly lower responding during the tact test sessions. Similar to the first experiment conducted by these authors, a modification was made to the mand test conditions to assess the stimulus control of the target object for this participant. When the item was placed in the participant's sight but out of reach the participant did not respond; however, when also provided with a verbal prompt the level of responding did increase. The authors suggested that the requirement of a verbal prompt to elicit responding during these sessions may support tact functioning more so than mand functioning for this participant.

Limitations and future directions of the functional analysis of verbal behavior. Findings from these three studies (Kelley et al., 2007; LaFrance et al., 2009; Lerman et al., 2005) represent relatively stable and significant findings (i.e., at least one function was identified for at least one verbalization for all participants) setting the basis for further research in the area of functional analysis of verbal behavior for children with developmental disabilities. Future systematic replications of the methodology of Lerman et al. should continue to elaborate on findings of Kelley et al. and LaFrance et al. in terms of modifications that may be implemented for procedural ease or participant differences. Specifically noted as a concern and area for future research involves the required modifications during the mand condition in LaFrance et al. The change of placing the object in sight of the participant reflects a potentially more realistic reflection of manding behavior as requests for objects in the everyday environment often result from the item being present in the child's environment. Skinner (1957) indicated that a mand is most often associated with a state of deprivation or a primary need, therefore, if the target response/item is an edible then its visual presence may not impact a child's increased responding like it would the presence of a toy that fulfills a secondary need of pleasure or enjoyment.

Skinner's definition of a mand relates to potential limitations in the three investigations discussed above and questions whether a strong EO (Michael, 1982) (i.e., thirst or hunger) was present during the mand sessions across all three implementations. As LaFrance et al. point out, the periods of restriction from or access to the target object prior to the different sessions was used to induce a state of deprivation or satiation for the object; however, this was simply a theoretical assumption and not a proven antecedent variable. Attempts to strengthen the manipulation and presence of an EO will be made in the current study.

With the documented limitations within Lerman et al.'s (2005) methodology, particularly regarding the presence of MOs even with the modifications described above, further investigation and modification of determining the function of verbal behavior using this technique is needed. In terms of clinically relevant populations to study, there is evidence in the literature that the social deficits present in the majority of children with autism are the most recognizable (Carter et al., 2005); however, the impact poor functional communication skills have on social communication development is also well documented (APA, 2010; Dworzynski et al., 2007; Prizant & Wetherby, 2005). Thus far, the three research groups who have studied the functions of verbal behavior of children with developmental disabilities, including ASD, have suggested that the findings would be useful to guide treatment planning and intervention but no such studies have been conducted.

The present study included only children with ASD to allow for the investigation of this methodology in assessing functional communication abilities within a population more likely to also demonstrate social communication difficulties according to research. Identifying the uses of functional communication for children with ASD is hypothesized to assist parents, teachers and therapists in educational and intervention planning across symptom areas. Additionally, determining how best to intervene at a functional communication level may support more successful social communication interventions (NRC, 2001; Prizant & Wetherby, 2005).

Purpose of the Current Study

Research in the area of functional analysis of verbal behavior is promising (Kelley et al., 2007; LaFrance et al., 2009; Lerman et al., 2005; Normand, Severtson, & Beavers, 2008; Plavnick & Normand, 2013); however, only a small number of participants with ASD have been studied. Children with ASD exhibit a wide range of symptom severity in terms of communication abilities and repetitive and stereotypical patterns of behaviors, with specific links being established between deficits in language and the resulting negative impact on social development (Prizant & Wetherby, 2005). Therefore, the current study sought to replicate the findings of identifying the function of verbalizations for children with ASD to support an investigation of the applicability of using functional analysis data to guide functional communication intervention. Specifically, the current study extends the literature on functional analysis of verbal behavior by systematically replicating the methodology originally described by Lerman et al. including modifications implemented by Kelley et al. (2007) and LaFrance et al. (2009), as well as modifications addressing identified limitations, and applying it to a group of children with ASD exhibiting emergent language skills.

Methods

Participants and Setting

Three children participated in the current study. Two of the children were African-American, fraternal twins aged 3 years, 11 months at the commencement of the study. The third participant was a Caucasian-Hispanic female aged 3 years, 6 months. All three children carried a diagnosis of ASD and were evaluated and diagnosed by a clinic specializing in assessment of

ASD in Baltimore, Maryland. Specifically, twins Selena and Edward carried diagnoses of autistic disorder and Pervasive Developmental Disorder – Not Otherwise Specified, respectively. Jessica was diagnosed with autistic disorder. Parent report indicated that all three children engaged in little spontaneous, functional language but were observed to frequently verbalize at least two words regularly in their natural environment without a consistent reason according to parents (e.g., presence of item, requesting item, echoing prompt). In other words, while parents reported varying degrees of single words and multiple word utterances having been emitted by the participants, criteria for inclusion was based on at least two single words being emitted consistently at a high frequency as opposed to having been observed on few or rare occasions. For example, Selena's parents reported that she frequently emitted the words "popcorn" and "cup" and would sometimes state part of the alphabet or a line from a song heard on television but rarely with the same consistency. Selena and Edward attended a half day preschool program and received multiple outside services, including speech and occupational therapy. Jessica attended a half day preschool program but did not receive additional outside services. All sessions were conducted in the children's homes. Participant demographic information, including scores for measures described below, are presented in Table 2.1.

Of note is the potential limitation of Selena and Edward being twins and therefore accessing highly similar learning and reinforcement environments. Although Selena and Edward demonstrate different cognitive and language abilities (Table 2.1) and have different target words, it cannot be overlooked that environment or caregiver characteristics may have influenced both of these participants.

Measures

Autism spectrum disorder diagnosis. Caregivers provided the diagnostic reports for the researcher to review. Assessments for all three participants were conducted within 12 months of their enrollment in the study. Review of the reports indicated that the participants met ASD diagnostic cut-off scores on the Autism Diagnostic Observation Schedule (ADOS) – Module 1 (Lord et al., 2000).

Cognitive functioning. The Kaufman Assessment Battery for Children – Second Edition (KABC-II) Nonverbal Index (NVI; Kaufman & Kaufman, 2004) was administered to participants to gain more information on their overall cognitive functioning and to allow for more detailed description of their abilities for comparison with populations in future replications of this methodology. Research has shown that children with ASD who demonstrate cognitive functioning above a standard score of 50, and are considered high-functioning; tend to develop in a similar sequence as their non-ASD peers with similar cognitive abilities (Burack & Volkmar, 1992). Children with ASD whose cognitive abilities fall below a standard score of 50 tend to not only deviate from a more typical trajectory of development but are more likely to demonstrate a regression in skills across developmental domains; particularly in language development (Burack & Volkmar,1992; Wenar, Ruttenberg, Kalish-Weiss, & Wolf, 1986). Assessment of participants' cognitive functioning allowed for the hypothesis of whether a typical sequence of development could be expected in terms of the mastery of verbal operants as discussed by Bijou and Baer (1965). Selena earned a standard score of 64 (1st percentile) on the KABC-II NVI, whereas Edward earned a standard score of 78 (7th percentile). Jessica's administration of the KABC-II NVI resulted in a standard score of 75 (5th percentile). Based on these scores and results of previously discussed research it is hypothesized that the participants will demonstrate mastery of verbal operants in a similar sequence as expected for their typically developing peers (i.e., echoic, mand, tact).

Expressive and receptive vocabulary. The Expressive Vocabulary Test – Second Edition (EVT-2; Williams, 2007) and Peabody Picture Vocabulary Test – Fourth Edition (PPVT-4; Dunn & Dunn, 2007) were administered to quantify parent report of the participant's expressive and receptive language. Selena earned standard scores of 74 (4th percentile) and 64 (1st percentile) on the EVT-2 and PPVT-4, respectively. Edward performed significantly higher than his sister earning an EVT-2 standard score of 90 (25th percentile) and a PPVT-4 standard score of 91 (27th percentile). Jessica earned a standard score of 89 (23rd percentile) on both the EVT-2 and the PPVT-4. Standard scores for Edward and Jessica suggest Low Average range functioning in expressive and receptive communication abilities. Review of results with caregivers suggested that many of the children's responses had not been spontaneously observed by parents. Inclusion criteria for the current study were based on parent report of participants' limited spontaneous vocabulary (i.e., observation of spontaneous emissions of 15-20 words or less heard more than once).

Functional communication. Caregivers completed the Communication Index of the Vineland Adaptive Behavior Scales – Second Edition (Vineland-II; Sparrow, Cicchetti, & Balla, 2005) interview form with the researcher. Overall Communication Domain scores for all three participants fell within the Moderately Low range. Selena and Edward both earned receptive language scores in the Moderately Low range, expressive language scores in the Low range, and written language scores in the Adequate range. Jessica scores for expressive and written language both fell in the Moderately Low range, whereas her receptive language score fell in the Adequate range according to parent report.

Response Selection

Target responses for each participant were based on parent report of distinguishable verbalizations frequently heard in the child's natural environment. Two responses were selected for each participant; "popcorn" and "cup" for Selena, "grapes" and "car" for Edward, and "toast" and "bubbles" for Jessica.

Experimental Design

A multielement design with sequential alternation of each test condition being repeatedly alternated with a control condition, as conducted in Lerman et al. (2005), was used to measure the frequency of target vocalizations across three phases, i.e., mand, tact, and echoic. A fourth phase was utilized to assess for an automatic function as conducted by LaFrance et al. (2009). All recording sessions were 5 min in duration, with additional 5 min segments occurring before each session as described below. Sessions were divided into 20 s intervals with the frequency of target vocalizations per interval being recorded. In an attempt to limit possible sequencing effects and based on the hypothesized progression of language development through the verbal operants, (i.e., echoics, mands, tacts; Burack & Volkmar, 1992; Conti-Ramsden & Durkin, 2012; Lerman et al., 2005; Sidener et al., 2010); conditions were administered in the reverse order for each participant. In other words, if a participant's target verbalization served only an echoic function, receiving reinforcement during echoic test sessions prior to mand or tact conditions could increase the likelihood of the participant emitting the target verbalization in subsequent test sessions for the other operants due to learning during the echoic test sessions. Conversely, if a target verbalization serves only an echoic function, it is unlikely that the participant would emit the verbalization during tact or mand test sessions completed prior to echoic test sessions according to hypotheses about the progression of language development.

Procedures

As stated above the following conditions were manipulated and measured (a) tact test, (b) tact control, (c) mand test), (d) mand control, (e) echoic test, (f) echoic control, and (g) automatic test. Procedures were identical to those used in Lerman et al. (2005) unless otherwise identified as a modification. For all conditions, non-targeted verbalizations and other behaviors were ignored except to maintain the participant's safety and presence in the room (e.g., physically blocking participant from going up stairs or touching the video camera).

Tact test session. Sessions were conducted after the participant had free access to the item for 5 min. The participant was provided with continued access to the item during the session. The author provided the verbal prompt, "What's this?" every 20 s. Brief verbal praise (e.g., "good talking" or "nice job") was provided after every correct verbalization. The provision of non-specific verbal praise assumes that this type of reinforcement is motivating to the participant which may confound responding if it is unclear whether praise, as opposed to access to another preferred item, is highly reinforcing.

Tact control session. Tact control sessions began after the participant had interacted with the item for 5 min. The item was then removed from the room and the author sat away from the participant. No consequences were provided for target responses.

Motivating operation assessment. A motivating operation assessment (MOA) was conducted prior to each mand test session. As stated earlier, a MO alters the reinforcing value of a particular item depending on a state of deprivation (EO) or satiation (AO) and subsequently alters its effectiveness as reinforcement for a particular behavior. A mand is verbalized when there is some need for the item or object being requested and therefore, occurs when an EO is present. Therefore, if an EO is present for a particular object and the individual understands and is capable of requesting the object, the likelihood that they will mand for it is increased compared to a situation where there is no EO for the object. In the original functional analysis of verbal behavior (Lerman et al., 2005) it was presumed that restricting access from the target object for a period of time established an EO for the object based on principles described in Skinner's theory; however, it is not clear whether an EO for the target object controlled the child's response. The following modification was added to the procedures of the mand test condition.

Prior to beginning the MOA, participants were restricted from accessing the target item for 5 min (Kelley et al., 2007). Upon commencing the MOA, the author placed the target item and a parent-reported preferred distractor item of the same class (e.g., edible distractor when target item was another edible) on the table in front of the participant. If the participant reached for the distractor item, the target item was removed from the table and the participant was given 1 min to interact with the distractor item. After 1 min, the item was removed and the target item was replaced on the table with a different distractor item of the same class. If the participant again reached for the distractor item, the same procedure was repeated for a total of five distractor items after which time it was determined that an EO for the target item was not present and the mand test session was not conducted. If on any paired choice presentation the participant reached for the target item, the distractor item was removed from view while the participant engaged with the target item for 10 s. The author then removed the target item and began the mand test session.

Mand test session. Once it was determined that an EO was present the investigator showed the participant the item for 5 s before placing the item out of the participant's view. If the target vocalization was emitted, the author allowed 20 s of access to the item, or a small piece of the edible item to consume. If the target response was not emitted after 60 s, the author represented the item to the participant for 5 s before again removing it from their view. A verbal prompt was not paired with the representation of the item, similar to the modification proposed in LaFrance et al. (2009). The goal of this modification was to provide a clear differentiation between the mand test sessions and the tact test sessions where a verbal prompt (“What is it?”) was used.

Mand control session. The participant did not have access to the item for 5 min leading up to the beginning of the mand control session. The author was seated away from the participant for the duration of the session. The participant had free access to the item and did not receive any consequences for any verbalizations.

Echoic test session. Prior to the echoic test sessions the participant had access to the item for 5 min. During the session the item was removed from the room and the author was seated next to the participant. The author provided the target verbalization (e.g., “cup”) every 20 s and provided brief verbal praise (e.g., “good talking” or “nice job”) if the participant correctly repeated the verbalization within 5 s (Kelley et al., 2007).

For one participant, data were recoded to account for the total frequency of target verbalizations and target verbalizations emitted within 5 s of the author’s verbal prompt. This was completed after it was observed that Edward seemingly engaged in frequent repetitions of the target word while watching the author tally the verbalizations on the data sheet. According to the definition typically used in the literature (Kelley et al., 2007; Kodak & Clements, 2009; Stock, Schulze, & Mirenda, 2008) a verbalization should only be considered an echoic if emitted within 5 s of the verbal prompt. Additionally, verbalizations emitted after 5 s of the verbal prompt did not receive verbal praise from the author.

Echoic control session. Echoic control sessions were identical to echoic test sessions except the author was seated away from the participant and did not provide the target response or any consequences for verbalizations.

Automatic test session. As described in LaFrance et al. (2009), the automatic test sessions were implemented to assess whether the function of a participant's behavior is self-stimulatory which is common for many repetitive, stereotypical behaviors displayed by children with ASD (APA, 2000). Prior to the automatic test sessions, the participant had access to the item for 5 min before all materials were removed from the session room. The participant was alone for the duration of the session and verbalizations were recorded via videotape.

Measurement and Reliability

Interrater reliability. All sessions were 5 min in duration and were conducted by the primary author; sessions were videotaped to allow for independent observation and scoring of the participant's verbalizations. Frequency of target verbalizations was recorded during 20 s intervals by the primary author. Reliability was calculated by dividing the number of agreement intervals (i.e., same frequency of responses during a 20 s period) by the total of 15 possible 20 s intervals and multiplying by 100%. Reliability was collected during 38.5% of sessions for Selena (37.9% for "popcorn" and 39.1% for "cup"), 40.7% of sessions for Edward (40.7% for both "grapes" and "car"), and 34.7% of sessions for Jessica (36.0% for "toast" and 33.3% for "bubbles"). For Selena's target words of "popcorn" and "cup," average reliability across sessions was 99.4% (range = 93.3-100%) and 91.3% (range = 66.7-100%), respectively. Average reliability across Edward's sessions for "grapes" and "car" was 97.7% (range = 86.7-100%) and 95.0% (range = 66.7-100%), respectively. For Jessica's target words of "toast" and "bubbles," average reliability across conditions was 99.4% (range = 93.3-100%) and 97.5%

(range = 86.7-100%), respectively. Reliability data for all sessions are presented in Tables 2.2-2.4.

Procedural integrity. Session videotapes were also used to assess procedural integrity of the implementation of condition protocols according to the descriptions presented above. Procedural integrity was collected by recording correct presence or removal of the target item depending on the condition, correct provision of verbal prompts (tact test and echoic test sessions) or representation of the item (mand test sessions), correct provision of reinforcement for target verbalizations (e.g., target item during mand test sessions, verbal praise during tact test sessions), and correct ignoring of target verbalizations during all control sessions. Therefore, opportunities for correct implementation of procedures varied between sessions. For example, if a participant emitted the target verbalization 14 times during a tact test session there would be 30 procedural steps (1 for the item being present, 15 verbal prompts, and 14 verbal praise statements), whereas, if a participant emitted the target verbalization 1 time there would be 17 procedural steps (1 for the item being present, 15 verbal prompts, and 1 verbal praise statement). Percentages of sessions coded for procedural integrity were identical to interrater reliability percentages. Average procedural integrity for Selena's target words "popcorn" and "cup" were 100% and 98% (range = 87.9-100%), respectively. For Edward's target words "grapes" and "car," average procedural integrity across conditions was 99.7% (range = 96.7-100%) and 98.2% (range = 83.3-100%), respectively. Coding of procedural integrity for Jessica's target words of "toast" and "bubbles" resulted in 100% integrity across all conditions. Procedural integrity results are presented in Tables 2.2-2.4.

Results

Graphic displays of the data for all three participants are presented in Figures 2.1-2.3 and descriptive statistics in Tables 2.5-2.7. Frequencies of responses during test and control conditions were compared for each phase of the assessment. Specifically, frequency of responding during test sessions for a particular operant was compared to frequency of responding during the yoked control sessions (i.e., tact test sessions compared to tact control sessions). According to Lerman et al.'s (2005) original investigation, "a function was identified if responding was consistently higher in a test condition than in its corresponding control condition" (p. 307); a similar interpretation rule was implemented with the current study. Although standard methods of functional analysis interpretation have been developed (Hagopian et al., 1997), interpretation of the functional analysis of verbal behavior has not placed a significant importance on the stability or trend of data to necessarily guide phase changes or assessment adjustments thus far (Lerman et al., 2005). Variability was noted within several conditions for the current participants and was addressed through extended sessions similar to Lerman et al. (2005); however, as stated above, extension until data were stable was not a priority for the assessment as it would be for an investigation of intervention effects using a similar research design. For the current study, consistently higher frequency of responding was assessed through visual inspection and comparing mean frequencies of responding between test and comparable control conditions. In regards to the latter criteria, the mean frequency for an operants test sessions was considered to be 100% and if the mean frequency of the comparable control sessions exceeded 20% of the test sessions mean frequency it was determined that the verbalization was not serving a function as that operant. Twenty percent was selected as the criterion as there are theoretically 15 opportunities to respond to prompts (verbal or representation of item) during tact, echoic, and mand test sessions, respectively, and the assessment goal was to complete three sessions each of test and comparable control sessions for each condition which would allow for 3 verbalizations per control condition due to carryover or a lack of discrimination between conditions. For example, if a participant responded to each prompt made during a tact test session across 3 sessions the mean frequency would be 15. If during 2 of the 3 tact control sessions the participant emitted the verbalization 3 times, the control mean frequency would be 2 which is 13.3% compared to the test mean frequency and would meet the criteria of being maintained by a tact function. If the participant emitted 4 target verbalizations during the 3 tact control sessions, the mean frequency would be 4 and is 26.7% compared to the test session mean frequency and would not meet the criteria of serving a tact function. However, significantly low rates of responding during test sessions (e.g., mean frequency of less than 1 verbalization) and visual analysis of the variability of the data was also considered when making final considerations of the functions being served and is discussed in detail for each participant.

Selena

Assessment results for Selena were variable (Figure 2.1 and Table 2.5). The target vocalization, “popcorn,” was recorded at high levels during tact test sessions (*M* = 11 responses) and during mand test sessions (*M* = 11.5 responses) with lower levels of responding during their comparable control conditions (*Ms* = 2.0 and 0.0 responses, respectively) which fall below the 20% criterion. This indicates a clear tact and mand function for the word “popcorn.” Some variability in occurrence during the echoic and automatic test sessions, as well as several control sessions, was noted. Specifically, Selena would often mand for “popcorn please” even after having noncontingent access to popcorn for 5 min prior to echoic control or automatic test sessions. It is possible that a carryover effect took place transitioning from the mand to echoic phase of the assessment as Selena's high frequency of responding during an echoic control session occurred immediately after the change from the mand sessions. Echoic control session frequencies decreased to consistent zero levels afterwards. This could also suggest that an EO for popcorn was higher during some non-mand test sessions which resulted in Selena making the target verbalization during these sessions without an association to the antecedent or consequent variables present in that session (e.g., model prompt of "popcorn" and verbal praise). The mean frequency of echoic control sessions surpassed the 20% criterion (69.7%); however, based on the pattern of responding described above and visually presented in Figure 2.1 with all control session verbalizations occurring in one session immediately after the transition from the mand condition, it is likely that "popcorn" is serving an echoic function, as well as tact and mand functions.

For "cup," Selena's frequency of responding was consistently high during tact test sessions and significantly lower during mand and echoic test sessions (*M*s = 12.5, 2.3, and 3 responses per session, respectively). Her responding during the comparable control sessions were near zero for all phases with all control mean frequencies falling below the 20% criterion. Responding during the automatic test sessions was consistently zero. This suggests that the verbalization "cup" was multiply maintained as well and served tact, mand, and echoic functions.

Selena's data also reflect what appears to be a brief extinction burst during the first tact control session for both target words. Specifically, for "popcorn" 6 target verbalizations were emitted within the first minute of the session with no additional verbalizations being emitted during the remaining 4 minutes of the session. Likewise, for "cup" Selena engaged in the target verbalization 4 times in the first minute of the first tact control session then did not emit the verbalization for the remainder of the session.

Edward

Edward’s target verbalizations of “grapes” and “car” reflected significant variability in responding (Figure 2.2 and Table 2.6). For "grapes,” Edward engaged in consistently high levels of responding during tact and mand test sessions (*Ms* = 15.0 and 9.3 responses, respectively). During echoic test sessions, Edward’s frequency of responding ranged from 1 to 22 total responses during the 5 min sessions, or 1 to 10 responses recorded within 5 s of the author’s verbal prompt (which received verbal praise from the author; Stock, Schulze, & Mirenda, 2008). The data were recoded for Edward as he was observed to engage in repetitions of the target word after 5 s of the verbal prompt and without receiving verbal praise from the author to reflect verbalizations which more accurately fit the definition of an echoic provided in the literature (Kelley et al., 2007; Kodak & Clements, 2009). The adjusted mean frequency of responding during the echoic test sessions resulted in moderate levels of responding. Edward did not emit the target verbalization in any control sessions or in the automatic test sessions, suggesting that “grapes” serves multiple functions; tact, mand, and echoic, in his verbal repertoire.

Edward’s second target, “car,” occurred in a somewhat similar pattern as “grapes.” Specifically, the response was recorded at consistent high levels during tact test sessions, lower consistent levels during mand test sessions, and significantly variable rates during echoic test sessions. During mand test sessions, Edward only emitted the target verbalization when the author briefly represented the car after 60 s had elapsed without the target word being emitted. This would suggest that “car” serves a tact function more so than a mand as the item was always present when the target response occurred. However, during the echoic test sessions, it appeared as though the verbalization "car" was serving a mand, as well as an echoic function. Responding during the echoic test sessions ranged from 10 to 103 total verbalizations during the 5 min sessions or 8 to 29 verbalizations within 5 s after the author's verbal prompt (data were recoded as with the target word "grapes"). Verbalizations often included phrases like, "car please," which suggested that Edward was requesting the car (mand) while also repeating the target word within 5 s of the author's prompt (echoic). Edward also emitted an acceptable target verbalization of "car please" during two of the six echoic control sessions that were conducted. Control mean frequencies for all conditions were below the 20% criterion. No target verbalizations were recorded during the automatic test sessions. Therefore, the target word "car" was also multiply maintained, serving tact, mand, and echoic functions.

Jessica

Jessica's assessment results also reflected multiple functions for both target verbalizations (Figure 2.3 and Table 2.7). For "toast," target responses occurred at a consistently high level for tact test sessions and echoic test sessions (*Ms* = 10.3 and 8.7 responses, respectively). During the first mand test session, Jessica emitted the target verbalization 6 times; however, for the 4 subsequent mand test sessions she did not mand for toast more than 1 time per session. No target verbalizations were recorded during any control sessions or during the automatic test sessions suggesting that "toast" serves tact, mand, and echoic functions.

A similar pattern of responding was observed during the assessment of "bubbles" with high levels of responding during tact and echoic test sessions and near zero levels of responding during mand test sessions. One target response was recorded during a mand test session; however, it was after the author represented the bubbles and Jessica did not engage with them during the 20 s access she was provided for emitting the target verbalization. No target verbalizations were recorded during tact, mand, and echoic control sessions or during automatic test sessions. This suggests that "bubbles" serves tact and echoic functions in Jessica's verbal repertoire.

Motivating Operation Assessment Results

Completion of the motivating operation assessment (MOA) prior to each mand test sessions was a novel modification to the functional analysis of verbal behavior assessment methodology. Contrary to previously published replications of this methodology, the results of the MOA suggested that brief periods of deprivation from a specific item do not consistently create an EO (Michael, 1982) for that item. Specifically, for Selena 1 of 4 mand test sessions for "popcorn" and 2 of 3 mand test sessions for "cup" required 2 or more MOAs to be conducted before an EO for the target item was identified by her selecting it during one of five paired choice presentations. The results of Jessica's MOA data for "toast" showed that multiple MOAs were completed prior to 2 of the 5 completed mand test sessions, including 9 MOA sessions before an EO for "toast" was identified during session 9. For her second target verbalization, "bubbles," 4 MOAs were required before an EO was established during 2 of 3 mand test sessions. A maximum of three MOAs were conducted for a target item per day. Edward displayed a high EO for both items, selecting the target item on the first paired choice trial during the first MOA prior to each mand test session for both "grapes" and "car." Data are displayed in Table 2.8.

Discussion

Results of the current study support previous findings of the functional analysis of verbal behavior assessment methodology developed by Lerman et al. (2005) to successfully identify at least one function for words in the verbal repertoires of children with ASD. That is, manipulating antecedent and consequent variables across four phases of possible verbal operants resulted in all three participants demonstrating differentiated patterns of responding between test and comparable control conditions to reflect functions identified by Skinner (1957). Differing from the results of Lerman et al., all three participants demonstrated multiply maintained functions for the three operants assessed (tact, mand, and echoic) for at least one target verbalization which suggests that this methodology may not be appropriate to assess the function of verbalizations for children who exhibit this level of cognitive and/or language skills. Historically, research has suggested that children with ASD who demonstrate high functioning cognitive abilities (i.e., standard score > 50), as the current participants all did develop on a similar sequential hierarchy as their typically developing peers (Burack & Volkmar, 1992). With the current participants, it was difficult to discriminate whether the verbal operants had developed in the same sequence as typically developing children suggested in the research (echoic, mand, then tact). This was because the target verbalizations appeared to be maintained by multiple functions which suggested that the participants demonstrated some mastery of all the verbal operants, comparable to their typically developing peers. Only one participant demonstrated a deviation from the pattern; Jessica's target word "bubbles" did not serve a mand function. This inability to assess the sequence of mastery of the verbal operants may also be a reflection of the participants' involvement in preschool and outside therapy services and thus, a stronger reinforcement or learning history for items unassociated with a particular task (i.e., non-related preferred item for reinforcement) compared to other children with ASD who may not have received the same intensity of services. However, participants in the Lerman et al. and Kelley et al. (2007) investigations were all enrolled in academic or language-training programs at the time of the previous studies (academic placements for 2 of the 3 participants in the LaFrance et al. (2009) were not reported) and were likely exposed to similar discrete-trial or language instruction as the current participants.

In general, the participants in the current study demonstrated higher rates of responding overall compared to participants in the previous investigations. Participant demographic variables, including specific cognitive functioning, expressive and receptive vocabulary, and adaptive communication scores were not presented in previous investigations for comparison with the current participants. However, it is likely that the cognitive abilities for the current participants were higher than those in earlier inquiries. Additionally, scores on the PPVT-4 and EVT-2 for all three participants would suggest that verbal repertoires of the current participants were more advanced than participants in previous research based on qualitative descriptions by the authors (Kelley et al., 2007; Lerman et al., 2005).

Significant notation of higher rates of responding occurred in echoic test sessions for both of Edward's target words. The data were recoded to count the frequency of target verbalizations emitted within 5 s of the verbal prompt which is the traditionally used definition of an echoic in the literature (Kodak & Clements, 2009; Stock, Schulze, & Mirenda, 2008); however, it is possible that his repeated verbalizations were maintained by an additional function not assessed in the current study. A *self-echoic* is under the stimulus control of a verbalization emitted by oneself and is reinforced by automatic stimulation (Esch, Esch, McCart, & Petursdottir, 2010; Skinner, 1957) and could describe the pattern observed during echoic test sessions with Edward. This pattern was not observed during tact, mand, or automatic test sessions so it is not clear whether this increased repetition of the target words truly meets the definition of a self-echoic. If this pattern is observed in future research, it may be beneficial to separately code the frequency of verbalizations emitted outside of the 5 s after the verbal prompt during echoic test sessions, as well as the verbal prompt during tact test sessions and during the reinforcement interval during mand test sessions. The addition of the automatic test session was included to evaluate this form of reinforcement but adding an additional level of coding within the standard operants (tact, mand, and echoic) may lessen the need to prolong the assessment for this purpose.

The current study utilized Lerman et al.'s (2005) interpretation suggestion of a consistently higher level of responding in a test condition compared to the paired control condition as an initial tool for visual analysis. A more detailed criterion was implemented to measure the difference in level of responding between test and comparable control conditions by introducing a 20% criterion for mean frequency of control sessions compared to mean frequency of test sessions. A target verbalization's control mean measuring below 20% compared to a test mean was considered to be maintained by that function. Visual analysis was also necessary for making final decisions due to variability and possible carryover or generalization effects. This provided a slightly more structured method for interpreting functional analysis of verbal behavior results; however, additional research on this or more structured criteria for interpretation, similar to traditional functional analysis of behavior (Hagopian et al., 1997), should be conducted.

Another novel modification of the current study was the addition of the MOA prior to completing the mand test sessions. This modification was implemented to address reflections in previous research regarding low levels of responding by participants being due to a lack of manding ability versus a lack of motivation to mand (LaFrance et al., 2009). For 2 of the 3 participants (Selena and Jessica), multiple MOAs were necessary before an EO for the target item was deemed present for several mand test sessions. Had a MOA not been conducted and the presence of an EO only assumed based on a period of deprivation from the target item, the frequency of responding may have been lower during those sessions creating a different data path for interpretation. Future replications which include this modification for assessing the presence of an EO may wish to complete a MOA prior to mand control sessions as well. Although the participant has free access to the item during the mand control sessions, support of the presence of an EO coupled with the assumed lack of responding during mand control sessions would further strengthen any differentiation between the data collected during mand test and mand control conditions. Based on anecdotal observations made with the current participants during echoic test and control sessions, it may be beneficial to conduct a MOA to determine the presence of an AO for the target item. Specifically, the MOA could be implemented to assess whether a period of free access to the target item created a state of satiation for that item, thus decreasing its value as reinforcement prior to echoic test and control sessions. It was noted on several occasions that verbalizations made by the participants during echoic test and control sessions suggested the presence of an EO or appeared to be a mand (e.g., "grapes please"), therefore, completing a MOA and continuing only if the participant does not select the target item (presence of AO) may be a way to circumvent this potential confound.

The current study further supported the applicability of this methodology to be conducted in a non-clinic setting, specifically, the participants' homes. This may allow for more consistent implementation of the assessment if practitioners are better able to attend to a family's logistical needs and may reflect a somewhat more natural expectation for the child to make verbalizations when in their home environment. Additional adjustments could have been made to further decrease the demands of completing the assessment. Specifically, less control conditions across phases may have been able to be conducted especially once patterns of zero or near-zero rates of responding were observed for all the participants. Overall, this study suggests that the functional analysis of verbal behavior methodology is applicable for use with children with ASD and can successfully identify the functions of language in their verbal repertoires.

Limitations

Several limitations are important to note. First, evidence of carryover effects was present for some of the participants. Less significant evidence (e.g., one minute of responding during one session) occurred during the initial transition from a tact test session to a tact control session. For example, Selena appeared to make the target verbalization without the author's prompt likely based on the quick learning history of receiving verbal praise for responding during the first tact test session (i.e., an extinction burst as responding was high during first minute of session then decreased for the remainder of the session). A more significant carryover effect or extinction burst (e.g., extended through multiple sessions) occurred when transitioning from the mand to echoic condition for Edward. During both test conditions (mand and echoic) the target item was not present during the 5 min session; however, during mand test sessions, a correct verbalization resulted in brief access to the item whereas in the echoic test sessions verbal praise only was provided for correct verbalizations. Observation of the verbalizations during echoic test sessions further suggested that an extinction burst and/or carryover effect of verbalizations representing a mand function based on the length of the utterances. For Edward's target word "car," the first two echoic test sessions resulted in 75.7% and 81.1% (78 and 73 responses, respectively) of verbalizations taking the form of 2- or more word utterances (e.g., "car please") as opposed to the expected single word utterance of "car." For the remaining four echoic test sessions, no 2- or more word utterances were observed. Single- or multi-word utterances received verbal praise from the author if emitted within 5 s of the verbal prompt. This may have also been due to the modification from the original methodology (Lerman et al., 2005) to decrease the pre-session exposure time with the target item from 60 min to 5 min as in Kelley et al. (2007) and therefore not allowing the participant enough time to satiate on the item. As discussed above, completing a MOA prior to not only mand condition sessions but also echoic condition sessions, with the goal of determining the presence of an AO or in other words, confirming that the participant had satiated on the item and an EO was no longer present in the latter, may provide more confidence in stating whether the verbalizations emitted are, in fact, measuring the target operant.

Related to threats to the validity of visual analysis, the interpretative guidelines for the functional analysis of verbal behavior as outlined by Lerman et al. (2005) were somewhat vague and subjective. Specifically, no clear decision making criteria or cut-offs in regard to statistically significant differences between test and comparable control conditions or the trend and stability/variability of data within a condition were noted. Compared to visual analysis of a single subject design measuring, for example, the efficacy of an intervention to decrease rates of problem behavior where trend and stability of data would be highly relevant to outcomes, the current assessment methodology does not need to place as strong an emphasis on these measurement variables but could benefit from the introduction of more structured interpretation criteria similar to those outlined by Hagopian et al. (1997) for the functional analysis of problem behavior.

The addition of the automatic test condition to the current study may not have been necessary, as there was clear differentiation between test and control session responding for at least one operant prior to beginning the automatic test sessions for each participant. Conducting the sessions in the participants' home impacted the ability of the session to be conducted as described in the LaFrance et al. (2009) paper as there was not a room where all items could be removed and the therapist could observe without being present. The automatic test condition in the investigation served more as an extended control which does support the results of the previously completed control conditions as responding remained at zero or near zero levels without any variations in the session manipulations.

Finally, participant related limitations include that demographic information, including cognitive functioning and expressive, receptive, and adaptive communication abilities (a) could not be compared to previous research participants and (b) were not able to be compared with other research investigating the similar sequences in development for children with ASD. While this limitation does not necessarily impact the outcomes of the current investigation it provides another pathway to be incorporated into future research on the functional analysis of verbal behavior methodology. Additionally, more stringent assessment of parent report of expressive communication/vocabulary abilities in future research would continue to extend the literature on implementing this methodology to successfully identify functional verbal operants for children demonstrating varying levels of impairment (e.g., poor to average abilities on measures of expressive vocabulary compared to observations by parents or teachers). Although the results suggest that the methodology accurately identified functions being maintained in the participants' verbal repertoires; it could be argued that this methodology was not appropriate for use with the current sample of children with ASD as their level of responding was generally high and consistent across operants for two target words. The single-word vocabularies (EVT-2) for 2 of the 3 participants were in the Average range which may serve as an indicator that this methodology would not be a necessary step in guiding intervention planning for single word learning as they are already demonstrating abilities commensurate with their same-age peers in this area. As such, the information provided from the assessment with these children does not distinguish significant strengths or weaknesses within their respective single-word verbal repertoires as was found in previous replications where fewer participants demonstrated multiple functions maintaining target verbalizations. As previously stated, the sibling relationship between two of the participants is another limitation as both participants were exposed to identical environmental and caregiver variables (e.g., same living environment, interactions with each other) which could have impacted their responding.

Future Directions

In general, the current study does replicate the findings of Lerman et al.'s (2005) original functional analysis of verbal behavior methodology with at least one function being identified for each participant's target verbalizations. Additionally, the inclusion of participants all diagnosed with ASD suggests that this methodology can be utilized effectively with this population. However, as stated above, the sample of participants with ASD was higher functioning than those included in previous investigations and multiple functions were identified for the target verbalizations of each participant. This does not allow for a discrimination of areas of strength or weakness to be targeted in subsequent interventions for these participants which was the suggested intention of Lerman et al.'s results. The current investigation also supports LaFrance et al.'s (2009) finding that the methodology can be implemented with high fidelity in the participant's home. Future research in this area could focus on several possible modifications or branches of investigation.

Including only children diagnosed with ASD was a more specific population of participants to target compared to previous evaluations of this methodology. Future investigations would benefit from continuing to target more specific participant populations (e.g., children with ASD, children with expressive language delay only) also including more details on variables of current learning environment or reinforcement history at home or school to better identify how these variables may impact the results of the functional analysis. As stated above, more in depth analysis of participant demographic information and relations to assessment outcomes may assist in bolstering the research on sequences of development for children with ASD presenting with varying levels of cognitive and communication impairments. Specifically, the current participants demonstrated high single-word expressive vocabularies according to a standardized assessment (EVT-2) and FA results suggesting multiple functions being maintained in the participants' verbal repertoires; future research may wish to target children with ASD with similar single-word expressive vocabularies to assess whether a similar pattern with FA results emerges. If so, it may be that measures of expressive vocabulary could serve as a rule-out for use of this methodology with higher functioning individuals as it is not likely that function specific information will be provided from the analysis. Other extensions may wish to investigate this methodology targeting multiple word utterances or phrases for individuals who demonstrate average range single-word vocabulary skills to assess how results may guide intervention targeting these skills.

The current methodology has been applied in the home setting with success, similar to traditional functional analysis methodology (Wacker et al., 1998). Traditional functional analysis methodology targeting assessment of problem behavior has also been effective when implemented by caregivers (Wacker et al., 2005). Future research could investigate a similar line of questioning to have parents implement the functional analysis of verbal behavior with their children. Similarly, completing the assessment with teachers or therapists in an academic setting may be a beneficial line of additional research. This may provide more natural consequences of verbal praise or access to preferred items coming from a caregiver compared to a clinician and could provide more accurate information about the child's functional use of language in their verbal repertoire.

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Table 2.1

Participant Demographic Information

	Participant		
	Selena	Edward	Jessica
Age at enrollment	3 years, 11 months	3 years, 11 months	3 years, 6 months
Race/Ethnicity	African American	African American	Caucasian-Hispanic
Diagnosis[a]	Autistic Disorder	Pervasive Developmental Disability – Not Otherwise Specified	Autistic Disorder
KABC-II NVI	64 (1st)	78 (7th)	75 (5th)
EVT-2	74 (4th)	90 (25th)	89 (23rd)
PPVT-4	64 (1st)	91 (27th)	89 (23rd)
Vineland-II Communication Composite	Communication Domain: 81 (10th) Receptive: 11 Expressive: 8 Written: 17	Communication Domain: 83 (13th) Receptive: 12 Expressive: 9 Written: 16	Communication Domain: 78 (7th) Receptive: 13 Expressive: 11 Written: 10

Note. KABC-II NVI = Kaufman Assessment Battery for Children – 2nd Edition Nonverbal Index; EVT-2 = Expressive Vocabulary Test – 2nd Edition; PPVT-4 = Peabody Picture Vocabulary Test – 4th Edition; Vineland-II = Vineland Adaptive Behavior Scales – 2nd Edition. Scores presented as Standard score (percentile); Subtest scores are *v*-scale scores (M = ; SD =).
[a] = Diagnosis information as reported in previously completed diagnostic evaluations within 12 months of study enrollment.

Table 2.2

Functional Analysis Interrater Reliability and Procedural Integrity Data for Selena

Selena							
"Popcorn"				"Cup"			
Session	Condition	Interrater Reliability	Procedural Integrity	Session	Condition	Interrater Reliability	Procedural Integrity
2	Tact Control	100%	100%	3	Tact Test	80%	87.9%
3	Tact Test	100%	100%	4	Tact Control	100%	100%
4	Tact Control	100%	100%	5	Tact Test	86.7%	89.3%
6	Tact Control	100%	100%	6	Tact Control	100%	100%
8	Tact Test	100%	100%	12	Motivating Operation Assessment	100%	100%
11	Motivating Operation Assessment	100%	100%	12	Mand Test	66.7%	100%
11	Mand Test	100%	100%	13	Mand Control	93.3%	100%
16	Mand Control	100%	100%	15	Echoic Test	86.7%	95%
22	Echoic Test	93.3%	100%	16	Echoic Control	100%	100%
23	Echoic Control	100%	100%	22	Automatic Test	100%	100%
27	Automatic Test	100%	100%				
28	Automatic Test	100%	100%				

Note. Interrater Reliability = Agreements/(Agreements +Disagreements) x 100%; Procedural Integrity = Correct Opportunities/(Correct+ Incorrect Opportunities) x 100%

Table 2.3

Functional Analysis Interrater Reliability and Procedural Integrity Data for Edward

Edward							
"Grapes"				"Car"			
Session	Condition	Interrater Reliability	Procedural Integrity	Session	Condition	Interrater Reliability	Procedural Integrity
1	Tact Test	100%	96.7%	2	Tact Control	100%	100%
2	Tact Control	100%	100%	3	Tact Test	100%	100%
9	Motivating Operation Assessment	100%	100%	7	Motivating Operation Assessment	100%	100%
9	Mand Test	100%	100%	7	Mand Test	100%	83.3%
10	Mand Control	86.7%	100%	8	Mand Control	100%	100%
13	Echoic Test	100%	100%	13	Echoic Control	100%	100%
14	Echoic Control	93.3%	100%	14	Echoic Test	66.7%	100%
17	Echoic Test	100%	100%	18	Echoic Test	100%	100%
18	Echoic Control	100%	100%	19	Echoic Control	93.3%	100%
22	Echoic Test	93.3%	100%	23	Echoic Test	80%	96.4%
23	Echoic Control	100%	100%	24	Echoic Control	100%	100%
27	Automatic Test	100%	100%	27	Automatic Test	100%	100%

Note. Interrater Reliability = Agreements/(Agreements +Disagreements) x 100%; Procedural Integrity = Correct Opportunities/(Correct+ Incorrect Opportunities) x 100%

Table 2.4

Functional Analysis Interrater Reliability and Procedural Integrity Data for Jessica

Jessica							
"Toast"				"Bubbles"			
Session	Condition	Interrater Reliability	Procedural Integrity	Session	Condition	Interrater Reliability	Procedural Integrity
3	Tact Test	100%	100%	1	Tact Test	93.3%	100%
4	Tact Control	100%	100%	2	Tact Control	100%	100%
13	Motivating Operation Assessment	100%	100%	9d	Motivating Operation Assessment	100%	100%
13	Mand Test	93.3%	100%	9d	Mand Test	100%	100%
14	Mand Control	100%	100%	10	Mand Control	100%	100%
15	Motivating Operation Assessment	100%	100%	13	Echoic Test	86.7%	100%
15	Mand Test	100%	100%	14	Echoic Control	100%	100%
16	Mand Control	100%	100%	20	Automatic Test	100%	100%
19	Echoic Test	100%	100%				
21	Echoic Control	100%	100%				
23	Automatic Test	100%	100%				

Note. Interrater Reliability = Agreements/(Agreements +Disagreements) x 100%; Procedural Integrity = Correct Opportunities/(Correct+ Incorrect Opportunities) x 100%

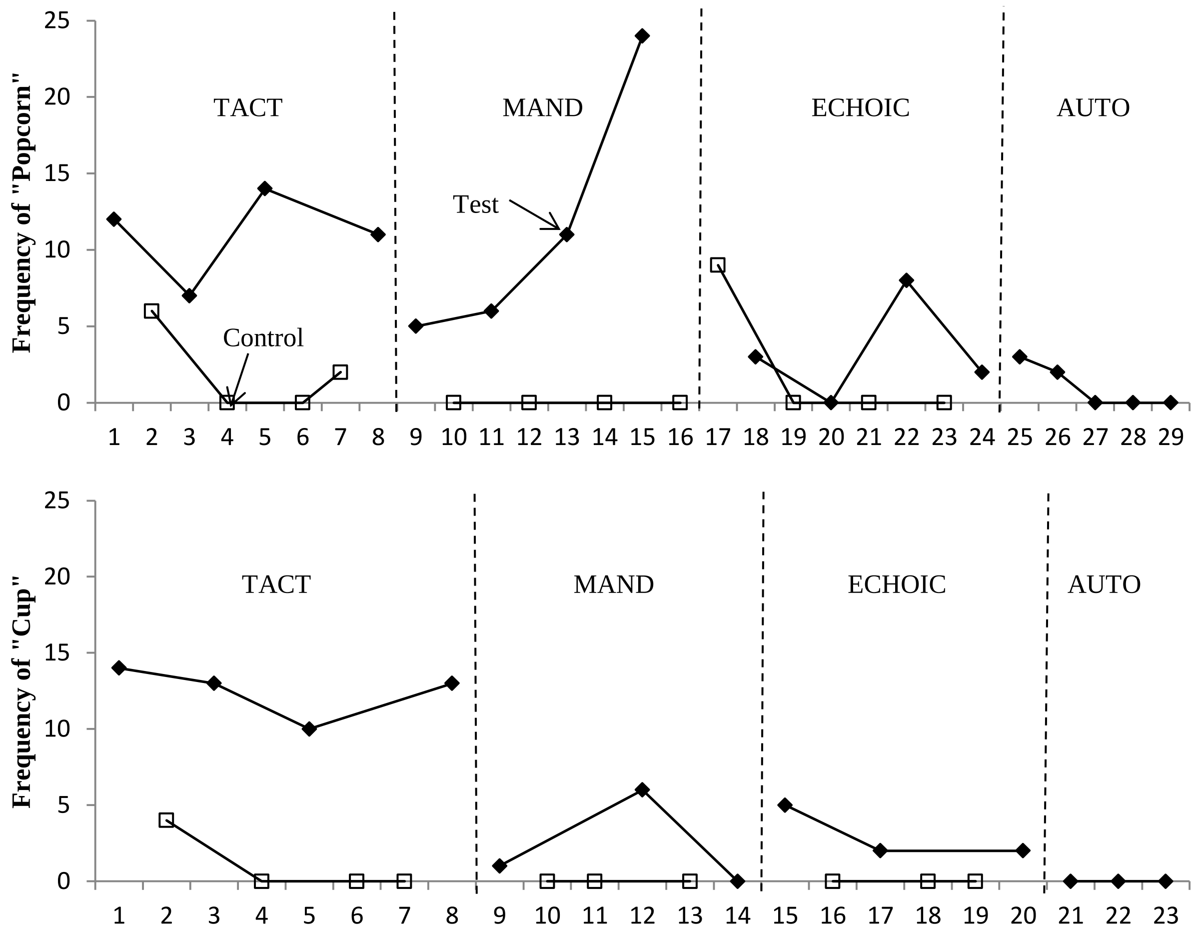

Figure 2.1. Functional analysis results for Selena. Closed data points represent frequency of target verbalization recorded during test sessions for the identified operant. Open data points represent frequency of target verbalization recorded during control sessions for the identified operant. AUTO = Automatic.

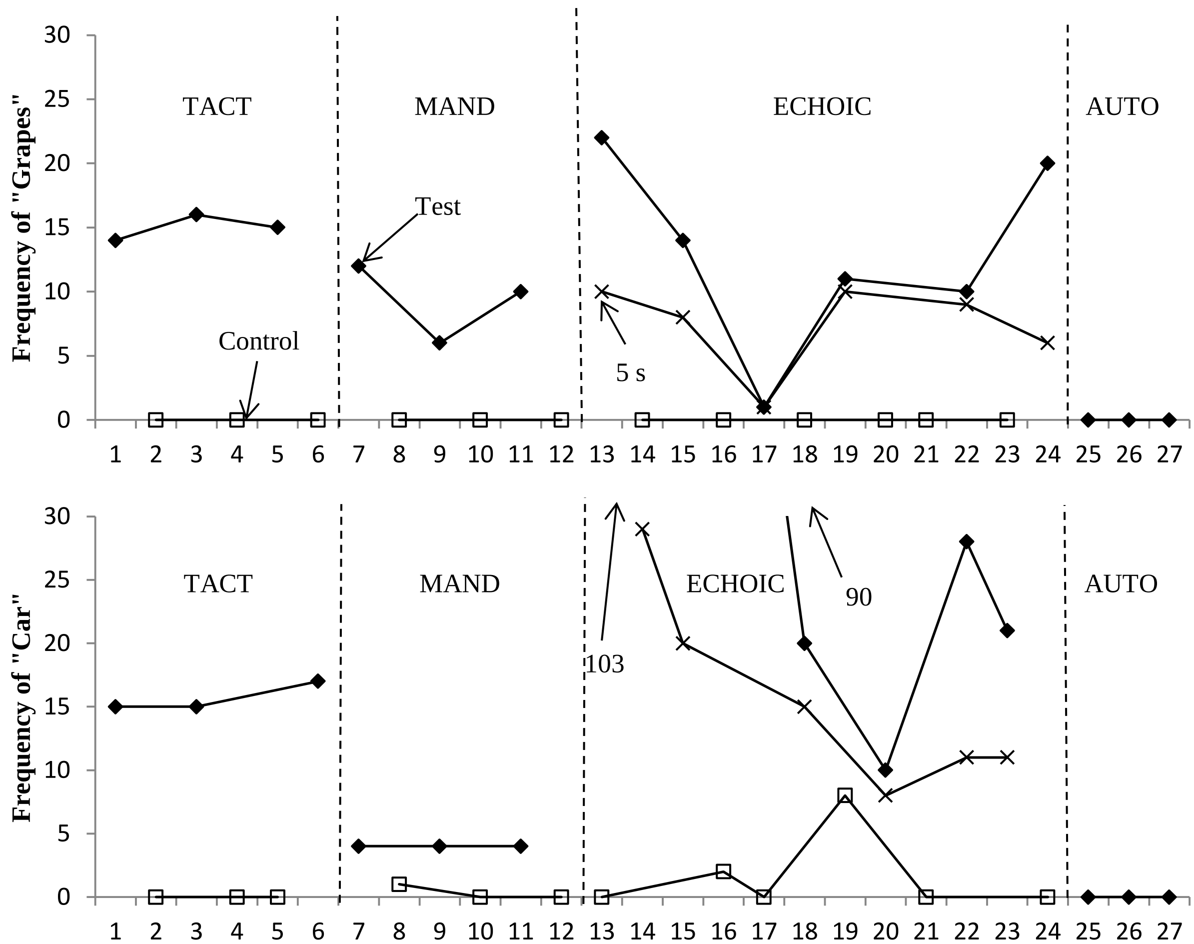

Figure 2.2. Functional analysis results for Edward. Closed data points represent frequency of target verbalization recorded during test sessions for the identified operant. Open data points represent frequency of target verbalization recorded during control sessions for the identified operant. X data points represent frequency of target verbalizations when test sessions were recoded to reflect only those verbalizations emitted within 5 s of the author's verbal prompt. AUTO = Automatic.

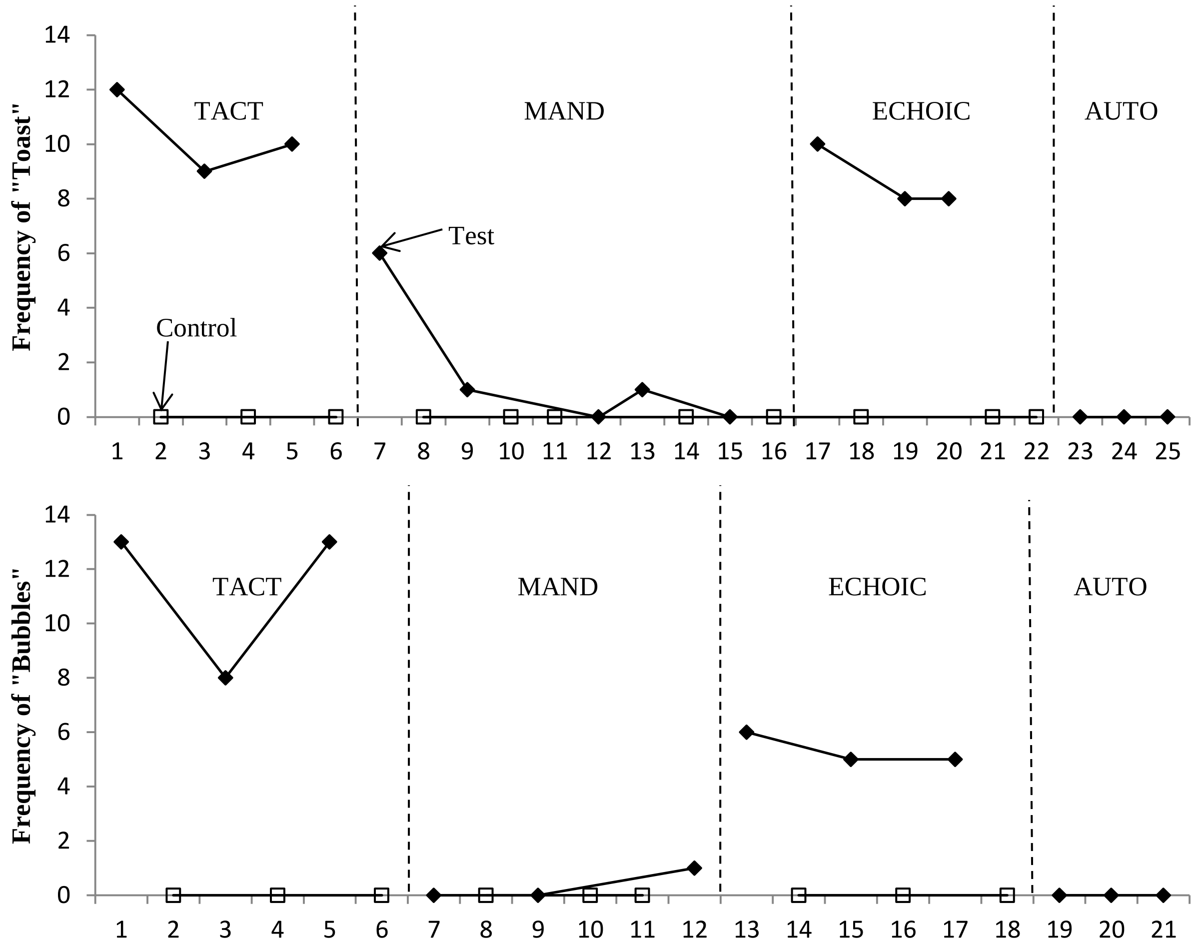

Figure 2.3. Functional analysis results for Jessica. Closed data points represent frequency of target verbalization recorded during test sessions for the identified operant. Open data points represent frequency of target verbalization recorded during control sessions for the identified operant. AUTO = Automatic.

Table 2.5

Functional Analysis Descriptive Data for Selena

	Selena					
	"Popcorn"			"Cup"		
Condition	*n*	*M (SD)*	Range	*n*	*M (SD)*	Range
Tact Test	4	11.0 (2.6)	7-14	4	12.5 (1.5)	10-14
Tact Control	4	2.0 (2.5)	0-6	4	1.0 (1.7)	0-4
Mand Test	4	11.5 (7.6)	5-24	3	2.3 (2.6)	0-6
Mand Control	4	0.0 (0.0)	0	3	0.0 (0.0)	0
Echoic Test	4	3.3 (2.9)	0-8	3	3.0 (1.4)	2-5
Echoic Control	4	2.3 (3.9)	0-9	3	0.0 (0.0)	0
Automatic Test	5	1.0 (1.3)	0-3	3	0.0 (0.0)	0

Note. Mean and standard deviation calculations approximated to one decimal point.

Table 2.6

Functional Analysis Descriptive Data for Edward

	Edward					
		"Grapes"			"Car"	
Condition	*n*	*M (SD)*	Range	*n*	*M (SD)*	Range
Tact Test	3	15.0 (0.8)	14-16	3	15.7 (0.9)	15-17
Tact Control	3	0.0 (0.0)	0	3	0.0 (0.0)	0
Mand Test	3	9.3 (2.5)	6-12	3	4.0 (0.0)	4
Mand Control	3	0.0 (0.0)	0	3	0.3 (0.5)	0-1
Echoic Test	6	13 (6.9)	1-22	6	45.3 (36.7)	10-103
Echoic Test[a]	6	7.3 (3.1)	1-10	6	15.7 (7.1)	8-29
Echoic Control	6	0.0 (0.0)	0	6	1.7 (2.9)	0-8
Automatic Test	3	0.0 (0.0)	0	3	0.0 (0.0)	0

Note. Mean and standard deviation calculations approximated to one decimal point.
[a]Echoic test sessions were recoded to analyze frequency of target verbalizations emitted within 5 s of author's verbal prompt.

Table 2.7

Functional Analysis Descriptive Data for Jessica

	Jessica					
		"Toast"			"Bubbles"	
Condition	*n*	*M (SD)*	Range	*n*	*M (SD)*	Range
Tact Test	3	10.3 (1.2)	9-12	3	11.3 (2.4)	8-13
Tact Control	3	0.0 (0.0)	0	3	0.0 (0.0)	0
Mand Test	5	1.6 (2.2)	0-6	3	0.3 (0.5)	0-1
Mand Control	5	0.0 (0.0)	0	3	0.0 (0.0)	0
Echoic Test	3	8.7 (0.9)	8-10	3	5.3 (0.5)	5-6
Echoic Control	3	0.0 (0.0)	0	3	0.0 (0.0)	0
Automatic Test	3	0.0 (0.0)	0	3	0.0 (0.0)	0

Note. Mean and standard deviation calculations approximated to one decimal point.

Table 2.8

Motivating Operation Assessment (MOA) Results

Selena		Edward		Jessica	
"Popcorn"	"Cup"	"Grapes"	"Car"	"Toast"	"Bubbles"
1 (9)	2 (9)	1 (7)	1 (7)	1 (7)	4 (7)
1 (11)	1 (12)	1 (9)	1 (9)	9 (9)	4 (9)
1 (13)	3 (14)	1 (11)	1 (11)	2 (12)	1 (12)
3 (15)				1 (13)	
				1 (15)	

Note. Number of MOA sessions completed for target words before a motivating operation was established. Parentheses = (Session number).

CHAPTER 3

INVESTIGATING VOCABULARY INTERVENTION RESULTS AND SENSITIVITY OF FUNCTIONAL ANALYSIS METHODOLOGY FOR CHILDREN WITH AUTISM SPECTRUM DISORDERS

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Abstract

Discussions of research investigating the functional use of verbal behavior by children with autism spectrum disorders (ASD) and other developmental disabilities have provided suggestions for future exploration of using results to guide communication interventions (Lerman et al., 2005). Many techniques for increasing the language and communication of children with ASD have been developed and shown to be efficacious for this population in general; yet, the selection of techniques based individual characteristics continues to be debated. The use of functional analysis methodology to determine the function being served by children's emerging verbalizations has been growing in the literature. To date, however, no investigations have been conducted using functional analysis results to determine the most efficient method for increasing participant word learning. Additionally, investigations on the sensitivity of the functional analysis of verbal behavior to accurately assess known function-specific words in a child's verbal repertoire have yet to be conducted (Plavnick & Normand, 2013). The current study (a) used the results of a functional analysis of verbal behavior to assess the efficiency of instruction when novel words are taught using different operant based strategies in a constant time delay format for participants with ASD and (b) assessed the sensitivity of the functional analysis of verbal behavior to measure the use of the instructed novel words once mastered.

INDEX WORDS: Autism Spectrum Disorder, language intervention, functional analysis, verbal operants

Introduction

Autism spectrum disorders (ASD) have historically been characterized by impairments in social interaction, behaviors and interests, and communication (American Psychiatric Association [APA], 2000), with the latter symptom cluster being the most frequently identified area of first concern reported by parents (Chawarska et al., 2007). Delays or deviancy in any of the identified symptom areas have been shown to be best improved upon or remediated when intervention begins as early as possible (Ben Itzchak & Zachor, 2011; Magiati, Moss, Charman, & Howlin, 2011; National Research Council [NRC], 2011). Early intervention services have been incorporated into federal law with a specific portion of the Individuals with Disabilities Education Act (IDEA, 2004) focusing on this area of education. Specifically, children ages birth to 3 years demonstrating any developmental delay or disability are eligible to receive early intervention services and State and Local Education Agencies are permitted to allocate funds for this purpose (Part C; Boyd, Odom, Humphreys, & Sam, 2010; Mandlawitz, 2005) because of improved prognoses for the majority of children with disabilities, including ASD, who receive these services (NRC, 2001). In addition, communication and language functioning have been documented as improving long term functioning outcomes for children with ASD (Ben Itzchak & Zachor, 2011; Magiati et al., 2011), thus, early intervention for language delays continues to be a priority among practitioners, researchers, and families.

Communication Interventions for Children with ASD

Goldstein (2002) conducted a review of studies examining the treatment efficacy of interventions targeting communication and language development of children with ASD. Goldstein organized findings into six types of interventions, which are discussed below.

Sign language and non-verbal communication interventions. Sign language and other augmentative and alternative communication (AAC) systems have been utilized with children with ASD for more than 20 years (Duffy & Healy, 2011; Goldstein, 2002). Goldstein's review of empirical studies using AAC approaches reported consistent results with children learning more information (e.g., novel target vocabulary words) more quickly compared to verbal communication training. This finding was particularly true for more impaired individuals (e.g., lower communication repertoires). Manual signing continues to be an effective method for increasing vocabulary development for children with ASD; however, variables including the child's motor skills, educating others to use manual signs, and creating a signing environment for the child have led to a transition to other AAC approaches including, visual-graphic symbol systems and voice output devices (Duffy & Healy, 2011).

The Picture Exchange Communication System (PECS; Bondy & Frost, 1994) is a well-known example of a visual-graphic symbol system that has been used effectively with children with ASD to increase spontaneous functional communication. By using PECS, a child is taught initially to exchange a picture for a desired item and later taught how to use symbols and graphics to create more complex communication interchanges including full sentences, questions, and responses. Similarly, voice output devices are electronic aids that communicate verbal messages for an individual according to their action of pressing a button or typing a message (Duffy & Healy, 2011). Both strategies require less skill development from the child, as well as the individuals who interact with the child, and have continued to demonstrate favorable results in communication development for children with ASD using AAC systems.

Discrete trial training formatted interventions. Discrete trial training (DTT) programs are structured interventions often incorporating elements of differential reinforcement and error correction procedures using modeling and prompt-fading into the design methodology (Goldstein, 2002). The DTT format is most often associated with Applied Behavior Analysis (ABA; Baer, Wolf, & Risley, 1968) and involves massed and repeated trials of instruction targeting specific skills. Although only 12 studies were included for review in Goldstein (2002), the efficacy of DTT based programs has been demonstrated in the literature with multiple populations for a significant period of time (Baer, et al., 1968; Lovaas, 1987). Thus, it is not surprising that the empirical studies involving children with ASD reviewed by Goldstein evidenced positive and successful results in teaching communication to this population. Criticisms of the DTT format include the potential for the highly structured nature to negatively impact a child’s ability to spontaneously communicate as the focus is more often placed on correct responding (Duffy & Healy, 2011). This difference, among others, is discussed by LeBlanc, Esch, Sidener, and Firth (2006) in their comparison of the DTT format and natural milieu teaching strategies. The authors discuss the theory behind both formats including a focus on increasing individual word repertoires and multiple opportunities to respond with DTT compared to increasing functional and environmentally based language using limited naturally occurring teaching moments with natural milieu training. Although DTT may be criticized by some, its effectiveness in increasing the verbal repertoires of children with ASD and other developmental disabilities cannot be disputed.

Natural milieu teaching interventions. Natural milieu or environment training uses naturally occurring needs or desires of the child which take place in their everyday environment as teaching opportunities. Similar to DTT, milieu teaching usually incorporates different error correction procedures, modeling, and prompt fading within each teaching trial (Goldstein, 2002). According to Goldstein’s (2002) review, milieu teaching was effective in increasing targeted responding in the included studies; however, there was no significant difference in efficacy when directly compared to DTT programs. Several specific methods of milieu teaching have been developed including, incidental teaching (IT), the Mand-Model procedure, and the Natural Language Paradigm (NLP) (Goldstein, 2002; LeBlanc et al., 2006). IT requires the child to make the initial attempt at communication, usually in the form of requesting, which becomes a single teaching trial where the instructor provides different levels of prompting to elicit correct or more complex verbalizations. Compared with DTT, as described above, IT's single opportunity teaching trial has been criticized as children are not likely to learn new skills as quickly as they would when multiple presentations of the trial are provided. The Mand-Model procedure is similar to IT in that it is conducted in a naturalistic setting, but the teaching trials are not solely dependent on the child. The child still needs to initiate interest in an item; however, the instructor can set up opportunities for requesting within each session depending on the preferred items of the child. Once interest in an item is established, the instructor uses similar prompting techniques as in IT to elicit the correct response from the child before providing access to the item. The NLP generally involves the child choosing an object from an array, the instructor modeling an appropriate action and phrase using the chosen object, and the child attempting to imitate the behavior before receiving reinforcement. Although the above descriptions of natural milieu training interventions may seem to lend themselves more to increasing child initiations, promising results have been shown when using these strategies to target other areas of functional communication (Duffy & Healy, 2011; Goldstein, 2002; LeBlanc et al., 2006).

Interventions to replace challenging behavior. Children with ASD who demonstrate limited communication abilities have a tendency to engage in high levels of problem behavior when unable to communicate their needs. Research reviewed by Goldstein (2002) included investigations which sought to substitute appropriate communication skills which served the same function as the challenging or problem behavior, in other words, functional communication training (FCT). Several different strategies were used with gains in the use of functional behavior and decreased problem behavior (e.g., echolalia and disruptive behavior) being noted. A more recent review of eight studies specifically targeting challenging behaviors for intervention through FCT with children with ASD was completed by Mancil (2006). The studies in this review targeted problem behaviors including aggression, self-injury, property destruction, tantrums, body rocking, hand flapping, oppositional behavior, and walking away. Behavioral functions were identified and FCT procedures aligned with the function were implemented, including verbal language, sign language, picture based language, or augmentative communication devices. Results of this review indicated that regardless of the topography or function of the challenging behavior or the mode of FCT utilized, authors reported decreases in challenging behavior and increases in the use of the replacement communication.

Promoting social and scripted interactions. Goldstein (2002) included a separate category for studies which targeted increasing spontaneous communication initiations specific to social interactions. Peer modeling of interactions and social scripts were the primary intervention strategies and improvements in interactions with peers were seen by all participants. More recently, Duffy and Healy (2011) summarized research demonstrating the effectiveness of providing social scripts of appropriate interactions to children with ASD with the additional element of script fading to decrease the amount of prompting received by the child.

Group studies involving parents and classrooms. The final category identified by Goldstein (2002) includes studies focused on group outcomes of parent training and classroom administered interventions. Reported results varied with one parent training intervention evidencing positive results for children with better imitation skills but no long-term benefits and another parent training study resulting in increased communication from both parents and children. No significant differences were found in two classroom based studies (integrated versus segregated and intervention versus control); however, a third study comparing typical day care to a day care where parents and staff received additional information and consultation resulted in significant differences in the scores of a language measure administered to the children. The limited number of studies in this category and the difficulty in meeting requirements of a true experiment design (Goldstein, 2002) do not allow for a broad discussion of the efficacy of group designed interventions but do highlight the need for increased undertaking of this challenging area of research.

Demonstrations of effective interventions targeting the language and communication skills of children with ASD are readily available in the literature. Targeted skills for intervention can range from receptive identification of objects to initiations to asking and answering questions (Goldstein, 2002). For children with ASD, an applied behavior analytic approach including effective reinforcement, stimulus control, prompting, and similar procedures has been shown to be the most effective, particularly when provided on an intensive schedule (Sundberg & Michael, 2001). Although intervention targets can be defined in almost any form, there has been a growing focus on using B.F. Skinner's analysis and definitions of verbal behavior (Skinner, 1957) when developing curricula and interventions for children with ASD (LeBlanc et al., 2006; Sundberg & Michael, 2001).

Skinner's Analysis of Verbal Behavior

Skinner (1957) defined verbal behavior as behavior that is reinforced by the actions of another as the listener. The action or response of the listener is what determines the function or type of verbal behavior initially emitted by the speaker. The type of behavior is labeled as a verbal operant, which can be interchanged with the term response; however, "the terms permit us to make the distinction between an *instance* of behavior… and a *kind* of behavior" (Skinner, 1957, p. 50). According to Skinner, a response can be both an instance and a kind of behavior, but an operant is concerned with the antecedents and consequences associated only with a kind of behavior. Skinner identified six verbal operants: *mand, tact, echoic, intraverbals, textual,* and *transcription*. For the purposes of the current study, textual (the act of reading) and transcription (the act of writing) will not be discussed as they require higher functioning skills not often mastered by children with ASD requiring early language development intervention.

Mands are a form of requesting, with the goal of the verbalization being to acquire the item being named. There is a direct reinforcement relationship between, for example, verbalizing the word "candy" and subsequently receiving candy from the listener. Tacting is equivalent to labeling items in the environment. Seeing a dog and then saying, "dog" is an example of tacting. Echoics are verbalizations that are emitted following a model verbalization being provided. This is often how children first begin to learn language as caregivers use the strategy of, "say, 'ball'" with the goal of their child responding, "ball." Intraverbals, like echoics, also require a verbal stimulus; however, there is no point-to-point correspondence with the stimulus (i.e., the "correct" response is not provided by the stimulus). An example of an intraverbals is the alphabet, when a child hears "A, B, C, D,…" a correct verbalization would be to continue with "E, F, G,…" Other examples of intraverbals include answering questions or fill in the blank statements such, as "a sheep says ____" requiring the response, "baaaa."

"In all verbal behavior under stimulus control there are three important events to be taken into account: a stimulus, a response, and a reinforcement" (Skinner, 1957, p. 81). Classification of a response as a particular verbal operant depends entirely on the stimulus and resulting reinforcement, particularly when distinguishing between mands and tacts. A child who says "car" and receives a toy car that is out of his reach while playing is considered to be manding, whereas, a child who says "car" when he walks out of the house and sees a car in the driveway is considered to be tacting. An emphasis in the literature on the antecedents and consequences of verbal behavior has demonstrated the functional independence of verbal operants originally noted by Skinner (Hall & Sundberg, 1987; Lamarre & Holland, 1985; Pérez-González, García-Asenjo, Williams, & Carnerero, 2007; Sundberg & Sundberg, 1990; Twyman, 1996). The evidence supporting the functional independence of Skinner's verbal operants has recently led to the development of methodology assessing the functions being served by the verbalizations of children with limited verbal repertoires (Lerman et al., 2005).

Functional Analysis of Verbal Behavior

Lerman et al. (2005) designed a functional analysis methodology to study the verbal behavior of children with developmental disabilities with the goal of improving the efficacy of operant based interventions used with this population. The results of Lerman et al. indicated that at least one function was being served by the verbalizations of participants. These results have been replicated, with little to no methodological modifications, with other children with developmental disabilities (Kelley, Shillingsburg, Castro, Addison, & LaRue, 2007; Kelley et al., 2007; LaFrance, Wilder, Normand, & Squires, 2009; Schieltz et al., 2010; Shillingsburg, Kelley, Roane, Kisamore, & Brown, 2009), including an extension of the methodology to non-vocal communication behavior (Normand, Severtson, & Beavers, 2008). The majority of the literature utilizing the Lerman et al. methodology has discussed the use of functional analysis results to guide and support intervention with the participants; however, as of yet no research has examined operant intervention based on the results of a functional analysis of verbal behavior (Plavnick & Normand, 2013).

Verbal Operant Interventions

The use of Skinner's (1957) definitions of verbal operants when assigning targets for intervention with children with ASD and other developmental disabilities has become an increasingly common practice in the literature. Specifically, when intervening with children with limited verbal repertoires, targeting the skills of manding and tacting is arguably the most adaptive use of intervention time as developing these abilities are likely to have the most benefit on the child's day to day functioning.

Mand training. Generally speaking, there are two methods for teaching mands to children: (a) requesting preferred items (Bourret, Vollmer, & Rapp, 2004; Egan & Barnes-Holmes, 2009; Gutierrez et al., 2007) or (b) requesting placement of/access to an object determined by the experimenter (Carroll & Hesse, 1987; Egan & Barnes-Holmes, 2010; Hall & Sundberg, 1987; Jennett, Harris, & Delmolino, 2008). When training mands in either form, it is ideal to first establish the presence of an establishing operation (EO; Michael, 1982). An EO describes a state or need of the participant "which alters the effectiveness of some object or event as reinforcement and simultaneously alters the momentary frequency of the behavior that has been followed by that reinforcement" (Michael, 1982, p. 150-151). In other words, demonstrating the presence of an EO for the target item strengthens the experimental control of the item itself eliciting the manding behavior.

Mand training with children with ASD employs effective techniques including exchanging of pictures for items (Gutierrez et al., 2007), verbal prompting of the target word (Bourret et al., 2004), and teaching target words as tacts (Egan & Barnes-Holmes, 2010; Hall &

Sundberg, 1987; Sigafoos, Reichle, Doss, Hall, & Pettitt, 1990; Wallace, Iwata, & Hanley, 2006). Jennett, Harris, and Delmolino (2008) conducted an investigation directly comparing mand training with the more traditional applied behavior analytic discrete trial instruction (DTI). Mand training was conducted in a naturalistic manner with the child initiating the teaching trial by choosing the item from an array. DTI involved the instructor determining which item would be used in each trial and consisted of a contrived manding situation where the child experienced less of an EO for the target item. Two groups of children participated with three children receiving mand training followed by DTI and three children receiving DTI followed by mand training. Five of the six participants made more independent requests and required fewer sessions to meet criterion in the mand training condition compared to DTI. The sixth participant did not demonstrate gains in independent responding in either condition. The authors concluded that, although both mand training and DTI were effective in facilitating the acquisition of requests for five of the participants, mand training was accomplished more quickly and resulted in increased independent requesting. Jennett et al. concluded that the presence of an EO in the mand training condition "was the primary factor in the speech of acquisition" (p. 81). Other differences included the participants learning to request a higher number of items in the DTI contrived manding sessions (M = 9.6 items per session) compared to mand training (M = 3.4 items per session) and engaging in more appropriate eye contact during DTI than mand training sessions.

Tact training. Unlike mand training, an EO for the target verbalization (i.e., the item to be named) is not required; however, some form of reinforcement is necessary but it should not take the form of access to the target item (Skinner, 1957). The majority of tact training research has used transfer of stimulus control procedures to teach tacts after a participant has acquired the target verbalization as an echoic (Barbera & Kubina, 2005; Bloh, 2008; Kodak & Clements, 2009) or as a mand (Egan & Barnes-Holmes, 2009; Petursdottir, Carr, & Michael, 2005). Additional techniques within each type of transfer to tact training include most-to-least physical (Sigafoos, Doss, & Reichle, 1989) or verbal prompting (Bloh, 2008; Kodak & Clements, 2009), and listener or receptive probes (Barbera & Kubina, 2005; Egan & Barnes-Holmes, 2009). For children with ASD, effective results have generally been demonstrated when assessing spontaneous use of a target verbalization as a tact after being trained as a mand, as described above, or an echoic (e.g., reinforcing correctly repeating a target word when a verbal prompt is provided without the item being present).

Functional Independence of Verbal Operants

Skinner (1957) described verbal operants as functionally independent, meaning that an individual may have mastered a verbalization as one operant but that does not guarantee spontaneous transfer to use as another operant, especially in the early stages of language development. The functional independence of mands and tacts has been investigated in the literature with mixed results. Lamarre and Holland (1985) conducted a study to verify Skinner's claim and found that during acquisition mands and tacts were found to be functionally independent for the 9 typically developing preschool age participants. Half the participants were taught to mand using either the phrase "on the right" or "on the left" whereas the other participants were taught to tact using the same phrases. Neither group's mastery of the phrases in the trained operant transferred to the other operant during probe trials. These results have been replicated with children with developmental disabilities including children with ASD (Nuzzolo-Gomez & Greer, 2004; Twyman, 1996.) Petursdottir, Carr, and Michael (2005) conducted a similar investigation with five typically developing preschool age children. Their results did not entirely support those of earlier studies, with the four children who received mand training all demonstrating acquisition of tacts but none of the children acquiring correct use of mands after tact training. Petursdottir et al.'s findings of a lack of functional independence were partially supported by a recent study with a group of boys all diagnosed with ASD (Egan & Barnes-Holmes, 2010). Egan and Barnes-Holmes investigated mand emergence after tact training with and without an additional receptive identification component or the receptive identification alone. Results were mixed with several participants acquiring the target mands after all three training types and other participants only after the combined tact-receptive training. These outcomes further the discussion regarding the conditions under which functional independence of verbal operants is evident and support the utility of assessing for generalization of acquired verbal language across functional operants not receiving direct instruction.

Assessment Guiding Intervention

Prior to intervention, particularly for children with ASD, teachers and practitioners conduct assessments to determine the areas in which additional training, support, or instruction is needed. Little has been done, however, to investigate what variables may impact the efficacy of a particular intervention for a child and how that child's abilities or deficiencies can be used to select an intervention most likely to elicit efficient, successful results. The few studies that have investigated this linkage within language and instructional situations have demonstrated positive findings.

Bourret et al. (2004) evaluated an assessment to teach mands to three individuals with developmental disabilities who were found to emit mand utterances at differing levels of prompting. The authors then began treatment with each participant using different intervention strategies which were hypothesized to be most effective in learning novel mands based on the assessment results. For example, a participant who emitted partial utterances of target response after being provided with phoneme prompt, ‘ch’ for ‘chip,’ began shaping and stimulus fading treatment. Results for all three participants indicated that mand training interventions linked to assessment information were effective in the acquisition of mands.

Kodak, Fisher, Clements, Paden, and Dickes (2011) recently conducted a functional assessment of variables influencing the instruction of conditional discrimination to children with ASD and subsequently provided the intervention prescribed by the assessment compared to an alternative (i.e., not hypothesized to be effective based on assessment results) and control intervention. Specific to the intervention linked to assessment portion of the study, three of four students demonstrated significantly higher levels of unprompted correct responding in the prescribed function-based treatment compared to the alternative and control conditions. The fourth participant exhibited similar levels of unprompted correct responding in the prescribed and the alternative conditions, both of which were higher than the control, indicating multiple teaching strategies may be effective for this participant.

Plavnick and Ferreri (2011) conducted a functional analysis of gestural behavior, similar to Iwata et al. (1982/1994) methodological conditions, and then implemented a mand training intervention using peer video modeling of function and nonfunction based mands according to the functional analysis results. Results suggested that three of the four participants with ASD diagnosis and severe language impairments acquired two to three function based mands via video modeling but did not master the nonfunction based mands. The fourth participant, who responded using picture exchange as opposed to verbal responses, acquired the targeted nonfunction based mands; however, at a much slower rate than the function based mands. This study most closely resembles the purpose of the current study in focusing on the verbal repertoires of children with ASD.

Purpose of the Current Study

Studies utilizing previously developed assessment procedures to guide the selection and implementation of appropriate interventions targeting specific skill sets for children with ASD and developmental disabilities have reported successful results (Bourret et al., 2004; Kodak et al., 2011). As described earlier, a methodology has been developed to analyze the functional use of verbalizations according to Skinner's (1957) verbal operants for children with limited verbal repertoires (Lerman et al., 2005). The methodology has been validated (Kelley, Shillingsburg, Castro, Addison, & LaRue, 2007; Kelley, Shillingsburg, Castro, Addison, LaRue, & Martins, 2007; LaFrance et al., 2009; Plavnick & Normand, 2013; Schieltz et al., 2010; Shillingsburg et al., 2009) and resulted in various suggestions regarding the potential value of using functional analysis results to guide subsequent intervention. Potential intervention goals for children with ASD may include acquiring novel mands and tacts or further developing the child's adaptive use of language using single and mixed operant training strategies described above. Thus, the purpose of the current study was to (a) assess whether the function of language used by children with ASD identified through functional analysis of verbal behavior methodology assists in determining the most efficient method for teaching new vocabulary words and (b) evaluate the sensitivity of Lerman et al.'s functional analysis methodology in measuring the use of labels taught using function specific instruction. Specific questions addressed follow:

a) Does linking intervention to results of a functional analysis result in more efficient word learning? For example, if a child's verbalization is found to serve the function of a mand, will that child learn to use a new word more quickly if taught as a mand compared to an equivalent new word taught as a tact?

b) Does the functional analysis of verbal behavior methodology accurately identify the function of words in the repertoire of a child with ASD? For example, do words taught using a specific operant intervention serve that function according to the functional analysis of verbal behavior methodology? Or if a child is taught a new word as a mand, will they then correctly use that word as a tact without tact specific training according to assessment procedures?

Method

Participants and Setting

Three participants were recruited for participation in a study assessing the use of a functional analysis methodology to determine the function(s) of verbalizations made by children with ASD demonstrating limited verbal repertoires (Dommestrup, Campbell, Ardoin, & Dubin, 2013). Results of the functional analysis of verbal behavior for all three participants indicated that target vocabulary words were maintained by at least one verbal operant as defined by Skinner (1957). Data collection for the present study was commenced upon completion of the initial functional analysis. Sessions were conducted in a room in the participants' homes.

Experimental Design

An adapted alternating treatments design was implemented to assess the efficiency of word learning when instruction targeted specific verbal operants. Percentage of trials correct was used to measure and compare the acquisition of novel item labels. Adapted alternating treatment designs (AATD; Sindelar, Rosenberg, & Wilson, 1985) are appropriate when measuring the efficiency of multiple strategies on different behaviors of equivalent difficulty (Wolery, Gast, & Hammond, 2010).

Procedure

Prior to intervention, participants completed a functional analysis of verbal behavior. Participants' target responses were identified to serve multiple functions (i.e., tact, mand, and echoic) as such, it was not clear that participants would benefit from a particular type of targeted operant intervention over another (e.g., tact training versus mand training).. Based on these results, and supporting literature discussing the adaptive use of tacts and mands in the daily activities of children with autism (Barbera, 2007), tact and mand instruction were the operant instructions investigated in the current study. A 5 s constant time delay procedure was implemented for all training conditions.

Target Stimuli Selection

The author accumulated a pool of 12 items/toys that had not been observed to be preferred items of the participants based on observation during the functional analysis of verbal behavior study. Novel items were selected as potential target stimuli as utilizing novel items which the participant only had access to during intervention sessions may assist in maintaining a high motivating operation and preference for the selected items. A paired choice assessment (Fisher et al., 1992) was conducted using the novel items to determine which items were more highly preferred for each participant. Results of the preference assessments are presented in Figures 3.1-3.3. The items which were selected most often during the preference assessment were then included in the baseline condition to assess whether participants currently had a label for the items in their vocabularies.

Baseline Assessments

Baseline assessments of item labels were conducted to measure each participant's ability to verbalize a potential label for the six or seven items with the highest percentage of trials selected in the preference assessment. During baseline trials, the author presented one of the highly preferred items to the participants and asked, "What do you want?" If the participant provided an appropriate label for the item, they were given 5 s to access that item and the verbatim response was recorded. If the participant did not provide a verbal label or approximation after 5 s, the author removed the item and prompted a known demand or skill (e.g., "clap your hands"), which received reinforcement in the form of a non-targeted preferred item. Items were presented in a randomized order until 5 baseline trials per item had been completed. If any of the target items were correctly labeled (including approximations) in more than one trial, that item was removed from the remaining baseline trials and was no longer eligible as a target stimuli for instruction. The next highly preferred item identified in the paired choice preference assessment was then included in baseline trials. Thus, the three items selected for each participant represent the three highest preferred items from the preference assessment which did not already have a verbal label within the participant's verbal repertoire. After the baseline assessment, one item was randomly assigned to one of the three conditions (mand training, tact training, or control). Based on baseline assessments, the following target words were selected for each of the participants: "stingray," "wand," and "robot" for Selena; "alligator," "blowout," and "robot" for Edward; and "stingray," "eye glass," and "wand" for Jessica. For Jessica, the magnifying glass was preferred and not labeled during baseline trials; however, "magnifying glass" was difficult for her to say during initial echoic training sessions as described below so, "eye glass" was used at the target word for subsequent training.

Stimuli Equivalence and Echoic Training

"The major feature of the AATD involves the identification of… equivalent and functionally independent instructional sets" (Sindelar et al., 1985, p. 70). Because target stimuli were chosen according to parent and teacher knowledge of the participants' vocabulary and preference assessments, the equivalence of difficulty of the item names could not be initially controlled for. To remedy this and establish target item equivalence prior to instruction, the author identified functional and appropriate labels for each of the target items. Labels were then taught to the participants through echoic training procedures. Echoic training sessions consisted of 10 trials where the participant was prompted to "say, [target word]" and received reinforcement with a non-target item or edible for successfully repeating the word within 5 s of the author's prompt. The target items were not present during any of the trials. A verbalization was considered mastered after 100% correct responding was recorded for three successive ten-trial sessions. Once all three target words for each participant were mastered it was hypothesized that there is an equivalent opportunity for the participant to independently use the label during the designated instructional condition.

Intermixed Tasks

To ensure each participant was able to access reinforcement during baseline, echoic, and instructional sessions, known verbal and/or motor tasks were intermixed with test trials. Intermixed tasks were accumulated based on parent report during initial intake procedures (e.g., Vineland Adaptive Behavior Scales – 2nd Edition; Sparrow, Cicchetti, & Balla, 2005), review of academic or behavioral evaluations which suggested skills already mastered by each participant (e.g., identifying body parts, gross motor imitation). Reinforcement for completion of these tasks was provided in the form of access to non-target, preferred items.

Mand Training

Mand training sessions consisted of 10 trials for the target stimuli. Mastered tasks were intermixed and reinforced with non-target reinforcers. Each trial started with the target stimuli being placed in front of the participant. Once the participant engaged with the item, the author provided 5 s access before removing the item from reach and beginning the constant time delay trials. Initial trials were 0 s delay, where the author provided the control prompt (a verbal model of the correct response) as soon as the item was removed or represented in the participant's view after an intermixed task. If the participant correctly echoed the author they were immediately reinforced by receiving brief access to the target item (approximately 5 s) before the item was again removed the process was repeated for 10 trials. Incorrect or no response within 5 s of the controlling prompt resulted in the author saying, "Wrong," and removing all access and attention for approximately 3 s before continuing with the next trial or intermixed task. Once the participant demonstrated 100% correct responding for one 10-trial session of 0 s delay, the author began 5 s delay trials. During 5 s delay trials, the author removed the item from the participant's reach and waited 5 s before providing the controlling prompt. If the participant correctly labeled the item before the prompt they were provided with the item and the trial was recorded as a correct unprompted response. If the participant responded correctly after the verbal model they still received access to the target item; however, the response was recorded as a correct prompted response. Unprompted correct responses were used to calculate and determine independent mastery of labeling the novel item. Detailed correction procedures can be found in Appendix A. Mastery at the 5 s delay was considered met once a participant engaged in 100% correct responding during three consecutive sessions.

Tact Training

Ideally, "the antecedent for a 'pure' tact will not include an instructor's question, 'What is it?' (Barbera, 2007, p. 119) but the presence of an item alone. This expectation is somewhat unrealistic when teaching children with ASD (Barbera, 2007) and does not allow for a clear difference in prompts administered during mand and tact training trials. Thus, tact training in the current study is considered to be "impure" tact training. Tact training sessions consisted of 10 trials per session. Prior to commencing tact training sessions a brief preference assessment was conducted using 2-3 non-target items and allowing the participant to pick one. Once a reinforcer was chosen by the participant, the author removed the reinforcer, presented the target item and asked, "What is it?" Similar to mand training, early trials were 0 s delay so the instructor immediately followed the task direction with the controlling prompt (e.g., "What is it? Ball."). If the participant correctly echoed the item label they received immediate access to the previously chosen reinforcer item. During subsequent 5 s delay trials, the instructor waited 5 s after giving the task direction before giving the controlling prompt. If the participant correctly labeled the item within 5 s of the task direction they were given 5 s to access the chosen reinforcer and the trial was recorded as an unprompted correct response. If the participant did not respond within 5 s of the task direction but responds correctly after the controlling prompt, the participant still earned access to the reinforcer but the response was recorded as a prompted correct. Mastered tasks were intermixed throughout the 10 trial sessions. Additional correction procedures are delineated in Appendix B.

Control Condition

One target item did not receive any instruction but was probed as a mand and a tact during the intervention period. The mand probe consisted of the participant accessing the item for 5 s before the author removed it from reach similar to a mand training trial. If the participant correctly labeled the item within 5 s of the item being held out of reach, they received access to the item. The tact probe was similar to tact training trials with a brief preference assessment of non-target items being conducted followed by the task direction "What is it?" upon presentation of the target item. If the participant labeled the item correctly within 5 s of the task direction, they received access to the selected reinforcer. No corrective feedback was provided for incorrect or no responses during the mand or tact probe. Mastered tasks were intermixed in between the two probes.

Efficiency of Instruction

Percentage of unprompted correct response trials were used to determine efficiency of instruction on responding. Mastery of the functional operant use of the target item name was considered met after three consecutive sessions of 100% unprompted correct response trials.

Post-Intervention Functional Analysis

After the target item labels reached mastery criteria, a functional analysis of verbal behavior was conducted to assess the use of the acquired label(s) outside of the intervention sessions. Additionally, this allowed for the evaluation of whether each participant's use of the acquired label was restricted to the function in which it was taught or if cross-function generalization had occurred. Since the target words are considered mastered as a specific functional operant, the post-intervention functional analysis allowed for assessment of the sensitivity of the methodology to identify the functions maintaining language in the repertoire of children with ASD. Functional analysis conditions were identical to those in Dommestrup et al. (2013).

Interpretation of functional analysis results included comparing mean frequency of test sessions of a verbal operant to the mean frequency of the comparable control condition. If the control mean frequency represented less than 20% of the test mean frequency it was suggestive of that operant maintaining the target verbalization in the participant's verbal repertoire. Visual analysis was also utilized to evaluate variability in responding.

Interrater Reliability and Procedural Integrity for Intervention

Percentage of correct responding during trials was collected for baseline, echoic training, mand training, tact training, and control conditions interrater reliability. Tables 3.1-3.3 display interrater reliability percentages for each session scored. One baseline session consisting of 5 trials per item was conducted with each participant with 100% reliability for all three participants. Echoic training, mand training, and tact training conditions all consisted of 10 trials per session at both the 0 s constant time delay (CTD) and 5 s CTD level of intervention and the control condition consisted of 2 trials per session. For Selena, average interrater reliabilities per condition for her target words were as follows (percentage of sessions coded in parentheses); "wand:" echoic training = 100% (50%), mand training 0 s CTD = 100% (42.9%), and mand training 5 s CTD = 100% (40%), "stingray:" echoic training = 100% (42.9%), tact training 0 s CTD = 100% (42.9%), and tact training 5 s CTD = 100% (50%), and "robot:" echoic training = 100% (60%) and control condition = 100% (37.5%). Edward's average interrater reliabilities per condition for his target words were; "blowout:" echoic training = 100% (33.3%), mand training 0 s CTD = 100% (50%), and mand training 5 s CTD = 100% (37.5%), "crocodile:" echoic training = 100% (33.3%), tact training 0 s CTD = 100% (50%), and tact training 5 s CTD = 100% (40%), and "robot:" echoic training = 100% (33.3%) and control condition = 100% (42.9%). Average interrater reliabilities for Jessica were; "stingray:" echoic training = 100% (66.6%), mand training 0 s CTD = 100% (50%), and mand training 5 s CTD = 100% (40%), “eye glass:” echoic training = 100% (66.6%), tact training 0 s CTD = 100% (100%), and tact training 5 s CTD = 100% (33.3%), and “wand:” echoic training = 100% (50%) and control condition = 100% (38.5%).

Procedural integrity data were collected for the same percentage of sessions as interrater reliability data and is also presented in Tables 3.1-3.3. Procedural integrity is reported as percentage of trials completed correctly according to mand and tact training procedures outlined in Appendices A and B and baseline, echoic training, and control conditions as described above. A trial was considered correct if the author provided the appropriate antecedent stimulus for the trial and consequence for the participant’s response. Similar to interrater reliability, procedural integrity for each participant’s baseline session was 100%. Average procedural integrity for conditions completed with Selena’s target words were; “wand:” echoic training = 100%, mand training 0 s CTD = 93.3% (range = 80-100%), and mand training 5 s CTD = 100%, “stingray:” echoic training = 100%, tact training 0 s CTD = 93.3% (range = 80-100%), and tact training 5 s CTD = 100%, and “robot:” echoic training = 100% and control condition = 100%. Edward’s average procedural integrity across his target words were as follows; “blowout:” echoic training = 100%, mand training 0 s CTD = 100%, and mand training 5 s CTD = 93.3% (range = 80-100%), “crocodile:” echoic training = 100%, tact training 0 s CTD = 90%, and tact training 5 s CTD = 100%, and “robot:” echoic training = 100% and control condition = 100%. For Jessica’s target words, average procedural integrity data were; “stingray:” echoic training = 100%, mand training 0 s CTD = 90% (range = 80-100%), and mand training 5 s CTD = 100%, “eye glass:” echoic training = 100%, tact training 0 s CTD = 100%, and tact training 5 s CTD = 100%, and “wand:” echoic training = 100% and control condition = 100%.

Interrater Reliability and Procedural Integrity for Post-functional Analysis

All sessions were 5 min in duration and were conducted by the primary author; sessions were videotaped to allow for independent observation and scoring of the participant's verbalizations. Frequency of target verbalizations was recorded during 20 s intervals by the primary author. One of three sessions conducted per condition was randomly selected for reliability and procedural integrity coding (33.3% of sessions for each participant). Reliability was calculated by dividing the number of agreement intervals (i.e., same frequency of responses during a 20 s period) by the total of 15 possible 20 s intervals and multiplying by 100%. Average interrater reliabilities for Selena's target words of "wand," "stingray," and "robot" were 100%, 95.2% (range = 80-100%), and 100%, respectively (Table 3.4). Edward's target words, "blowout," "crocodile," and "robot," received average interrater reliabilities of 94.2% (range = 80-100%), 97.1% (range = 86.7-100%), and 96.2% (range = 86.7-100%), respectively (Table 3.5). Average interrater reliabilities for Jessica's target words; "stingray," "eye glass," and "wand," were 99% (range = 93.3-100%), 100%, and 100%, respectively (Table 3.6).

Procedural integrity data were collected during the same sessions which interrater reliability was recorded. Steps included in the calculation of procedural integrity differed across sessions depending on the frequency of responses from the participant. For example, if a participant emitted the target verbalization 10 times during an echoic test session there were 10 opportunities to provide verbal praise; however, if they emitted the target verbalization 0 times during a similar condition there would be no opportunities to provide verbal praise. Other steps incorporated into the calculation of procedural integrity include, the presence or removal of the target item and correct verbal or item presentation prompts (tact and echoic test, and mand test sessions, respectively). Procedural integrity data are presented in Tables 3.4-3.6. Average procedural integrity data for Selena's target words were 98.7% (range = 90.9-100%), 100%, and 100%. Edward's average procedural integrity data for his target words were 99.6% (range = 97-100%), 99.4% (range = 86.7-100%), and 99.6% (range = 97.1-100%). Average procedural integrity data for Jessica's target words were 97.8% (range = 90.9-100%), 100%, and 100%.

Results

Intervention Results

Results of the current study suggest that all three participants were able to learn new item names through both mand and tact training instructional procedures. Selena, Edward, and Jessica all learned a novel item label as a mand and a second novel item name as a tact to mastery criteria; however, the efficiency with which they reached mastery differed.

Selena. Results of the functional analysis for Selena suggested that two words commonly heard by her caregivers in her daily activities primarily and consistently served multiple functions, including tact, mand, and echoic. Selena received mand training for the target word "wand," tact training for the target word "stingray," and no training for the target word "robot." Data are presented in Figure 3.4. Seven sessions at the 0 s CTD were required for both "wand" and "stingray" to reach 100% correct responding for one session. After this point, Selena mastered the tact to mastery criteria in four sessions, whereas, the mand training required seven sessions before mastery was met. Selena never correctly label the control item, "robot." These results suggested that Selena may learn new words more efficiently when instructed as a tact compared to as a mand which, as previously discussed, may be associated with Selena's prior learning history from outside the setting of the current study (e.g., speech and language and early intervention services or reinforcement from caregivers for spontaneous verbalizations), as well as the differences in reinforcer value across the intervention conditions.

Edward. Initial functional analysis results for target words in Edward's verbal repertoire suggested that verbalizations were maintained by tact, mand, and echoic functions based on significant differences between respective test sessions and their comparable control sessions.

Edward's target words of "blowout," "alligator," and "robot" were trained as a mand, tact, and control target item, respectively. Data for Edward's intervention training are presented in Figure 3.5. For both "blowout" and "alligator," Edward reached 0 s constant time delay mastery criteria in two sessions. Similar to Selena, Edward reached mastery criteria for the target word trained as a tact, prior to the target word trained as a mand (5 sessions versus 8 sessions to mastery criteria). Of note, during the first 5 s constant time delay trial for the target word being trained as a tact ("alligator"), Edward spontaneously labeled the item as a "crocodile" which was accepted as correct by the author and used for the remainder of the study. This had not been observed during baseline trials where Edward did not provide any label for the item across 5 trials. Edward also correctly labeled the control item, "robot," during both mand and tact probe trials consistently throughout the intervention. Edward had not labeled this item during baseline assessments which suggested that he may have generalized the label to the item simply from having learned the word as an echoic during the stimuli equivalence echoic training. Results of the intervention study suggested that Edward may learn new words more efficiently when taught as a tact compared to words taught as a mand. Also, similar to Selena, this may be attributed to Edward's prior learning and reinforcement history in other academic or intervention settings or may be a reflection of the reinforcement value during tact sessions compared to mand sessions.

Jessica. Jessica's participation in a functional analysis of verbal behavior resulted in one target word serving tact, mand, and echoic functions and a second target word being multiply maintained by tact and echoic functions.

Jessica's target words were "stingray," "eye glass," and "wand," and received instruction as a mand, tact, and control, respectively. Data for Jessica are displayed in Figure 3.6. During 0 s constant time delay instruction trials, Jessica reached mastery criteria for the tact "eye glass" in one session; however, required four sessions before the mand "stingray" reached the mastery level. Conversely, during 5 s constant time delay instructional trials the mand reached mastery criteria in 11 sessions, whereas, the tact did not reach mastery until after 15 sessions. Jessica correctly labeled the control item, "wand," during one mand training trial but did not use the item label during any other control probe sessions. Of note, although Jessica reached mastery criteria at the 5 s constant time delay for the mand prior to the tact, the total number of sessions, including 0 s constant time delay trials for each, were 15 and 16, respectively, since the tact only required one 0 s trial, whereas, the mand required four 0 s trials. As such, it could be argued that Jessica had more exposure to the target mand during 0 s trials which may have impacted the efficiency with which she mastered that word during the 5 s trials. More specifically, it is unclear whether Jessica would have mastered the target word instructed as a tact more quickly if the same number of 0 s CTD trials had been conducted as the target word instructed as a mand. Therefore, Jessica's intervention results did not suggest a clear difference in efficiency for instruction in a particular verbal operant.

Post-Functional Analysis Results

Graphical representations of the post-functional analysis results for each participant are reported in Figures 3.7-3.9 and descriptive data are reported in Tables 3.7-3.9. Graphs display the frequency of responses recorded during each 5 min session.

Selena. Results from the post-functional analysis for Selena (Figure 3.7 and Table 3.7) suggested that the functional analysis methodology accurately measured the target verbalization in the operant it was taught (i.e., word mastered as a tact during intervention was assessed as a tact during functional analysis) and that for Selena, verbalizations did not spontaneously generalize across operants. Specifically, for the target word "stingray," which was trained as a tact, there was a significant difference between frequency of the verbalizations during tact test and controls sessions (control mean frequency was below the 20% criterion) indicating that Selena was successfully using the verbalization as a tact. Lower frequency of the target verbalization were observed during mand test and control conditions, which did not meet the 20% criterion, further supporting that the target verbalization was serving a tact function as Selena tended to say the target word only when the item was represented for 5 s intervals during the mand test condition and spontaneously emitted the word while accessing it during the mand control condition. During the echoic phase, low levels of the target verbalization were recorded during the test sessions and zero levels during the control sessions suggesting that "stingray" continued to serve an echoic function as well since the target word was initially trained as an echoic. Selena's second target word, "wand," was trained as a mand (after being trained as an echoic). Differentiation between test and control sessions was observed during both of these phases with zero rates of responding during tact test and control sessions. Finally, the control word of “robot” was only verbalized during the echoic test sessions which was expected since the target verbalization had not received any additional instruction pairing it with the item itself.

Edward. Post-functional analysis results for Edward (Figure 3.8 and Table 3.8) suggested that cross-operant generalization did spontaneously occur, including the control verbalization which had been observed during the intervention phase. Edward’s target verbalization “crocodile” was trained as a tact; however, differentiation between test and control conditions was observed during tact, mand, and echoic phases indicating that this verbalization serves multiple functions in his verbal repertoire. Similar to the pattern noted in the original functional analysis of verbal behavior, Edward engaged in high frequency of responding during the echoic test conditions that seemed unrelated to the author’s verbal prompt (i.e., repeating the verbalization 8-10 times during a 20 s interval). As such, a third date path was added to reflect those verbalizations which occurred within 5 s of the author’s verbal prompt and thus meeting the definition of an echoic within the literature (Kodak & Clements, 2009; Stock, Schulze, & Mirenday, 2008) and the current study. This was required for all three of Edward’s target verbalizations. As discussed in Dommestrup et al. (2013), it is possible that Edward’s repeated verbalizations during the echoic test sessions reflect a *self-echoic* which is maintained by automatic reinforcement and is under the control of the verbal stimulus provided by oneself (Esch, Esch, McCart, & Petursdottir, 2010; Skinner, 1957). This is difficult to interpret as the pattern of responding was not evident during tact or mand test sessions but was consistent across all three target verbalizations. Edward’s second target verbalization, “blowout,” was trained as a mand, but showed a similar pattern with significant differentiation between test and control sessions frequencies being observed across operant phases (all control mean frequencies were below the 20% criterion). The control verbalization, “robot,” had spontaneously generalized during the intervention phase without specific instruction was found to function as a tact, mand, and echoic during the post-functional analysis with a similar pattern to Edward's trained target verbalizations.

Jessica. Results from Jessica's post-functional analysis (Figure 3.9 and Table 3.9) did not reflect similar findings to Selena and Edward. For all three of Jessica's target verbalizations, "stingray," "eye glass," and "wand," differentiation between test and control sessions was observed during the echoic phase only, all meeting the 20% criterion. For "stingray," which was trained as a mand, one verbalization was observed during one mand test session. Similarly, one verbalization of the tact-trained target verbalization "eye glass" was recorded during a tact test session and a mand test session. The control word "wand" was not emitted during any tact or mand sessions.

Discussion

Results of the current study, coupled with outcomes of an initial functional analysis of verbal behavior investigation, provide information relevant to ongoing extension and application of Lerman et al.'s (2005) assessment methodology. Previous research has suggested that results of a functional analysis of verbal behavior may assist in guiding intervention and treatment planning. The current study attempted to investigate this hypothesis for three children with ASD with mixed results. Results of an initial functional analysis of verbal behavior conducted with each child suggested that each child used words already in their verbal behavior as tacts, mands, and echoics so a clear area of strength or weakness was not identified during the initial assessment to specifically guide intervention procedures. An intervention was conducted to teach each child a novel item label as a mand and a second novel item label as a tact to assess whether they would learn more efficiently when instruction was provided targeting a specific operant.

Selena and Edward both mastered the target verbalization trained as a tact more efficiently than the target trained as a mand, conversely, Jessica mastered both target words with approximately the same efficiency (i.e., 15 and 16 total CTD sessions). Of note, Edward also mastered the control word during mand and tact probe trials without additional instruction. It is unclear whether baseline trials were inaccurate in measuring whether Edward had a previously mastered label for the item or if he independently paired the item with the label after receiving echoic training for the three target verbalizations. It is important to note that these results are very tentative since only one word was instructed per operant for each participant. Replications across additional pairs of words in future research would strengthen the conclusions that may be drawn from this type of investigation. All three participants in the current study received preschool instruction, and Selena and Edward also received additional speech and language therapy which may have affected the results of the current study. Specifically, prior learning and reinforcement history (e.g., access to non-targeted, preferred items for correct responding) may have impacted responding during tact conditions if outside services focused instruction on this operant including responding to verbal prompts such as, “What’s this?” which was used in the current study.

A second purpose of the current study was to assess the sensitivity of Lerman et al.’s (2005) methodology in measuring verbalizations which were known to function as a specific operant based on intervention instruction. Results of this portion of the current study were variable. Selena’s post-functional analysis of verbal behavior suggested that the methodology was accurate in measuring the frequency of verbalizations for her target words, including a control word which did not receive instruction. Results of Edward’s post-functional analysis of verbal behavior suggested that the instructed words had spontaneously generalized across operants and were multiply maintained. In other words, multiple functions were identified for each of the target words even though instruction targeting multiple operants for each word had not occurred. Jessica's post-functional analysis results did not follow this pattern with all three of her target words being identified as only serving an echoic function. This could be attributed to several possible variables. During tact training, participants received reinforcement for correct responding in the form of a preferred non-target item whereas during the functional analysis tact test sessions the participant had access to the target item and received only verbal praise for correct responding. Therefore, an EO may not have been captured during the functional analysis tact test sessions and may not represent Jessica's ability to tact the target item accurately. Mand test sessions were more similar to mand training sessions with the exception of the intermixing of mastered tasks with mand training trials which may have impacted the momentum of responding to the presence of the target item. An EO was assumed to be present based on the motivating operation assessment conducted prior to each mand training session so it is unlikely that this impacted participant's lack of responding during these sessions.

Overall, results of the current study do not directly support the findings in the literature on the functional analysis of verbal behavior. Two of the three participants demonstrated differentiated rates of efficiency during intervention targeting specific verbal operants; however, these results could not be directly linked to initial functional analysis results since target verbalizations were multiply maintained for all participants and therefore do not provide any additional information to support the hypothesized link between assessment and intervention as proposed in Lerman et al. (2005). Two participants' responding during a functional analysis of the newly acquired verbalizations reflected that the methodology identified the functions being served by specific verbalizations; however, for one of the participants multiple functions were identified through the assessment even though instruction had not targeted multiple operants for each of the target words. The third participant's results in both the intervention and post-functional analysis phases did not demonstrate similar findings. Specifically, the post-functional analysis did not capture the mastery of either target verbalization in their respective operant for this participant. This participant did not receive additional services outside of her preschool setting compared to the other two participants but otherwise no significant differences between participants were noted. Additional investigations assessing the sensitivity of the functional analysis of verbal behavior methodology should be conducted with participants receiving varying degrees of additional instruction to determine what role this may play in the assessment of functions maintaining verbal behavior in children with ASD.

Limitations and Future Directions

In general, results of this study suggested that both language intervention and functional analysis of verbal behavior methodology can be completed in a participant's home; however, it is possible that this setting may have impacted responding during individual sessions. For example, an EO for a target item may have been captured by the MOA but this could shift quickly if another item in the general environment captured the participant's attention without being obvious to the author. Significant problem behaviors were not observed from any of the three participants in the current study; but it is possible that conducting assessment or intervention sessions in the home may result in some negative behavior depending on the participant's learning history within that context.

As discussed above, results of Jessica's intervention and post-functional analysis participation in the current study did not reflect the hypothesized pattern of responding observed by the other two participants. This may have been partially due to the differences in consequences provided during intervention and functional analysis sessions. This could be addressed in future research by completing intervention or training using antecedent and consequent variables more similar to those used in the functional analysis of verbal behavior methodology. Specifically, completing tact training sessions where the participant receives only verbal praise instead of access to a preferred item. This is also a potential confound reflected in the more efficient learning of the tacts for Selena and Edward which may be similarly due to the difference in consequent variables. During tact training sessions, participants were provided with a brief preference assessment of non-target, low preferred items to serve as reinforcement for correctly tacting (labeling) the target item prior to completing the session. It is possible that the EO for this non-target item may have been stronger than the EO for the mand target item which may have impacted the efficiency of responding. Although a mand training session would not have been completed if the participant did not engage with the target item within 10 s of beginning the session, it was a forced choice for engagement since no other item was presented with the target item.

Use of this methodology for measuring the conditions which evoke and maintain a child's verbalizations is still relatively new in the literature on the language development of children with ASD and other developmental disabilities (Plavnick & Normand, 2013), as such, additional replications including participants of varying functioning levels should be continued to further identify variables which support the successful use of the methodology in not only identifying uses of current language but guiding intervention and treatment. Based on the results of the post-functional analysis in the current study, additional attention and potential modifications should be made to ensure that functional analysis conditions are accurately capturing situations in which verbalizations are made in the natural environment to ensure the validity of the information being accrued during a functional analysis of verbal behavior. For example, taking into account a child's learning and reinforcement history, pattern of responding and reinforcement during interactions with parents or other therapists, and presence of a motivating operation for the planned consequence or reinforcer (i.e., history of reinforcement for verbal praise).

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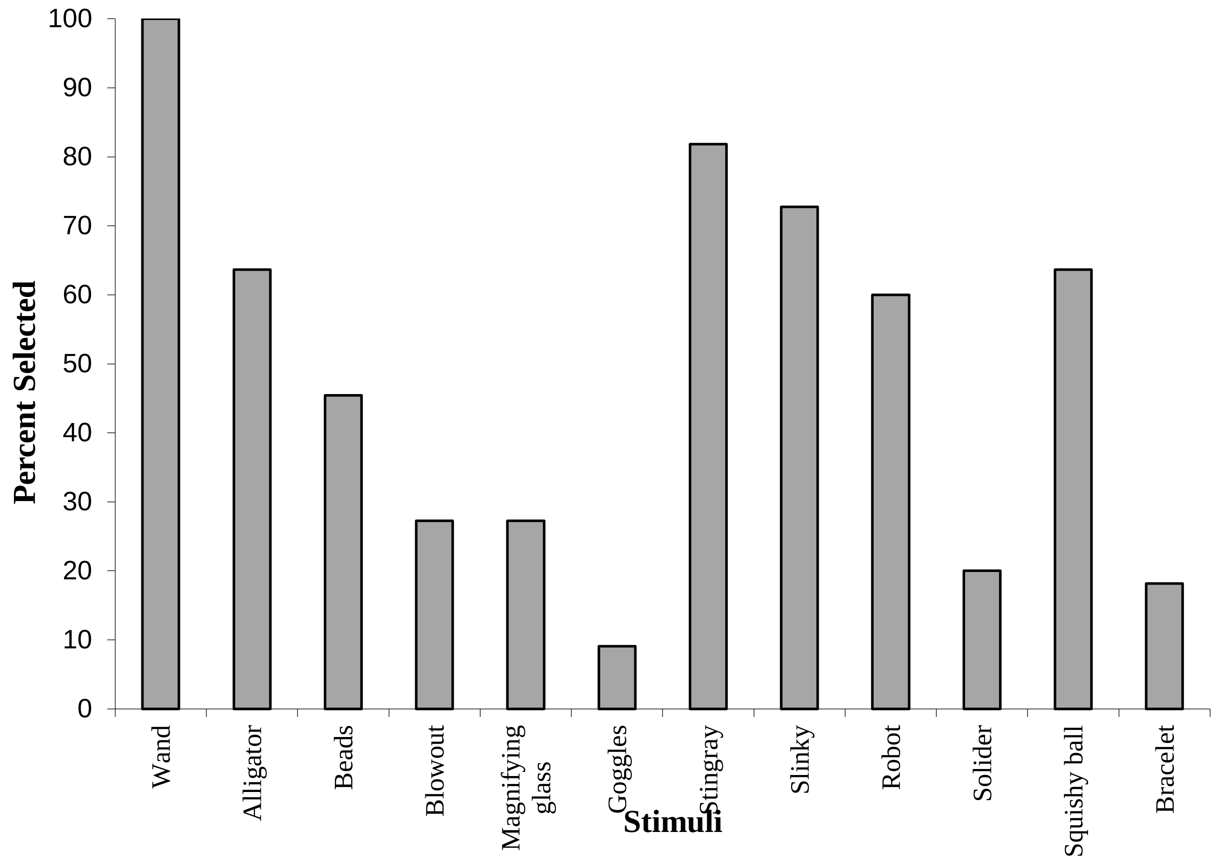

Figure 3.1. Paired choice preference assessment results for Selena. Bars represent percentage of trials the item was selected during paired presentations with each of the other items.

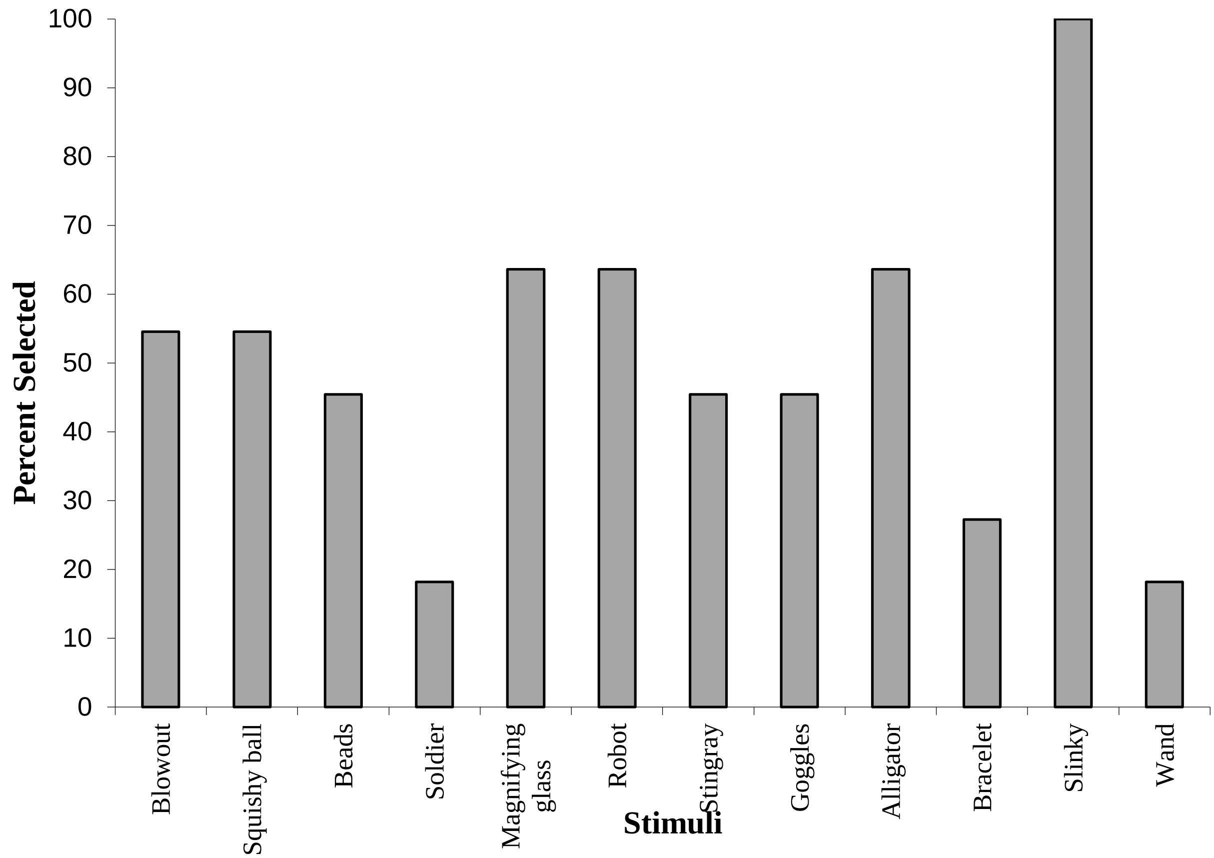

Figure 3.2. Paired choice preference assessment results for Edward. Bars represent percentage of trials the item was selected during paired presentations with each of the other items.

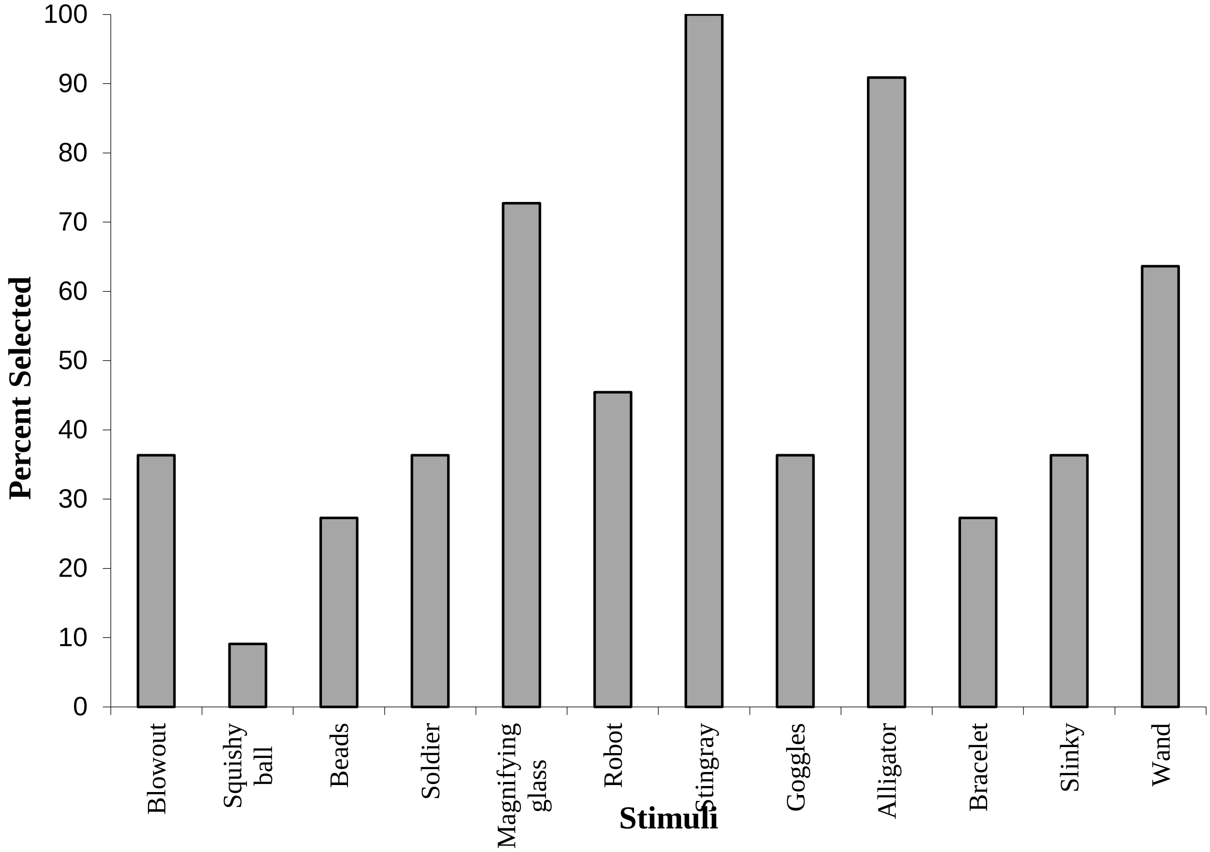

Figure 3.3. Paired choice preference assessment results for Jessica. Bars represent percentage of trials the item was selected during paired presentations with each of the other items.

Table 3.1

Intervention Interrater Reliability and Procedural Integrity Data

			Selena					
"Wand"			"Stingray"			"Robot"		
Condition (Session)	Interrater Reliability	Procedural Integrity	Condition (Session)	Interrater Reliability	Procedural Integrity	Condition (Session)	Interrater Reliability	Procedural Integrity
BL (1)	100%	100%	BL (1)	100%	100%	BL (1)	100%	100%
Echoic (3)	100%	100%	Echoic (3)	100%	100%	Echoic (3)	100%	100%
Echoic (5)	100%	100%	Echoic (5)	100%	100%	Echoic (5)	100%	100%
Echoic (6)	100%	100%	Echoic (6)	100%	100%	Echoic (6)	100%	100%
Mand 0 (11)	100%	80%	Tact 0 (12)	100%	80%	Control (16)	100%	100%
Mand 0 (13)	100%	100%	Tact 0 (13)	100%	100%	Control (18)	100%	100%
Mand 0 (15)	100%	100%	Tact 0 (14)	100%	100%	Control (20)	100%	100%
Mand 5 (16)	100%	100%	Tact 5 (16)	100%	100%			
Mand 5 (19)	100%	100%	Tact 5 (18)	100%	100%			
Mand 5 (22)	100%	100%						

Note. Interrater reliability = Agreements/Total number of trials. BL = Baseline condition (5 total trials); Echoic = Echoic training (10 trials per session); Mand 0 = Mand training 0 s constant time delay (10 trials per session); Mand 5 = Mand training 5 s constant time delay (10 trials per session); Tact 0 = Tact training 0 s constant time delay (10 trials per session); Tact 5 = Tact training 5 s constant time delay (10 trials per session); Control = Control condition (2 trials per session).

Table 3.2

Intervention Interrater Reliability and Procedural Integrity Data

			Edward					
"Blowout"			"Crocodile"			"Robot"		
Condition (Session)	Interrater Reliability	Procedural Integrity	Condition (Session)	Interrater Reliability	Procedural Integrity	Condition (Session)	Interrater Reliability	Procedural Integrity
BL (1)	100%	100%	BL (1)	100%	100%	BL (1)	100%	100%
Echoic (2)	100%	100%	Echoic (2)	100%	100%	Echoic (2)	100%	100%
Mand 0 (6)	100%	100%	Tact 0 (5)	100%	90%	Control (7)	100%	100%
Mand 5 (8)	100%	80%	Tact 5 (7)	100%	100%	Control (10)	100%	100%
Mand 5 (9)	100%	100%	Tact 5 (10)	100%	100%	Control (11)	100%	100%
Mand 5 (13)	100%	100%						

Note. Interrater reliability = Agreements/Total number of trials. BL = Baseline condition (5 total trials); Echoic = Echoic training (10 trials per session); Mand 0 = Mand training 0 s constant time delay (10 trials per session); Mand 5 = Mand training 5 s constant time delay (10 trials per session); Tact 0 = Tact training 0 s constant time delay (10 trials per session); Tact 5 = Tact training 5 s constant time delay (10 trials per session); Control = Control condition (2 trials per session).

Table 3.3

Intervention Interrater Reliability and Procedural Integrity Data

Jessica								
"Stingray"			"Eye Glass"			"Wand"		
Condition (Session)	Interrater Reliability	Procedural Integrity	Condition (Session)	Interrater Reliability	Procedural Integrity	Condition (Session)	Interrater Reliability	Procedural Integrity
BL (1)	100%	100%	BL (1)	100%	100%	BL (1)	100%	100%
Echoic (2)	100%	100%	Echoic (2)	100%	100%	Echoic (2)	100%	100%
Echoic (4)	100%	100%	Echoic (4)	100%	100%	Echoic (4)	100%	100%
Mand 0 (7)	100%	80%	Tact 0 (6)	100%	100%	Control (10)	100%	100%
Mand 0 (8)	100%	100%	Tact 5 (14)	100%	100%	Control (12)	100%	100%
Mand 5 (13)	100%	100%	Tact 5 (18)	100%	100%	Control (15)	100%	100%
Mand 5 (14)	100%	100%	Tact 5 (20)	100%	100%	Control (18)	100%	100%
Mand 5 (18)	100%	100%	Tact 5 (22)	100%	100%	Control (19)	100%	100%
Mand 5 (20)	100%	100%	Tact 5 (23)	100%	100%			

Note. Interrater reliability = Agreements/Total number of trials. BL = Baseline condition (5 total trials); Echoic = Echoic training (10 trials per session); Mand 0 = Mand training 0 s constant time delay (10 trials per session); Mand 5 = Mand training 5 s constant time delay (10 trials per session); Tact 0 = Tact training 0 s constant time delay (10 trials per session); Tact 5 = Tact training 5 s constant time delay (10 trials per session); Control = Control condition (2 trials per session).

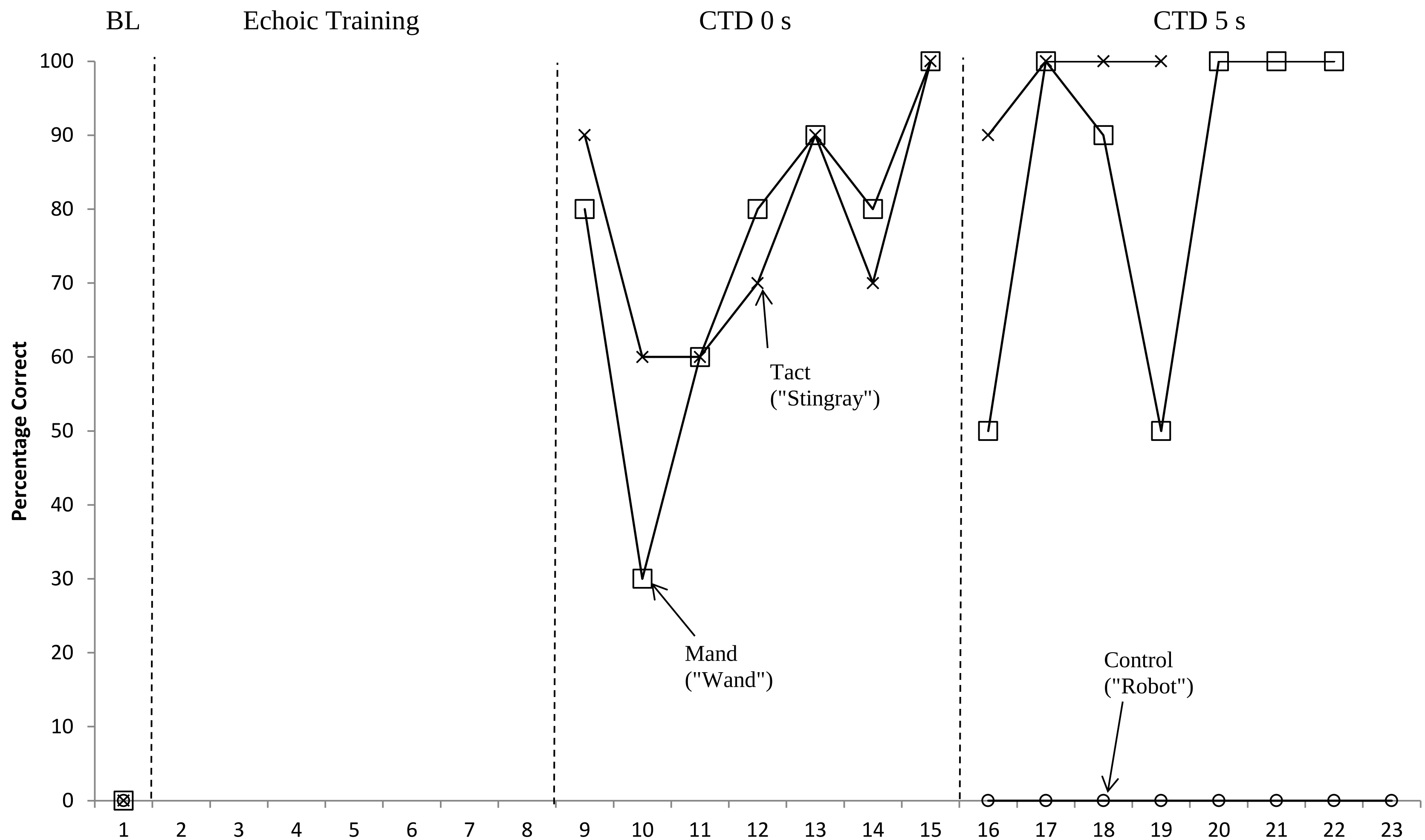

Figure 3.4. Mand and tact training intervention results for Selena. Open square data points represent percentage of correct unprompted responses for the mand training target word, "wand." X data points represent percentage of correct unprompted responses for the tact training target word, "stingray." Open circle data points represent percentage of correct responses for the control word, "robot." BL = Baseline; CTD = Constant time delay.

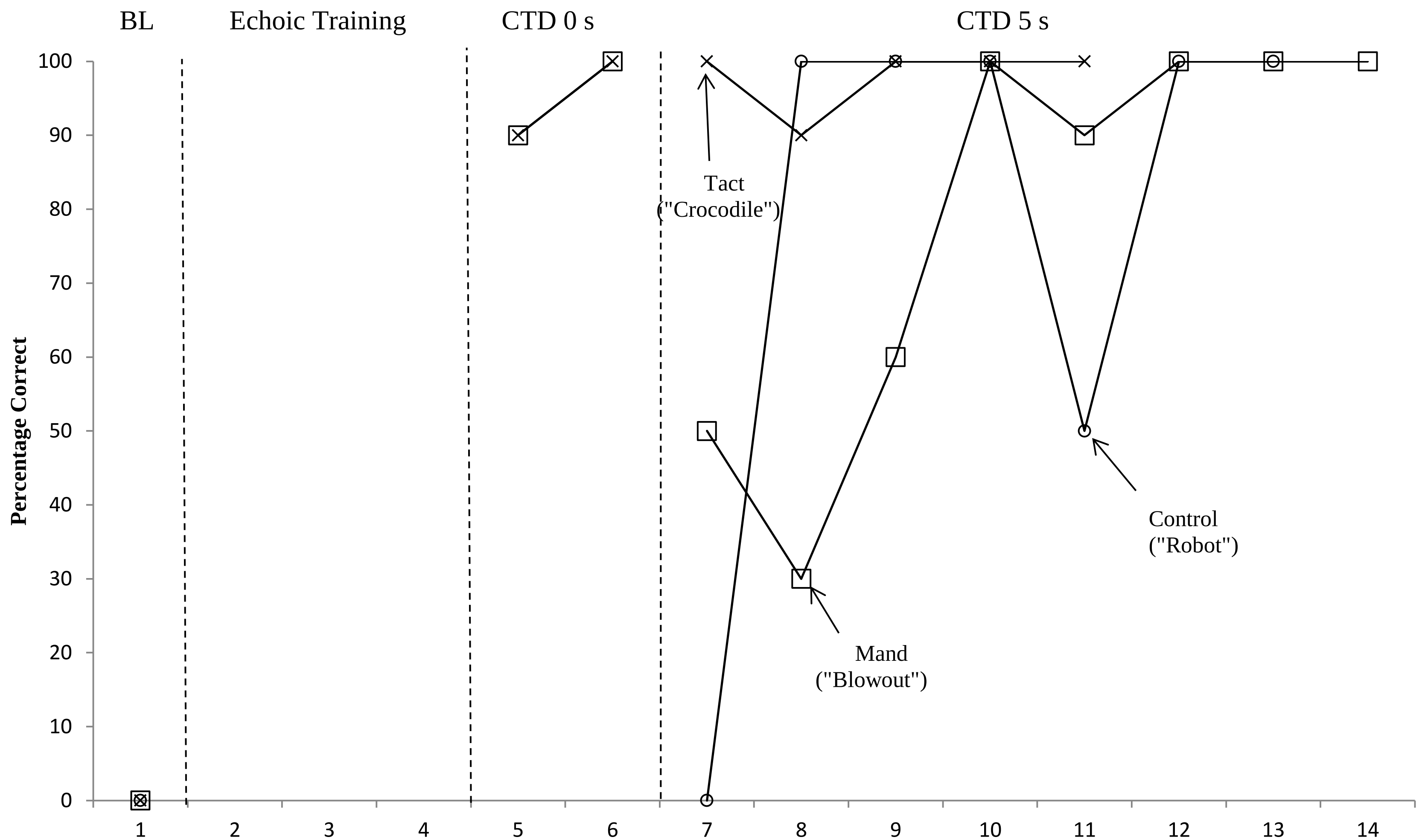

Figure 3.5. Mand and tact training intervention results for Edward. Open square data points represent percentage of correct unprompted responses for the mand training target word, “blowout.” X data points represent percentage of correct unprompted responses for the tact training target word, “crocodile.” Open circle data points represent percentage of correct responses for the control word, “robot.” BL = Baseline; CTD = Constant time delay.

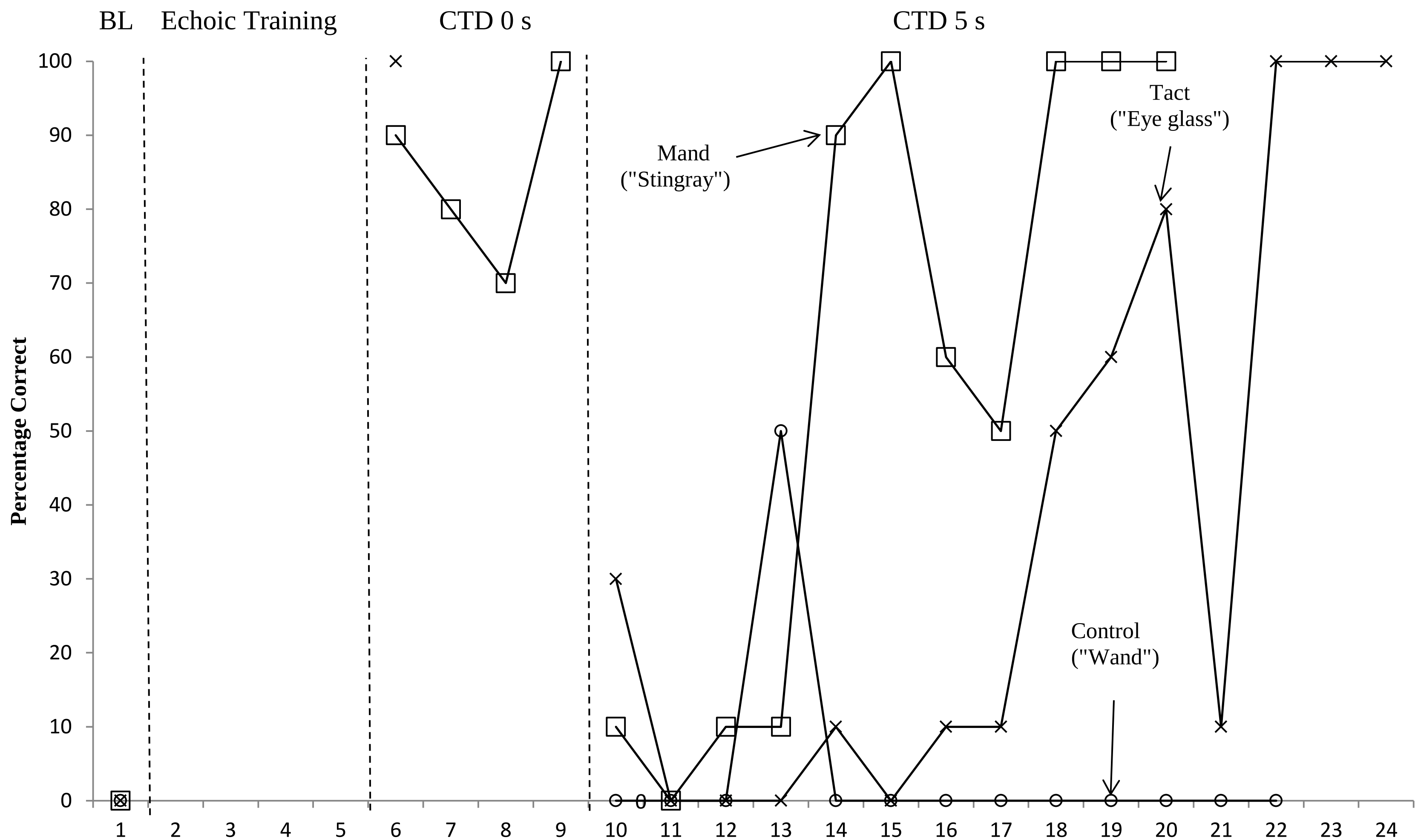

Figure 3.6. Mand and tact training intervention results for Jessica. Open square data points represent percentage of correct unprompted responses for the mand training target word, “stingray.” X data points represent percentage of correct unprompted responses for the tact training target word, “eye glass.” Open circle data points represent percentage of correct responses for the control word, “wand.” BL = Baseline; CTD = Constant time delay.

Table 3.4

Post-Functional Analysis Interrater Reliability and Procedural Integrity Data for Selena

	Selena									
	"Wand"			"Stingray"			"Robot"			
Condition	Session	Interrater Reliability	Procedural Integrity	Session	Interrater Reliability	Procedural Integrity	Session	Interrater Reliability	Procedural Integrity
Tact Test	3	100%	100%	3	80%	100%	5	100%	100%
Tact Control	4	100%	100%	2	100%	100%	2	100%	100%
Motivating Operation Assessment	7e	100%	100%	7	100%	100%	7	100%	100%
Mand Test	7	100%	90.9%	7	100%	100%	7	100%	100%
Mand Control	8	100%	100%	8	93.3%	100%	8	100%	100%
Echoic Test	15	100%	100%	14	100%	100%	15	100%	100%
Echoic Control	16	100%	100%	13	93.3%	100%	16	100%	100%

Note. Interrater Reliability = Agreements/(Agreements +Disagreements) x 100%; Procedural Integrity = Correct Opportunities/(Correct+ Incorrect Opportunities) x 100%

Table 3.5

Post-Functional Analysis Interrater Reliability and Procedural Integrity Data for Edward

	Edward								
	"Blowout"			"Crocodile"			"Robot"		
Condition	Session	Interrater Reliability	Procedural Integrity	Session	Interrater Reliability	Procedural Integrity	Session	Interrater Reliability	Procedural Integrity
Tact Test	3	93.3%	100%	1	93.3%	100%	3	100%	100%
Tact Control	2	100%	100%	2	100%	100%	4	100%	100%
Motivating Operation Assessment	8	100%	100%	7	100%	100%	7b	100%	100%
Mand Test	8	86.7%	100%	7	100%	100%	7	86.7%	100%
Mand Control	7	100%	100%	8	100%	100%	8	100%	100%
Echoic Test	15	80%	97%	13	86.7%	96%	15	86.7%	97.1%
Echoic Control	16	100%	100%	14	100%	100%	16	100%	100%

Note. Interrater Reliability = Agreements/(Agreements +Disagreements) x 100%; Procedural Integrity = Correct Opportunities/(Correct+ Incorrect Opportunities) x 100%

Table 3.6

Post-Functional Analysis Interrater Reliability and Procedural Integrity Data for Jessica

	Jessica									
		"Stingray"			"Eye Glass"				"Wand"	
Condition	Session	Interrater Reliability	Procedural Integrity	Session	Interrater Reliability	Procedural Integrity	Session	Interrater Reliability	Procedural Integrity	
Tact Test	1	100%	93.8%	5	100%	100%	1	100%	100%	
Tact Control	2	100%	100%	4	100%	100%	2	100%	100%	
Motivating Operation Assessment	7c	100%	100%	10	100%	100%	9	100%	100%	
Mand Test	7	100%	100%	10	100%	100%	9	100%	100%	
Mand Control	8	100%	100%	9	100%	100%	8	100%	100%	
Echoic Test	13	93.3%	90.9%	17	100%	100%	17	100%	100%	
Echoic Control	14	100%	100%	14	100%	100%	14	100%	100%	

Note. Interrater Reliability = Agreements/(Agreements +Disagreements) x 100%; Procedural Integrity = Correct Opportunities/(Correct+ Incorrect Opportunities) x 100%

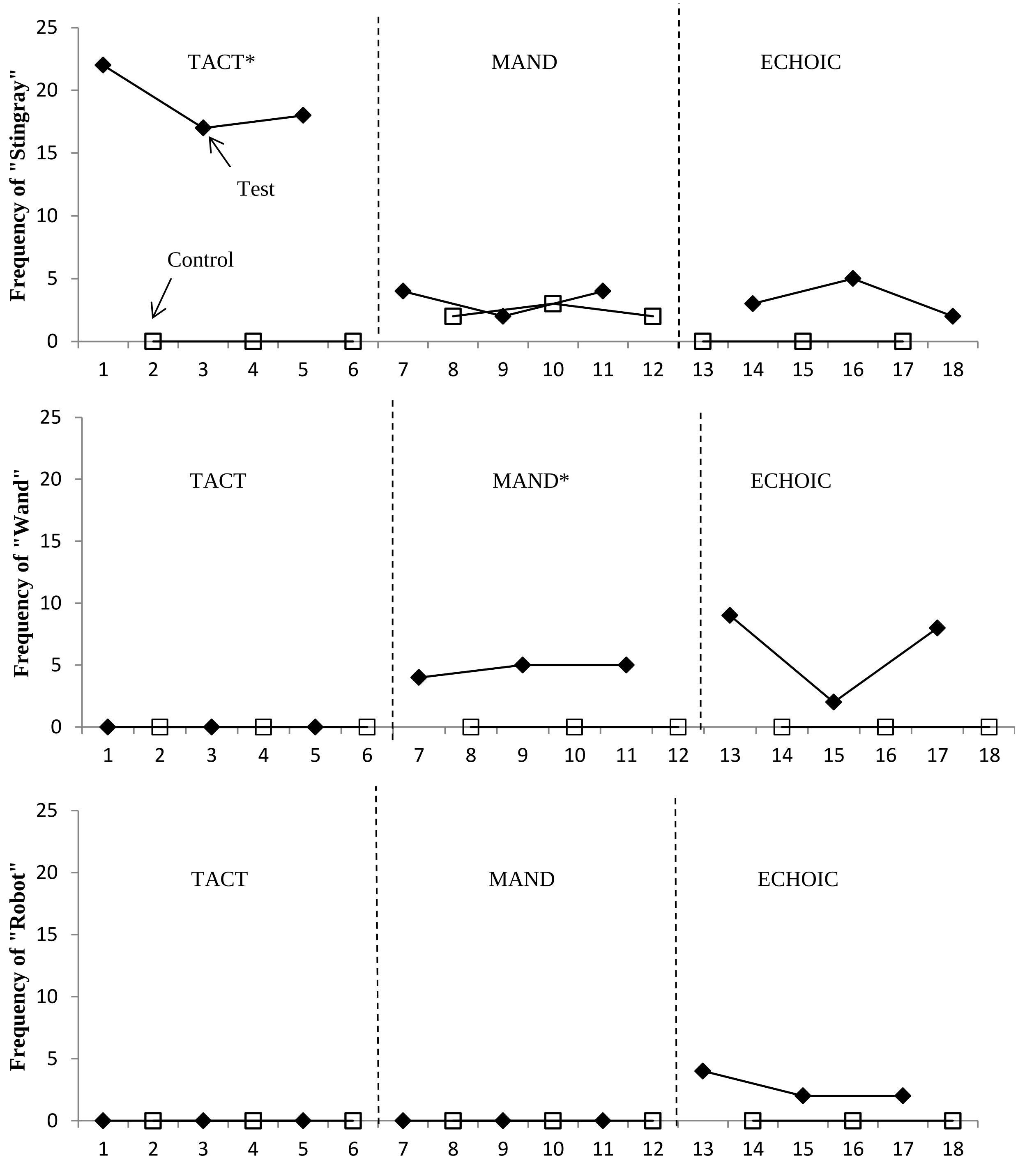

Figure 3.7. Post-functional analysis results for Selena. Closed data points represent frequency of target verbalization recorded during test sessions for the identified operant. Open data points represent frequency of target verbalization recorded during control sessions for the identified operant. * = operant in which target word received training.

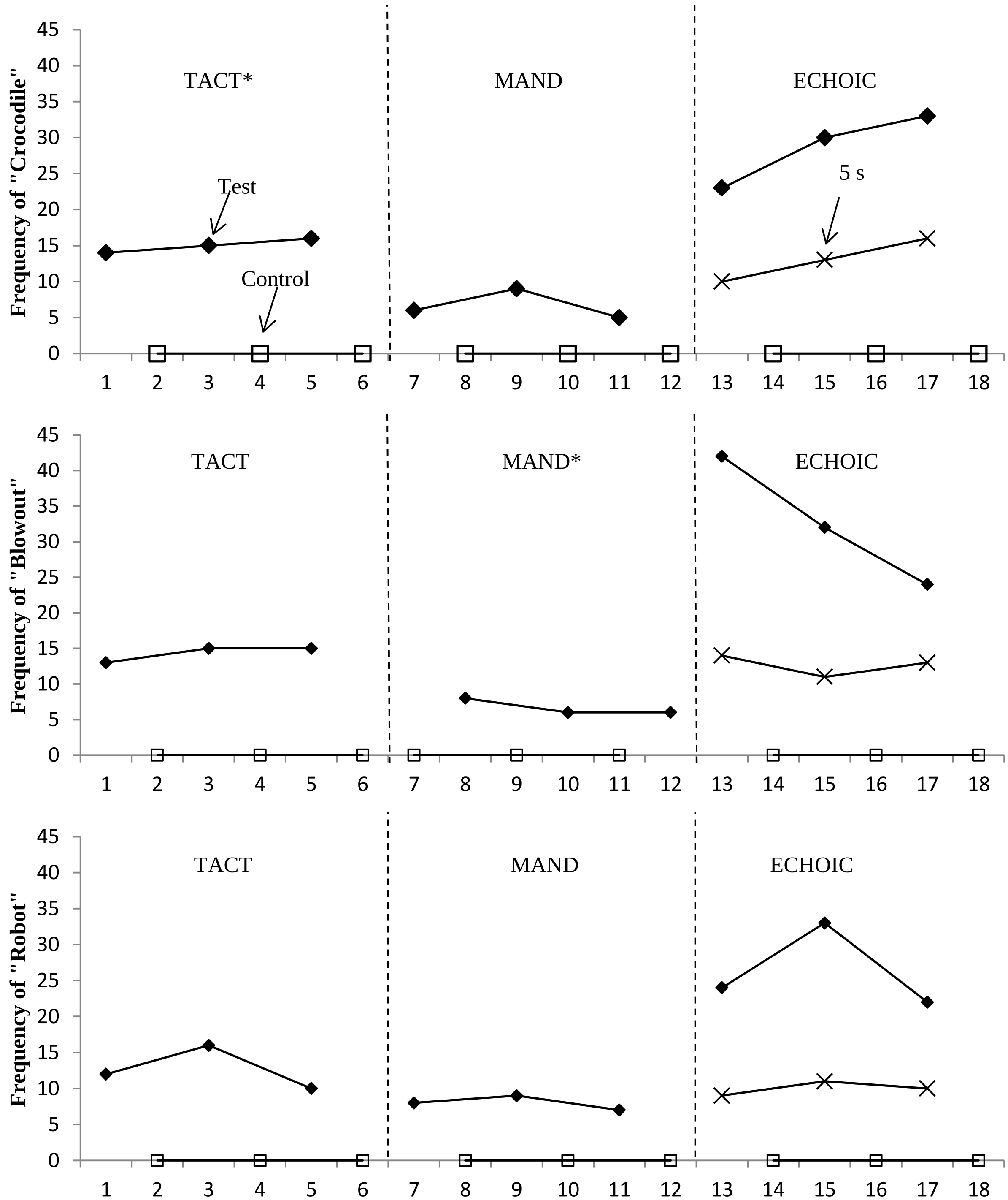

Figure 3.8. Post-functional analysis results for Edward. Closed data points represent frequency of target verbalization recorded during test sessions for the identified operant. Open data points represent frequency of target verbalization recorded during control sessions for the identified operant. X data points represent frequency of target verbalizations when test sessions were recoded to reflect only those verbalizations emitted within 5 s of the author's verbal prompt. * = operant in which target word received training.

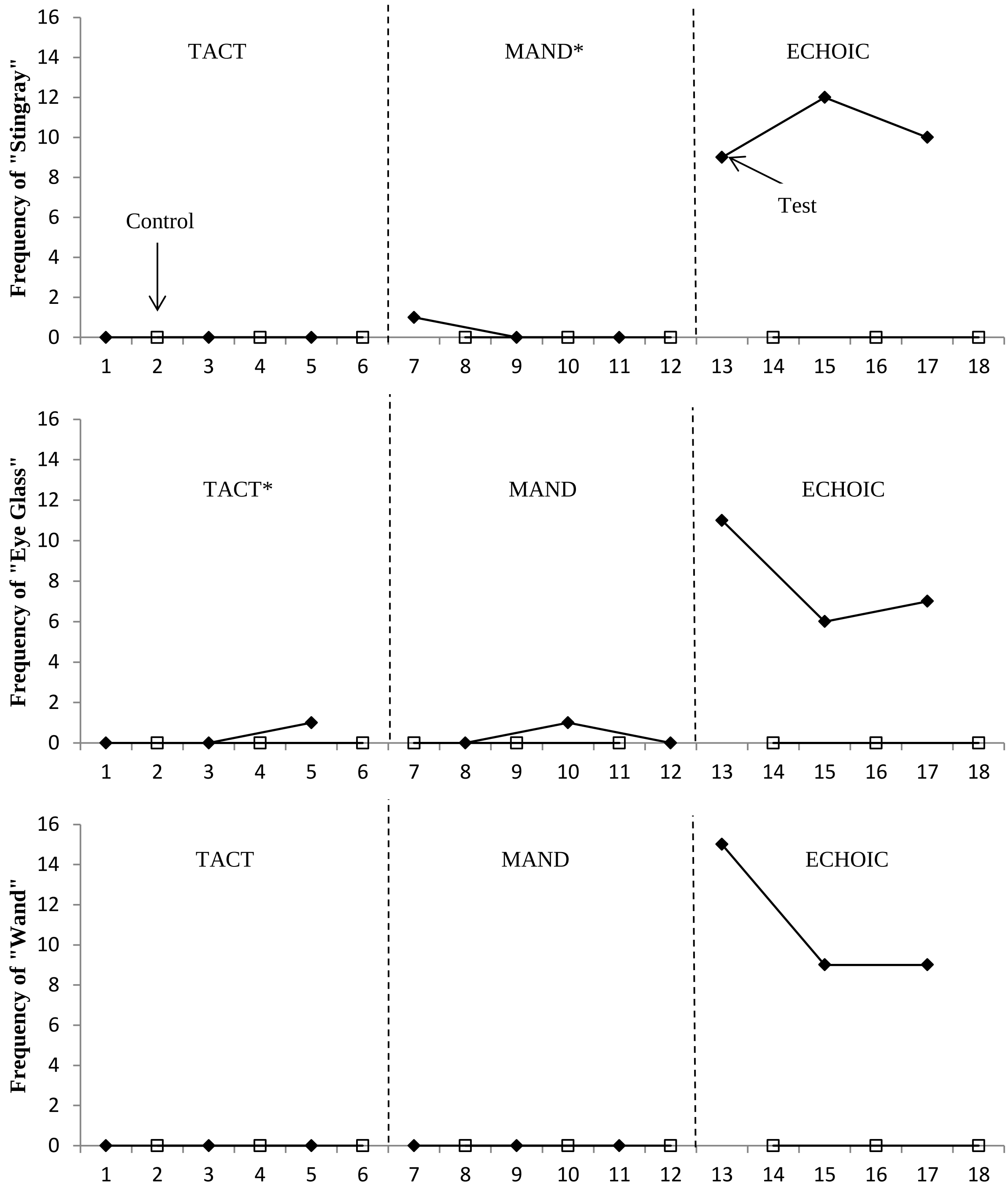

Figure 3.9. Post-functional analysis results for Jessica. Closed data points represent frequency of target verbalization recorded during test sessions for the identified operant. Open data points represent frequency of target verbalization recorded during control sessions for the identified operant. * = operant in which target word received training.

Table 3.7

Post-Functional Analysis Descriptive Data for Selena

Selena									
		"Wand"			"Stingray"			"Robot"	
Condition	*n*	*M (SD)*	Range	*n*	*M (SD)*	Range	*n*	*M (SD)*	Range
Tact Test	3	0.0 (0.0)	0	3	19.0 (2.2)	17-22	3	0.0 (0.0)	0
Tact Control	3	0.0 (0.0)	0	3	0.0 (0.0)	0	3	0.0 (0.0)	0
Mand Test	3	4.7 (0.5)	4-5	3	3.3 (0.9)	2-4	3	0.0 (0.0)	0
Mand Control	3	0.0 (0.0)	0	3	2.3 (0.5)	2-3	3	0.0 (0.0)	0
Echoic Test	3	6.3 (3.1)	2-9	3	3.3 (1.2)	2-5	3	2.7 (0.9)	2-4
Echoic Control	3	0.0 (0.0)	0	3	0.0 (0.0)	0	3	0.0 (0.0)	0

Note. Mean and standard deviation calculations approximated to one decimal point.

Table 3.8

Post-Functional Analysis Descriptive Data for Edward

Edward									
	"Blowout"			"Crocodile"			"Robot"		
Condition	*n*	*M (SD)*	Range	*n*	*M (SD)*	Range	*n*	*M (SD)*	Range
Tact Test	3	14.3 (0.9)	13-15	3	15.0 (0.8)	14-16	3	12.7 (2.5)	10-16
Tact Control	3	0.0 (0.0)	0	3	0.0 (0.0)	0	3	0.0 (0.0)	0
Mand Test	3	6.7 (0.9)	6-8	3	6.7 (1.7)	5-9	3	8.0 (0.8)	7-9
Mand Control	3	0.0 (0.0)	0	3	0.0 (0.0)	0	3	0.0 (0.0)	0
Echoic Test	3	32.7 (7.4)	24-42	3	28.7 (4.2)	23-33	3	26.3 (4.8)	22-33
Echoic Test[a]	3	12.7 (1.2)	11-14	3	13.0 (2.4)	10-16	3	10.0 (0.8)	9-11
Echoic Control	3	0.0 (0.0)	0	3	0.0 (0.0)	0	3	0.0 (0.0)	0

Note. Mean and standard deviation calculations approximated to one decimal point.
[a]Echoic test sessions were recoded to analyze frequency of target verbalizations emitted within 5 s of author's verbal prompt.

Table 3.9

Post-Functional Analysis Descriptive Data for Jessica

Jessica									
	"Stingray"			"Eye Glass"			"Wand"		
Condition	*n*	*M (SD)*	Range	*n*	*M (SD)*	Range	*n*	*M (SD)*	Range
Tact Test	3	0.0 (0.0)	0	3	0.3 (0.5)	0-1	3	0.0 (0.0)	0
Tact Control	3	0.0 (0.0)	0	3	0.0 (0.0)	0	3	.0 (0.0)	0
Mand Test	3	0.3 (0.5)	0-1	3	0.3 (0.5)	0-1	3	0.0 (0.0)	0
Mand Control	3	0.0 (0.0)	0	3	0.0 (0.0)	0	3	0.0 (0.0)	0
Echoic Test	3	10.3 (1.2)	9-12	3	8.0 (2.1)	6-11	3	11.0 (2.8)	9-15
Echoic Control	3	0.0 (0.0)	0	3	0.0 (0.0)	0	3	0.0 (0.0)	0

Note. Mean and standard deviation calculations approximated to one decimal point.

CHAPTER 4

GENERAL DISCUSSION

With recent adjustments being made to the diagnostic criteria for autism spectrum disorders (ASD; American Psychiatric Association [APA], 2013), as well as the increases in prevalence of ASD rising to 1 in 50 (Blumberg et al., 2013), ongoing investigations into the social and functional communication skills of children with ASD are becoming increasingly relevant. Language and communication interventions have been evaluated and proven effective for certain children with ASD (National Research Council of the National Academy of Sciences [NRC], 2001); however, better assessment measures and linking intervention to assessment results is a burgeoning area in the field of language development in children with ASD (Plavnick & Normand, 2013). Researchers have started incorporating Skinner's (1957) assessment of verbal behavior as a method to define and develop variables to measure the language being used in the verbal repertoires of children with ASD (Lerman et al., 2005). Specifically, Skinner defined six verbal operants, three of which were explored in the current studies: *tact*, *mand*, and *echoic.*

Tacts serve the function of an item label in that the item is present and a child emits a verbalization which they identify with that particular item. Mands are motivated by a need or desire for a particular item or activity (i.e., motivating operation [MO]) so the verbalization is emitted with the goal of gaining access to that item or activity. Echoics are the most basic verbal operant according to Skinner (1957) as the verbalization is emitted solely because the child is repeating what a parent or adult has said to them. How these operants are utilized in the verbal repertoires of children with ASD is an ongoing question in the literature.

The goal of the studies presented was to investigate the current methodology for assessing the functional use of verbal behavior in children with ASD, including the sensitivity of measurement, and the link between functional analysis results and intervention. Replications have been successfully completed supporting the effectiveness of the functional analysis of verbal behavior methodology (Kelley, Shillingsburg, Castro, Addison, LaRue, & Martins, 2007; LaFrance, Wilder, Normand, & Squires, 2009); however, to date, no research has followed the analysis with a language-based intervention to evaluate the clinical utility of the assessment results (Plavnick & Normand, 2013). Therefore, the current studies attempted to bridge this gap by assessing the sensitivity and accuracy of the functional analysis methodology prior to and post-verbal operant intervention with children with ASD.

The first study was a systematic replication with modifications of the functional analysis of verbal behavior methodology originally described by Lerman et al. (2005) implemented with three children with ASD. To address concerns noted in previous replications (LaFrance et al., 2009) a novel modification was made to the methodology to assess for the presence of an establishing operation (EO) prior to completing mand test sessions. This modification was effective in determining when a mand test session should or should not be conducted based on the participant's interest in, and therefore perceived EO for, the target item. Two target verbalizations were included in functional analyses for all three participants.

Results of this study suggested that the functional analysis of verbal behavior methodology effectively identified a consistently utilized function for the target verbalizations for all participants. For all three participants, both target verbalizations were found to serve multiple functions, including tact, mand, and echoic for all but one verbalization for one participant. This finding was inconsistent with Lerman et al.'s (2005) original results where participants were more consistently found to emit verbalizations which served two or fewer functions. The participants in the current study may have represented a higher functioning population in terms of cognitive ability and expressive and receptive vocabulary. Additionally, they had received early intervention and ongoing educational services which may have impacted their learning and reinforcement history to support higher levels of tact maintained verbalizations in their verbal repertoire.

With regard to intervention history, the second study aimed to bridge the gap in the current functional analysis of verbal behavior literature by conducting verbal operant specific interventions targeting novel word learning with each participant. The goal of this intervention was to not only increase the participants' vocabulary but to evaluate the efficiency of word learning in specific verbal operants to compare with functional analysis results. Participants were each taught a novel word as a tact and a second novel word as a mand. A third novel word did not receive any instruction beyond echoic training for stimulus equivalence and was probed as a control. A 5 s constant time delay procedure was implemented for both tact and mand training.

The results of the intervention suggested that for two of the three participants, novel words were mastered more efficiently when instructed as a tact. The third participant mastered the words taught as a mand and a tact with comparable efficiency. It is possible that differences in the tact training sessions compared to the functional analysis tact test sessions may have impacted responding for the participants. Specifically, during tact training sessions, correct responses were reinforced by providing access to a preferred, non-target item, whereas during tact test sessions, correct responses received verbal praise only. This may also have played a role in the responding of the previous two participants during mand training sessions. During mand training sessions an EO was assessed for and correct responding resulted in access to the target item; however, the EO for the non-target reinforcer used during tact training sessions may have been stronger and thus resulted in quicker learning for the tact trained word. Since the initial functional analysis results suggested that the target verbalizations were maintained by multiple functions, it was not possible to directly evaluate a link between functional analysis results and operant specific intervention outcomes.

A second goal of this study was to conduct another functional analysis targeting the three novel words used during the intervention for each participant. The purpose of this was to evaluate the sensitivity of Lerman et al.'s (2005) methodology to measure the function of words known to be served in the participant's repertoire. In other words, will the methodology accurately identify a mand function for a verbalization that received mand training to mastery criteria? Functional analysis of verbal behavior methodology was identical to those utilized in the first study presented with the exception of not including an automatic test condition for any of the verbalizations.

Results of this portion of the study were highly variable across participants. Analysis of the data for one participant suggested that the methodology was highly accurate in assessing the functions of verbalizations. Specifically, the word trained as a tact was assessed to be serving a tact function, the word trained as a mand served a mand function, and the control word did not serve either function. The second participant's results indicated that the methodology may not be as sensitive or that spontaneous cross-operant generalization had occurred for all three target words. Target words, including the control word which did not receive tact or mand training, were all found to be serving both tact and mand functions according to the functional analysis. .

The third participant's post-functional analysis data suggested even less sensitivity in regards to accurately identifying the functions being served by words in the verbal repertoire. For both words which received training, the functional analysis resulted in 1 or fewer responses across three test sessions for both tact and mand conditions. In other words, the word which was mastered as a tact was not assessed to function as a tact and the word mastered as a mand was not assessed to function as a mand according to functional analysis results. Differences in consequent variables as previously discussed may have negatively impacted levels of responding for this participant.

The issue of an EO for the different types of reinforcement available during intervention versus functional analysis sessions is a limitation of the current studies. Theoretically, Lerman et al.'s (2005) methodological design defines the antecedent and consequent variables according to Skinner's (1957) definitions; however, it may be inaccurate to assume that, for example, verbal praise is reinforcing during tact test sessions, especially considering learning and reinforcement history of children with ASD who may receive early intervention and other educational services. Therefore, it is difficult to conclude about the sensitivity of the functional analysis methodology until this is addressed further in future research, including evaluating the presence of an EO for social praise or modifying test conditions to include reinforcement of a non-target item which may more closely replicate situations where a participant is being asked to tact an object.

Exploration of modifications to this methodology and the application to specific populations of children ranging from disability type, cognitive and/or language impairment severity, and types of verbalizations (e.g., single word versus phrases) should be continued. Additionally, similar to the functional analysis of problem behavior literature (Wacker et al., 2005), future investigations should include parent or teacher implemented sessions as this may provide a more naturalistic measurement of the language a child with ASD uses.

As the prevalence and awareness of ASD increases, it is imperative that the availability of effective assessment and intervention practices increases alongside it. More specifically, an increase in the knowledge of which assessment and intervention practices may be better suited for individuals within the heterogeneous population of individuals with ASD. The studies presented here attempted to further this line of questioning by systematically replicating a relatively novel assessment methodology and filling a current hole in the literature regarding the link between language assessment and intervention for children with ASD.

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APPENDIX A

MAND TRAINING INSTRUCTIONAL PROCEDURE

The target stimuli will be placed in front of the participant. Once the participant initiates interaction with the target stimuli, the author will allow 5 s of interaction with the target item before removing the item from reach and beginning the appropriate delayed trial described below. Since the target stimuli name has been trained as an echoic, the controlling prompt to elicit correct responding from the participant will be a verbal prompt of the correct item name.

Zero Second Delay Trials

During the 0 s delay trials, the author will remove the chosen target stimuli from the participant's reach and immediately provide the controlling prompt (i.e., says item name). For example, after the participant has played with a toy car for 5 s the author will hold the car near the far edge of the table and say, "car."

- If the participant correctly echoes the item name (e.g., says "car") the author should immediately return the item to the participant and say, "You asked for the [item name]. Good job! Here is the [item name]." The author should allow the participant to interact with the item for 5 s before removing the item to provide a mastered task.
- If the participant responds incorrectly or does not provide a response within 5 s the author should day, "Wrong," remove the stimuli from the table, and wait 3 s without speaking or making eye contact with the participant before providing a mastered task or beginning the next trial. The author should note whether the participant gave an incorrect response or did not provide a response on the data sheet.

- At least one sessions with 100% correct responding in the 0 s delay format must occur prior to moving to the 5 s delay trial format

Five Second Delay Trials

During the 5 s delay trials, the author will remove the chosen target stimuli from the participant's reach and wait 5 s before giving the controlling prompt. For example, after the participant has played with the car for 5 s the author will hold the car near the far edge of the table and wait 5 s before saying, "car."

- If the participant responds correctly within 5 s after the removal of the item from the participant's reach the author should immediately return the item to the participant and say, "You asked for the [item name]. Good job! Here is the [item name]." The author should allow the participant to consume or interact with the item for 5 s and record the trial as a correct unprompted response on the data sheet before removing the item to provide a mastered task.
- If the participant responds incorrectly within 5 s after removal of the item from their reach the author should say, "Wrong. Remember to wait if you do not know the answer and I will tell it to you," remove the stimuli from the table, and wait 3 s without speaking to or making eye contact with the participant before providing a mastered task or beginning the next trial. The author should record this as an incorrect unprompted response on the data sheet.
- If the participant does not respond within the 5 s after the removal of the item from the participant's reach the author should provide the controlling prompt (verbal model of the item name).

- If the participant correctly imitates the verbal model within 5 s after the controlling prompt the author should immediately return the item to the participant and say, "You asked from the [item name]. Good job! Here is the [item name]," and record the trial as a correct prompted response on the data sheet.
- If the participant does not respond or responds incorrectly within 5 s of the controlling prompt the author should say, "Wrong," remove the stimuli from the table, and wait 3 s without speaking to or making eye contact with the participant before providing a mastered task or beginning the next trial.

Presence of Motivating Operation

- If the participant does not engage with the item within 10 s of it being placed on the table the author should remove the item and provide a mastered task before representing the stimuli.
- If after three consecutive representations the participants does not engage with the item, the session will be terminated as a motivating operation for the item would not be apparent.
- If at least 5 trials have been completed, percentage of correct responding for the session will be calculated and included with the data. If less than 5 trials for the item have been completed, the data will not be calculated or reported.

APPENDIX B

TACT TRAINING INSTRUCTIONAL PROCEDURE

Prior to every tact training session a preference assessment will be conducted to determine what reinforcer will be used for correct responding. The instructor will place 2-3 preferred but non-target stimuli items side by side in front of the participant. Once the participant interacts with one of the items the others will be removed from sight. After 5 s of interaction with the item the chosen reinforcer will be moved out of reach of the participant the session will begin.

Tact training sessions will consist of 10 trials per item. Since the target stimuli names have been trained as echoics, the controlling prompt to elicit correct responding from the participant will be a verbal prompt of the correct item name.

Zero Second Delay Trials

During the 0 s delay trials the instructor will hold of the target stimulus and say, “What is it? [item name].” The verbal model of the correct response will be said immediately following the task direction (i.e., “What is it?”). For example, the instructor will hold up a ball and say, “What is it? Ball.”

- If the participant responds correctly within 5 s of the controlling prompt the instructor should say, “You’re right! This is a [item name],” provide access to the chosen reinforcer, and wait 3 s before providing a mastered task or beginning the next trial.
- If the participant does not respond or responds incorrectly within 5 s of the controlling prompt the instructor should say, “Wrong,” remove the item from the table, and wait 3 s

without speaking or making eye contact with the participant before providing a mastered task or beginning the next trial. The instructor should note whether the participant gave an incorrect response or did not provide a response on the data sheet.

- At least one session with 100% correct responding in the 0 s delay format must occur prior to moving to the 5 s delay trial format.

Five Second Delay Trials

During the 5 s delay trials, the task direction will be given and the instructor will wait 5 s before giving the controlling prompt. For example, the instructor will hold up a ball and say, “What is it?,” then wait 5 s before saying, “Ball.”

- If the participant responds correctly within 5 s after the task direction the instructor should say, “You’re right! This is a [item name],” provide access to the chosen reinforcer, and record the trial as a correct unprompted response on the data sheet before removing the item and providing a mastered task or beginning the next trial.
- If the participant responds incorrectly within 5 s after the task direction the instructor should say, “Wrong. Remember to wait if you don’t know the answer and I will tell it to you,” remove the stimuli from the table, and wait 3 s without speaking or making eye contact with the participant before providing a mastered task or beginning the next trial. This trial should be recorded as an incorrect unprompted response on the data sheet.
- If the participant does not respond within 5 s of the task direction the instructor should provide the controlling prompt (verbal model of the item name).
- If the participant correctly imitates the verbal model within 5 s of the controlling prompt the instructor should say, “You’re right! This is a [item name],” provide access to the

chosen reinforcer, and record the trial as an correct prompted response on the data sheet before providing a mastered task or beginning the next trial.

- If the participant responds incorrectly or does not respond within 5 s of the controlling prompt the instructor should say, “Wrong,” remove the stimuli from the table, and wait 3 s without speaking to or making eye contact with the participant before beginning the next trial. This trial should be recorded as an incorrect prompted response or no response on the data sheet.

Reinforcement Considerations

If at any point during the session the participant rejects the chosen reinforcer the instructor should complete the trial using the procedures described above before conducting another preference assessment. The instructor should present 2-3 additional preferred but non-targeted items to the participant to reestablish a highly motivating reinforcer. This may be done as many times as necessary during the session and should be noted on the data sheet.

APPENDIX C

FUNCTIONAL ANALYSIS DATA SHEETS

Participant: Target item: Session:

Motivating Operation Assessment

1. Restrict participant access to target item for 5 min.
2. Instructor seated across from participant.
3. Place target item and distractor item of same class side by side in front of participant.
4. If participant reaches for the distractor item:
   a. Remove target item and allow 1 min of interaction with distractor item.
   b. Replace target item with a different distractor item side by side in front of participant.
   c. Repeat until participant initiates with target item or until 5 distractor item pairings have been completed.
5. If participant reaches for the target item:
   a. Remove distractor item and allow 10 s of interaction with target item.
   b. Remove target item and proceed with Mand Test session.

Trial	Target Item	Distractor Item	10s access for target or 1 min access for distractor
1			
2			
3			
4			
5			

If target item selected, begin Mand Test session ___________

If target item not selected in one of five trials, Mand Test session not completed ___________

Participant: Target item: Session:

Mand Test

1. Instructor seated across from the participant.
2. Instructor shows item to participant for 5 s then places the item out of participant's view.
3. If target vocalization is emitted:
   a. Participant accesses item for 20 s or consumes small amount of edible item.
   b. Target item removed from view.
4. If 60 s elapses without target vocalization being emitted:
   a. Item is presented to the participant for 5 s then placed out of sight again.
5. All other verbalizations and behaviors are ignored (except to maintain safety or presence in room).

Interrater Reliability

Interval	Target vocalizations (tally)
0-:20	
:20-:40	
:40-1:00	
1:00-1:20	
1:20-1:40	
1:40-2:00	
2:00-2:20	
2:20-2:40	
2:40-3:00	
3:00-3:20	
3:20-3:40	
3:40-4:00	
4:00-4:20	
4:20-4:40	
4:40-5:00	

Procedural integrity

Step	Correct Opportunities (tally)	Incorrect Opportunities (tally)
Shows items for 5 sec		
20 sec access or piece of edible for target word		
Item removed after access		
Shows item for 5 sec if no target word after 60 sec		

Participant: Target item: Session:

Mand Control

1. Restrict participant access to item for 5 min.
2. Instructor will be seated away from participant.
3. Participant will have free access to item.
4. No consequences for target verbalizations.
5. All other verbalizations and behaviors are ignored (except to maintain safety or presence in room).

Interrater Reliability

Interval	Target vocalizations (tally)
0-:20	
:20-:40	
:40-1:00	
1:00-1:20	
1:20-1:40	
1:40-2:00	
2:00-2:20	
2:20-2:40	
2:40-3:00	
3:00-3:20	
3:20-3:40	
3:40-4:00	
4:00-4:20	
4:20-4:40	
4:40-5:00	

Procedural integrity

Step	Correct Opportunities (tally)	Incorrect Opportunities (tally)
Participant has free access		
No consequences for target word		

Participant: Target item: Session:

Tact Test

1. Participant has free access to target item for 5 min prior to session.
2. Instructor seated next to participant.
3. Participant has continued access to item for duration of session.
4. Every 20 s instructor provides verbal prompt "What's this?"
5. If target verbalization is emitted:
    a. Brief verbal praise is provided (e.g., "good talking" or "nice job").
6. All other verbalizations or behaviors are ignored.

Interrater Reliability

Interval	Target vocalizations (tally)
0-:20	
:20-:40	
:40-1:00	
1:00-1:20	
1:20-1:40	
1:40-2:00	
2:00-2:20	
2:20-2:40	
2:40-3:00	
3:00-3:20	
3:20-3:40	
3:40-4:00	
4:00-4:20	
4:20-4:40	
4:40-5:00	

Procedural integrity

Step	Correct Opportunities (tally)	Incorrect Opportunities (tally)
Free access to target item		
"what's this?" every 20 sec		
Verbal praise for target		

Participant: Target item: Session:

Tact Control

1. Participant has free access to target item for 5 min prior to session.
2. Item removed from room.
3. Instructor seated away from participant.
4. No consequences provided for target verbalizations.
5. All other verbalizations and behaviors are ignored.

Interrater Reliability

Interval	Target vocalizations (tally)
0-:20	
:20-:40	
:40-1:00	
1:00-1:20	
1:20-1:40	
1:40-2:00	
2:00-2:20	
2:20-2:40	
2:40-3:00	
3:00-3:20	
3:20-3:40	
3:40-4:00	
4:00-4:20	
4:20-4:40	
4:40-5:00	

Procedural integrity

Step	Correct Opportunities (tally)	Incorrect Opportunities (tally)
Item removed from room		
No consequences for target word		

Participant: Target item: Session:

Echoic Test

1. Participant has access to target item for 5 min prior to session.
2. Item removed from room.
3. Instructor seated next to participant.
4. Instructor provides target verbalization every 20 s.
5. If participant repeats target verbalization correctly within 5 s:
    a. Instructor provides brief verbal praise (e.g., "good talking" or "nice job")
6. All other verbalizations and behaviors are ignored.

Interrater Reliability

Interval	Target vocalizations (tally)
0-:20	
:20-:40	
:40-1:00	
1:00-1:20	
1:20-1:40	
1:40-2:00	
2:00-2:20	
2:20-2:40	
2:40-3:00	
3:00-3:20	
3:20-3:40	
3:40-4:00	
4:00-4:20	
4:20-4:40	
4:40-5:00	

Procedural integrity

Step	Correct Opportunities (tally)	Incorrect Opportunities (tally)
Item removed from room		
Model target word every 20 sec		
Verbal praise for target word echo within 5 sec of prompt		

Participant: Target item: Session:

Echoic Control

1. Participant has access to target item for 5 min prior to session.
2. Item removed from room.
3. Instructor seated away from participant.
4. No consequences for target verbalization.
5. All other verbalizations and behaviors are ignored.

Interrater Reliability

Interval	Target vocalizations (tally)
0-:20	
:20-:40	
:40-1:00	
1:00-1:20	
1:20-1:40	
1:40-2:00	
2:00-2:20	
2:20-2:40	
2:40-3:00	
3:00-3:20	
3:20-3:40	
3:40-4:00	
4:00-4:20	
4:20-4:40	
4:40-5:00	

Procedural integrity

Step	Correct Opportunities (tally)	Incorrect Opportunities (tally)
Item removed from room		
No consequences for target word		

Participant: Target item: Session:

Automatic Test

1. Participant has access to target item for 5 min prior to session.
2. All materials, including target item, removed from room.
3. Instructor observes participant from one-way mirror.

Interrater Reliability

Interval	Target vocalizations (tally)
0-:20	
:20-:40	
:40-1:00	
1:00-1:20	
1:20-1:40	
1:40-2:00	
2:00-2:20	
2:20-2:40	
2:40-3:00	
3:00-3:20	
3:20-3:40	
3:40-4:00	
4:00-4:20	
4:20-4:40	
4:40-5:00	

Procedural integrity

Step	Correct Opportunities (tally)	Incorrect Opportunities (tally)
Item removed from room		
No consequences for target word		

APPENDIX D

INTERVENTION DATA SHEETS

Mand Training Session

Participant:______________ Instructor:______________ Date:_______ Time:________
Session:_____ Delay: 0 s 5 s Target stimuli:______________________________

Trial	**Participant**	**Response**	**Verbatim**
	Before Prompt	After Prompt	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
	Percentage Data for:		
	%Unprompted Correct		
	%Unprompted Incorrect		
	%Prompted Correct		
	%Prompted Incorrect		
	% No Response		

Procedural Integrity

Trial	
Correct/ Incorrect	If incorrect, step missed:
Percentage Data for:	
C Trials	
I Trials	

Key: + = correct response; - = incorrect response; 0 = no response
Observations:____
____
____
____
____

Tact Training Session

Participant:______________ Instructor:______________ Date:_______ Time:________
Session:_____ Delay: 0 s 5 s Target stimuli:_____________________________
Reinforcer:_______________________

Trial	**Participant**	**Response**	**Verbatim**
	Before Prompt	After Prompt	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
	Percentage Data for:		
	%Unprompted Correct		
	%Unprompted Incorrect		
	%Prompted Correct		
	%Prompted Incorrect		
	% No Response		

Procedural Integrity

Trial	
Correct/ Incorrect	If incorrect, step missed:
Percentage Data for:	
C Trials	
I Trials	

Key: + = correct response; - = incorrect response; 0 = no response
Observations:____
____
____
____
____

Control Sessions

Participant:______________ Instructor:______________ Date:________ Time:_________
Session:______ Target stimuli:__________________________

			Procedural Integrity:	
Control Mand probe:	C	I	C	I
Control Tact probe:	C	I	C	I

Participant:______________ Instructor:______________ Date:________ Time:_________
Session:______ Target stimuli:__________________________

			Procedural Integrity:	
Control Mand probe:	C	I	C	I
Control Tact probe:	C	I	C	I

Participant:______________ Instructor:______________ Date:________ Time:_________
Session:______ Target stimuli:__________________________

			Procedural Integrity:	
Control Mand probe:	C	I	C	I
Control Tact probe:	C	I	C	I

Participant:______________ Instructor:______________ Date:________ Time:_________
Session:______ Target stimuli:__________________________

			Procedural Integrity:	
Control Mand probe:	C	I	C	I
Control Tact probe:	C	I	C	I

Participant:______________ Instructor:______________ Date:________ Time:_________
Session:______ Target stimuli:__________________________

			Procedural Integrity:	
Control Mand probe:	C	I	C	I
Control Tact probe:	C	I	C	I