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Evaluating the Effectiveness of Motor Planning with Core Vocabulary: A Behavior Analytic Account

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Evaluating the Effectiveness of Motor Planning with Core Vocabulary:
A Behavior Analytic Account

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by

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Abstract

As the prevalence of autism spectrum disorders (ASD) increases, it is important for practitioners to continue to improve evidence-based practices (EBP) for the treatment of ASD symptoms (i.e., impairments in social communication and repetitive behaviors and restricted interests; American Psychiatric Association [APA], 2013). It is estimated that 30-50% of individuals with autism do not acquire functional speech (Wodka, Mathy, & Kalb, 2013). These individuals would make appropriate candidates for Augmentative and Alternative Communication (AAC; Mirenda, 2003). One form of AAC is the speech-generating device (SGD). Over the last ten years, tablet-based technologies including iPad minis® have been emphasized in the SGD research (Lorah, Parnell, Whitby, & Hantula, 2014b). One of the limitations in the tablet-based technology literature is that there are few protocols using EBP for teaching verbal behavior using tablet-based technology as a SGD (Hedges & AFIRM Team, 2017). Practitioners working with SGD users require support in designing the screen layout, selecting the vocabulary, and determining effective teaching procedures for increasing verbal behavior. Therefore, the current study introduced the topic of motor planning with core vocabulary as considerations for use with tablet-based technology as SGDs to the behavior analytic literature. Because motor planning refers to the inner process of determining how to move, behavior analysts may be skeptical of using motor planning in practice. However, this study identified that motor planning is not an intervention but a strategy used in designing the screen layout or icon location. In addition, this study evaluated a basic protocol using motor planning with core vocabulary and a prompting package including within stimulus prompts and constant time delay with response prompts to teach manding using the iPad mini® and Proloquo2Go™ as a SGD to three preschool aged children with ASD. This study also evaluated the effectiveness of the protocol on increasing

vocal utterances throughout the session and decreasing problem behaviors during mand training. Results of the study indicated the protocol was effective in increasing a manding repertoire and that there were no effects on vocal utterances and problem behaviors.

Keywords: speech-generating device, augmentative and alternative communication, manding, verbal behavior, applied behavior analysis, motor planning, core vocabulary

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Dedication

For my dad; all of our hard work has come to fruition. I am so lucky to have gotten to take this journey with you.

Table of Contents

Chapter One: Introduction

The purpose of this study was to evaluate motor planning with core vocabulary and a prompting package including within stimulus prompts and constant time delay with response prompts as a basic protocol for teaching manding to preschool aged children with autism spectrum disorder (ASD) using the iPad mini® and Proloquo2Go™ as a speech-generating device (SGD). Practitioners and other stakeholders working with SGD require support developing screen design, vocabulary selection, and evidence-based teaching procedures in order to effectively teach communication to SGD users. Few protocols have been developed to provide support in each of these areas (Halloran & Halloran, 2006; Hedges & AFIRM Team, 2017). The current study provides a basic protocol that can benefit both practitioners and stakeholders in improving manding with a SGD using effective evidence-based intervention. Additionally, this study addresses limitations in the current ASD and SGD literature including generalizability and a lack of social validity measures by including each of these considerations in the development of the procedures. Last, this study introduces the topics of motor planning and core vocabulary to the behavior analytic literature as considerations for screen design or layout.

Autism Spectrum Disorder

ASD is a neurodevelopmental disability that affects 1 in 59 children in the United States of America (USA; Centers for Disease Control and Prevention [CDC], 2018). Individuals with ASD exhibit impairments in social communication and restricted interests and repetitive behaviors (American Psychiatric Association [APA], 2013). ASD symptoms manifest in different ways and require varying levels of support. Deficits in social communication may include difficulty with vocal speech and can be addressed through behavioral intervention.

Verbal Behavior Intervention

Verbal behavior intervention is an evidence-based practice (EBP) effective in improving verbal behavior repertoires of individuals with ASD. Verbal behavior is a dyadic process within which a speaker's behavior is mediated by a listener. An analysis of verbal behavior evaluates the functional relationship between controlling variables and behavior. The unit of analysis in verbal behavior is the verbal operant. There are multiple verbal operants including the mand, tact, echoic, intraverbal, and autoclitic. The most researched verbal operant is the mand (i.e., requesting), which is the only verbal operant that directly benefits the speaker. The controlling variables of the mand include an establishing operation (i.e., a state of deprivation or aversion that alters the value of a stimulus), discriminative stimulus (i.e., a stimulus that signals the availability of a reinforcer), and the receipt of a specified reinforcer.

Teaching manding is important in a behavioral intervention program because improvement in a manding repertoire has been shown to lead to an increase vocalizations and emergent verbal behavior and a decrease in problem behaviors. Two strategies for teaching verbal behavior include discrete trial teaching (DTT) and natural environment teaching strategies (NET). DTT is a teacher-led strategy within which discrete skills are taught systematically through fast-paced direct instruction (Smith, 2001). NET is an evidence-based practice (EBP) within which teaching is conducted as opportunities arise or are contrived within the natural environment. These strategies use prompting and reinforcement to teach the acquisition of manding within a verbal behavior acquisition program. Effective behavioral intervention uses both strategies (Smith, 2001).

Augmentative and Alternative Communication

It is estimated that 30-50% of individuals with ASD do not develop functional vocal

speech (Wodka, Mathy, & Kalb, 2013). Augmentative and alternative communication (AAC) systems can be beneficial solutions to individuals who experience challenges with social communication (Mirenda, 2003). One type of AAC is the SGD. A SGD is a communication system that is manipulated by the user (e.g. selects an icon, flips a switch, eye tracking) and results in digitized speech output (Mirenda, 2003). There is growing evidence that supports the use of tablet-based technologies (e.g. iPad mini) as SGDs. SGDs can be effective tools to support individuals with ASD (Lorah, Parnell, Whitby, & Hantula, 2014b). In order for a SGD to be effective, it is important to identify evidence-based teaching procedures to pair with the SGD to teach the speaker to use the device.

Effective Strategies. Various prompting strategies including within stimulus prompts, within stimulus prompts with response prompts, graduated guidance, and least to most prompting were shown to be effective in increasing manding using a SGD. Manding repertoires were acquired across settings (e.g. one-to-one instruction, discrete trial teaching [DTT], play-based, classroom, recess, home). Additionally, it was determined that multi-step manding and advanced operations were acquired using tablet-based SGDs. Lastly, evidence in support of considering icon location when using a SGD suggested improvement in fluency of SGD usage (Dukhovny & Zhou, 2016). The byproduct of emphasizing icon location is motor planning. More detail on these strategies are included in a review of the literature in Chapter Two.

Key Limitations. The following limitations were discovered in the published literature. First, a limitation in the literature includes generalizability including a lack of emphasis on teaching in natural, play-based settings in lieu of discrete trial teaching (DTT) or clinically artificial formats (Achmadi et al., 2012; Alzrayer, Banda, & Koul, 2017; Lorah, Crouser, Gilroy, Tincani, & Hantula, 2014a; Lorah, 2016; Waddington, van der Meer, Carnett, &

Sigafoos, 2017; Xin & Leonard, 2014). Further, few studies evaluated generalization to another communication partner (Waddington, van der Meer, Carnett, & Sigafoos, 2017; Xin & Leonard, 2014). Additionally, social validity measures were not included in most of studies. Further, current research does not emphasize motor planning or screen layout as a factor that can affect the acquisition of manding using a SGD. Minimal studies have evaluated motor planning as a contributing factor to language acquisition with individuals with ASD (Bedwani et al., 2015; Gevarter et al., 2017; Stuart & Ritthaler, 2008). Finally, there is a gap in the literature regarding evidence-based best practice and vocabulary selection for SGD users (Banajee, DiCarlo, & Buras-Stricklin, 2003; Mirenda, 2003). These limitations as they pertain to the current study are addressed in detail in Chapter Two.

Current Study

The purpose of the current study is to evaluate the effectiveness of motor planning with core vocabulary and a prompting package including within stimulus prompts and a constant time delay with response prompts as a strategy for teaching manding using the iPad mini and Proloquo2Go as a SGD to preschool aged children with autism. A comprehensive review of the literature is included in Chapter Two. The review emphasizes limitations in the literature that this study addresses in the following ways: a) teaching manding using tablet-based technology in a play-based setting, b) including a measure of social validity, c) evaluating the effects of screen layout (i.e., motor planning) on the acquisition of manding, and d) incorporating core vocabulary (i.e., frequently used words in the toddler vocabulary) in the display. The research questions for the current study are as follows:

1. Does motor planning with core vocabulary and the prompting package increase manding using the iPad mini and Proloquo2Go as a speech-generating device to

preschool aged children with autism?

2. Does motor planning with core vocabulary and the prompting package increase vocal utterances in preschool aged children with autism?
3. Does motor planning with core vocabulary and the prompting package decrease problem behaviors in preschool aged children with autism?
4. Will implementers gain confidence in the use of motor planning with core vocabulary and the prompting package to teach manding using the iPad mini and Proloquo2Go as a speech-generating device to preschool aged children with autism?
5. Will implementers maintain the use of the iPad mini and Proloquo2Go as a speech-generating device, motor planning with core vocabulary, and/or the prompting package following this study?

In order to evaluate these research questions, the research design and procedures used in this study are defined in detail in Chapter Three. The results of the study are presented in Chapter Four, with a discussion and interpretation of the results following in Chapter Five.

Chapter Two: Literature Review

As the prevalence of autism spectrum disorders (ASD) increases, it becomes increasingly important for practitioners to continue to improve evidence-based practices (EBP) for the treatment of ASD symptoms. Wodka, Mathy, and Kalb (2013) estimated that 30-50% of individuals with ASD do not develop functional speech. These individuals are appropriate candidates for Augmentative and Alternative Communication (AAC; Mirenda, 2003). The speech-generating device (SGD) is one AAC modality. In the last decade, tablet-based technologies including iPad minis® have been prioritized in the SGD research (Lorah, Parnell, Whitby, & Hantula, 2014b). In the tablet-based technology literature, one limitation includes that few protocols using EBP for teaching verbal behavior using tablet-based technology as a SGD exist (Hedges & AFIRM Team, 2017). Practitioners working with SGD users require support in designing the screen layout, selecting the vocabulary, and determining effective teaching procedures for increasing verbal behavior. Therefore, the current study introduced the topic of motor planning with core vocabulary as considerations for use with tablet-based technology as SGDs to the behavior analytic literature.

In this chapter, a comprehensive review of these topics is provided highlighting the current limitations in the ASD and tablet-based SGD literature as pertaining to this study. First, this chapter will provide background information on ASD. Next, the chapter reviews verbal behavior including the mand as important components of language development programs. Then, a review of the literature highlighting the gaps that pertain to the current study includes the following topics: ASD and AAC, motor planning with core vocabulary and mand training and SGDs. Finally, the purpose of the current study and the research questions are presented.

Autism Spectrum Disorder

ASD is a developmental disability that affects more than 1 in 59 children in the United States of America (USA; Centers for Disease Control and Prevention [CDC], 2018). Individuals diagnosed with ASD can be characterized as having impairments in social communication and exhibiting restricted interests and/or repetitive behaviors (American Psychiatric Association [APA], 2013). ASD is a heterogeneous disorder, which means that each individual with ASD displays the core characteristics of the disorder differently with combinations of symptoms, often varying in severity. The ASD diagnosis encompasses this range by categorizing the levels of support required by the individual at diagnosis and ongoing evaluations. The levels of support address social communication and restricted interests and repetitive behaviors (APA, 2013).

The greatest amount of support required is categorized as a Level Three diagnosis (APA, 2013). The most severe symptoms would indicate a need for greater levels of support to communicate and to manage more challenging behaviors. For example, an individual with a Level Three diagnosis may show limited interest in people, low levels of autonomous social interaction or communication, and behaviors that interfere with functioning within a given environment (APA, 2013). A Level Two diagnosis indicates that these individuals require less support in social communication than individuals with a Level Three diagnosis. For example, an individual with a Level Two diagnosis may have the ability to communicate, though he/she may not communicate spontaneously or effectively. These skills may require prompts to support the individual to perform within a social context. Level Two diagnoses also require support with difficulties associated with restricted interests and repetitive behaviors in regard to flexibility within the environment (APA, 2013). The mildest symptoms are described in a Level One diagnosis. Individuals with a Level One diagnosis may require support in social settings and with other ASD symptoms, though these challenges are less significant than those in Levels Two

or Three (APA, 2013). For example, an individual with a Level One diagnosis may be able to communicate, but he/she may require support reading social cues or forming relationships. Difficulty with restricted interests and repetitive behaviors affects individuals with Level One diagnoses as well, though these challenges may be less difficult to redirect and require less support than those in other levels (APA, 2013).

Because of the marked impairments in social communication, it is important to approach treatment of individuals with ASD with a strategy that emphasizes the dyadic relationship of communication. Behavioral interventions (i.e., applied behavior analysis (ABA) and verbal behavior intervention) are effective strategies that address the functional relations of language through an analysis of verbal behavior (Dillenburger et al., 2014; Sundberg & Michael, 2001).

Verbal Behavior

Verbal behavior is the behavior analytic account of language. In verbal behavior, the behavior of the speaker is mediated by a secondary person (e.g. a listener) and thus, is considered a dyadic process (Skinner, 1957). The speaker communicates with the listener, and the listener reinforces the speaker's behavior. An account of verbal behavior includes an analysis of the functional relationships between the controlling variables and the behavior of the communication partners. Because the listener mediates the speaker's behavior, the listener determines the function of the speaker's behavior. The unit of analysis in Skinner's verbal behavior is the verbal operant (Skinner, 1957; Sundberg & Michael, 2001). There are several types of verbal operants, such as the mand, tact, echoic, intraverbal, and autoclitic, that are determined by the controlling variables.

The Mand. The mand is one of the first verbal operants acquired in language development, and it is the only operant that directly benefits the speaker (Miguel, 2017;

Sundberg & Michael, 2001). In other words, a manding repertoire allows an individual to meet his/her needs with the support of another person. For example, a person may not be tall enough to access a cup for water. If he/she does not have the ability to ask (i.e., gesture, speak, etc.) someone for assistance, he/she will have to find other means to access a water cup or go without. The implications of gaining a manding repertoire are vast, as manding occurs in order to gain access to an item/activity, to gain attention, and/or to gain information. Mands for information can include asking questions about the weather or asking a person about him/herself. A fluent manding repertoire can support an individual in navigating the community in such ways as ordering at a restaurant, cashing a check, acquiring the correct size of clothing, and making friends.

In terms of the mand, an establishing operation (EO; i.e., a state of aversion or deprivation that alters the value of a specified reinforcer) is present and increases the likelihood the mand will occur. The presence of a discriminative stimulus (S^D; i.e., a stimulus that signals the availability of a reinforcer) evokes the mand. The S^D in a manding episode is the listener. The listener mediates the speaker's behavior by providing a specified reinforcer to the speaker, which ultimately improves the aversive/deprived condition. The speaker's behavior is considered a mand when all of these variables are present. For example, a thirsty customer in a restaurant sees a waiter pass his table and the customer says, "Water." The waiter brings the customer water. In this situation, a state of deprivation (i.e., thirst [EO]) increased the value of receiving water in that moment and increased the likelihood the customer would ask for water. The presence of the waiter (S^D) signaled the availability of water under this condition, and thus, the customer asked for water (mand). Because he requested water and received it (specified reinforcer) from the listener, the customer's verbal behavior functions as a mand for

water. If a behavior does not evoke the specified consequence, the behavior is not considered a mand.

The Tact. Skinner (1957) described the tact as being under the stimulus control of a non-verbal stimulus in the physical environment. Tacts are maintained by generalized conditioned reinforcement provided by the listener. Forms of generalized conditioned reinforcement include praise statements or other social approval. For example, a woman tells her friend, "Your haircut looks great!" The friend says, "Thank you!" and smiles. In this example, the presence of the nonverbal stimulus and the listener (friend's haircut) functions as the S^D, which occasions the friend's comment (tact). The consequence (generalized conditioned reinforcement), the friend's saying "Thank you," determines the speaker's behavior is a tact. The informative tact can take many forms from basic to complex and can include labeling, naming, providing an opinion, and reporting (Baum, 2005; Cooper et al., 2007).

The Echoic. The echoic operant is one in which verbal behavior occasions the same form of verbal behavior that has point-to-point correspondence with the model behavior. In other words, an echoic occurs when the speaker imitates the verbal behavior of another speaker (i.e., vocal imitation). The speaker's behavior must match the verbal behavior of another speaker in every way including topography (i.e., spoken or using SGD). The listener mediates the speaker's behavior with generalized conditioned reinforcement. For example, a mother says, "Ball" to her toddler, and her toddler says, "Ball." The mother cheers saying, "Yay! You said ball!" In this example, the mother's verbal behavior, "Ball," (S^D) evoked the toddler's verbal behavior with formal similarity, saying "Ball" (echoic). The mother responded to the toddler's behavior by cheering (generalized conditioned reinforcer), which determined the speaker's behavior was an echoic. Echoics can be useful skills to assist in teaching or gaining more

complex verbal behavior (Baum, 2005; Catania, 2013; Cooper et al., 2007).

The Intraverbal. Skinner (1957) described the intraverbal operant as verbal behavior that is occasioned by verbal behavior. The intraverbal is under the stimulus control of verbal behavior by another speaker, which functions as the S^D and is maintained by generalized conditioned reinforcement. The difference between the intraverbal and the echoic is that the intraverbal does not require point-to-point correspondence or formal similarity as is necessary with the echoic. Intraverbals can be used to engage in complex verbal behavior such as responding to questions and engaging in conversations. For example, a cashier says, "Have a great day!" The customer says, "You too." Then the cashier responds, "Thanks!" In this example, the cashier's verbal behavior "Have a great day" (S^D) occasioned the customer's saying "You too" (intraverbal). The cashier responded, "Thanks" (generalized conditioned reinforcer) following the behavior, which determines the speaker's behavior is an intraverbal.

The Autoclitic. The autoclitic operant is interesting in that it only occurs in the presence of other verbal behavior of the speaker (Skinner, 1957). Autoclitics are an operant class that clarifies, quantifies, qualifies, and describes other verbal behavior. The autoclitic helps to describe grammar and syntax within behavior analytic constructs as more than contingency-shaped (implicitly-shaped) behaviors that were shaped by the verbal community. An example of an autoclitic would be the use of niceties such as *please* or *would you mind* when requesting the listener to get the speaker a glass of water.

Multiply Controlled Operants. It is common for a functional operant to have multiple functions when using verbal behavior. Often, a mand may also function as a tact and/or an intraverbal simultaneously. Catania (2013) and Skinner (1957) referred to multiply controlled behaviors as those with multiple causes. An antecedent stimulus (e.g. state of deprivation, visual

cue, verbal cue, etc.) can evoke many forms of responding from various people at various times and can influence the strength of responding (Cooper et al., 2007).

A common example of multiple control includes the impure tact (i.e. mand-tact; Cooper et al., 2007). A wife says to her husband, “My neck hurts,” and he says, “I’m sorry,” as he rubs her neck. In this example, the wife’s behavior functions as a tact because the wife says, “My neck hurts,” in response to a private event (i.e., pain in her neck) to which her husband provides generalized conditioned reinforcement (i.e., “I’m sorry”). However, he also rubbed her neck, which decreased the aversive stimulus for his wife (i.e., pain). In this example, the wife’s behavior also functioned as a mand, demonstrating multiple controlling variables.

Behavioral Intervention. Evidence-based practices (EBP) such as early intensive behavioral intervention (EIBI) and verbal behavior intervention have been shown effective in improving social communication in individuals with ASD. Studies have shown such behavioral interventions (i.e., EIBI and verbal behavior intervention) can be an integral part of a verbal behavior acquisition program for preschool aged children with ASD (Dawson et al., 2012; National Autism Center [NAC], 2015; Sundberg & Michael, 2001). The earlier treatment is received the better the noted outcomes (Dawson et al., 2012). Dawson et al. (2012) determined that behavioral interventions can change the trajectory of ASD, specifically regarding social communication. Sundberg and Michael (2001) discussed the importance of teaching verbal behavior to individuals with ASD as part of a comprehensive behavioral intervention package.

Effective verbal behavior programs emphasize teaching a manding repertoire, which can be targeted using discrete trial teaching (DTT) or naturalistic environment teaching (NET) strategies. DTT is a direct instruction method that emphasizes teaching discrete skills in a teacher-led, systematic and sequential order (Smith, 2001). NET is an EBP that uses a child-led

approach to facilitate responding within a child's play (Carr & Firth, 2005; NAC, 2015). The instructor teaches as opportunities naturally arise or by contriving opportunities to teach a skill, which enhances opportunities to teach and generalize various types of verbal behavior, especially the mand. An EIBI program is most effective when DTT is used in combination with a NET strategy (Smith, 2001).

Two teaching procedures that occur during DTT and NET include prompting and reinforcement (Smith, 2001). Prompting is a teaching procedure within which the instructor adds a supplementary stimulus that effectively evokes the target behavior (e.g. in mand training, a request for an item or activity; Cooper et al., 2007). Prompts are systematically faded in order to gain independent responding. There are many forms of effective prompting that can be found in behavioral intervention including full physical prompts, gestural prompts, vocal prompts, partial prompts, model prompts, within stimulus prompts, and time delay prompts (Albert et al., 2012; Cooper et al., 2007; Lancioni, 2007; Lorah et al., 2014b).

Reinforcement occurs when a stimulus is added or removed following a behavior, resulting in an increase in that behavior. In DTT, the reinforcing item/activity does not have to have formal similarity with the desired behavior. For example, a child correctly identifies a picture of a cat, and the instructor gives the child a blueberry. NET teaching procedures promote the use of more natural consequences as reinforcing items/activities that may naturally occur within the environment. The emphasis of natural consequences occurs because natural, relevant consequences are more likely to maintain the behavior (LeBlanc, Esch, Sidener, & Firth, 2006). For example, the child sees a cat and says, "Look, a cat!" The instructor may respond, "Hey! That is a cat!" Though colloquially the term *reinforcement* is used to signify an item/activity that is preferred, reinforcement actually defines an increase in frequency of a

behavior that is directly related to the addition or removal of a stimulus following said behavior. Using reinforcement in teaching requires an analysis of the increase or decrease in a behavior and manipulations of the environmental stimuli to evoke changes in the learner's behavior. In terms of verbal behavior, the verbal operants have functional independence and include specific types of reinforcers to maintain the behavior in naturalistic conditions.

Teaching manding in a verbal behavior acquisition plan is important for many reasons (Albert, Carbone, Murray, Hagerty, & Sweeney-Kerwin, 2012; Miklos & DiPuglia, 2010; Sundberg & Michael, 2001; Shafer, 1994). First, teaching an individual to mand provides opportunities for the individual to directly benefit from communicating with a partner (Sundberg & Michael, 2001). Second, when an individual gains the ability to mand, studies have shown an increase in vocalizations and other forms of verbal behavior (Drager, Light, & McNaughtin, 2010; Miklos & DiPuglia, 2010; Millar, Light, & Schlosser, 2006). Additionally, decreases in the frequency of problem behaviors can occur as a result of gaining a manding repertoire (Albert et al., 2012; Miklos & DiPuglia, 2010). Reasons provided for these favorable effects of mand training include that the learners gain the ability to control their environments and have gained the skills necessary to access desirables without requiring more challenging behavior (Miklos & DiPuglia, 2010; Sundberg & Michael, 2001).

Autism Spectrum Disorder and Augmentative and Alternative Communication

It is estimated that 30-50% of individuals with ASD will not develop functional vocal output (Bedwani, Bruck, & Costley, 2015; Mirenda, 2003; Wodka, 2013). If a person experiences difficulty with vocal output, an AAC system may support his/her communication by being used to facilitate current communication skills or providing an alternative to speech (Mirenda, 2003). There are two forms of AAC including unaided and aided options (Lancioni et

al., 2007; Lorah, Parnell, Whitby, & Hantula, 2014b; Mirenda, 2003). AAC that is unaided does not require supplemental equipment. Types of unaided AAC include manual sign language (MS) and gestures. AAC that is aided requires supplemental support to communicate such as a facilitative board, picture cards, or an electronic device. Widely used aided AAC options include the picture exchange communication system (PECS), picture exchange (PE) and SGD (Lorah, et al., 2014b; Mirenda, 2003).

Individuals with ASD have demonstrated the ability to use both aided and unaided forms of AAC to communicate, though there are some limitations regarding teaching MS to individuals with ASD including potential challenges associated with fine motor dexterity, imitative repertoires, and lack of verbal community members who can interpret MS (Lorah et al., 2014b). Preference for aided AAC forms (i.e., SGD and PE) in lieu of MS have been demonstrated in the literature (Achmadi et al, 2014; Couper et al., 2014; Lancioni et al., 2007; van der Meer et al, 2012a; van der Meer et al, 2012b; van der Meer et al, 2012c; van der Meer et al., 2013). This may be due to the visually supportive nature of an aided form of AAC, ease of participation on the part of the listener, or to the challenges associated with MS (Lorah et al., 2014b, Lancioni, et al., 2007; Mirenda, 2003).

Further, of those noted articles in which preference was assessed, most participants demonstrated preference for SGDs in lieu of PE when taught to use both communication forms (Couper et al., 2014; Lancioni et al., 2007; Lorah et al., 2014b; van der Meer et al., 2012a; van der Meer et al., 2012b; van der Meer et al., 2012c). It is important to consider device preference when working with an AAC candidate as it could contribute to device usage. Wong et al. (2013) determined that AAC and other assistive technology is an EBP that has been shown effective in the treatment of ASD. When implementing AAC within the ASD population, it is important to

select established EBPs to teach verbal behavior (e.g. manding). The current study will add to the AAC and ASD literature in order to further the evidence in support of AAC usage for individuals with deficits in functional communication.

Motor Planning with Core Vocabulary

Motor Planning. Motor planning refers to the inner process of determining how to move (Halloran & Halloran, 2006). For example, if one were eating soup, a motor plan for eating the soup might include picking up the spoon, dipping the spoon in the soup, and bringing the soup to the mouth to eat it. The planning component is internal and involves problem solving the path one will take to accomplish this task. Though eating with a spoon is habitual for most, for a person who has motor development deficits, this process could be more challenging. McCleery et al. (2013) indicated that individuals with ASD are at increased risk of exhibiting motor development delays. Deficits in motor development can contribute to challenges in oral motor movement, which can affect speech.

Motor planning using a SGD includes building a screen layout within which the user is required to do as little discrimination, visual scanning, and "planning" as possible. From a behavior analytic perspective, descriptions of "making plans" and "communicative intent," are foreign, as these internal events are not discussed within the field. Though there are advanced discussions on problem solving and thinking within the field of behavior analysis, a practitioner would not emphasize internal events as explanations for behavior (i.e., communication; Catania, 2013). Motor planning relies on the individual's procedural memory (i.e., motor memory; Halloran & Halloran, 2006). The stages of motor learning include the cognitive stage, the associative stage, and the autonomous stage (Halloran & Halloran, 2006).

These stages resemble the stages of memory or remembering as described by Catania

(2013). The stages of memory include encoding, retention, and retrieval. The encoding stage encompasses an introduction to the stimuli to be stored for remembering (i.e., cognitive stage) and rehearsal of the skill (i.e., associative stage; Catania, 2013; Halloran & Halloran, 2006). During the associative stage, rehearsal develops a motor plan for the individual with which to obtain the stored information. The retention stage of memory includes the passing of time, which is not addressed as a stage of motor learning. The retrieval stage resembles the autonomous stage of motor learning. In the retrieval stage, stored information is obtained. This is also seen in the autonomous stage, though motor learning theory emphasizes the individual's ability to use the new motor plan automatically (Halloran & Halloran, 2006). Further, Halloran and Halloran (2006) assert that with rehearsal of the new motor plan, new neural pathways in the brain make connections that support more automatic use of the motor skill. A review of the motor planning literature is included in the following section.

Mand Training and SGDs

Various prompting strategies to teach manding using a tablet-based SGD to individuals with ASD are effective. Teaching manding is fundamental to programs for individuals with limited functional communication skills, and clinical implications of introducing AAC early have been identified as increasing the functional language capability in individuals with ASD (Miklos & DiPuglia, 2010; Millar et al., 2006; Mirenda, 2003; Sundberg & Michael, 2001). Though recent efforts have been made in expanding the types of verbal operants and communication skills addressed by research with aided AAC, manding remains the most researched. Even so, limitations continue to exist in the literature regarding manding using tablet-based SGDs.

Within Stimulus Prompts. Most studies regarding manding and tablet-based SGDs evaluated the effectiveness of response prompts on improving a manding repertoire. Lorah,

Crouser, Gilroy, Tincani, and Hantula (2014a) addressed this limitation within the literature by evaluating the effectiveness of within stimulus prompts (i.e. modifications to the stimulus that evoke the target behavior) in isolation to teach manding using a tablet-based SGD. Lorah et al. (2014a) conducted a changing criterion within a multiple probe across participants design in order to evaluate the effectiveness of within stimulus prompts only on manding acquisition and discrimination using an iPad® and Proloquo2Go™ as a SGD in four preschool aged children with ASD. In order to determine preferred and neutral stimuli for use in manding sessions, Multiple Stimulus without Replacement (MSWO) preference assessments were conducted prior to the study. In vivo preference assessments were conducted at the beginning of each session. Within stimulus prompts were used in this study to evoke manding. The materials were in the participants' sight but out of reach. There were five phases, and within each phase, icon size, field size, and/or icon placement varied. Screen layout in the first phase included one large picture icon representing the participant's preferred item. In phase two, the preferred item icon size was decreased, and to the field, three blank icons were added. In all phases but phase one, the symbols were moved following each trial in order to examine the participant's ability to discriminate between the icon symbols and to decrease the likelihood the participant was selecting the icon that had most recently been reinforced. Phases three through five included replacing one of the blank icons with a neutral icon. In phase five, there were no longer blank icons, and the field of four included one preferred item and three neutral items. Maintenance data were collected to determine if independent discriminated manding persisted.

Results of this study showed improvement in the participants' discriminated manding repertoires using within stimulus prompting (Lorah et al., 2014a). The study showed high levels of experimental effect including minimal overlapping data points for only one

participant. Maintenance probes indicated stability in the newly acquired manding with discrimination repertoires of two participants. The other two participants displayed decreasing trends in maintenance, though only two data points were presented. Interestingly, no response prompts were used in this study, indicating that this fading method was effective in teaching a manding with discrimination repertoire with very little rehearsal required (i.e., average of 14.5 sessions required for mastery). The practical implications of using only within stimulus prompts without response prompts indicates a smaller margin of instructor error in implementing teaching procedures. The researchers addressed a gap in the tablet-based SGD literature in their evaluation of within stimulus prompts in lieu of response prompts. Limitations included lacking evaluations of social validity and generalization. For example, because this study occurred within a DTT format, which does not emphasize naturalistic opportunities for the participant to use the device to mand, it is unclear if the skills would generalize to a more natural setting or to other listeners.

Generalizability. Another limitation in the manding literature using tablet-based SGD literature includes a lack of generalizability of the results across settings or communication partners. Many studies are conducted in artificial, contrived formats for research, creating challenges in applying the results of the studies to naturalistic environments. In a replication with variation of Lorah et al. (2014a), Lorah (2016) evaluated the effectiveness of within stimulus prompts and constant time delay with full physical prompts in the acquisition of manding using the iPad mini and Proloquo2Go as a SGD with preschool aged children with ASD. The variation included the addition of response prompts and addressed the limitation of generalization of Lorah et al (2014a) by conducting the study in a more naturalistic, play-based setting. Three participants with an average age of over three years and seven months were taught

to mand for preferred items during play-based instruction or natural environment teaching (NET). Lorah (2016) conducted a multiple baseline across participants, within a changing criterion design including four intervention phases and maintenance probes. The procedures included a free operant preference assessment and MSWO preference assessment to determine valued items/activities for use in the study prior to the study. Intervention included a five second time delay with a full physical prompt along with within stimulus prompts. Within stimulus prompts progressed from a field of one large icon with a reinforcing item, a field of four smaller icons with one reinforcing item and three blank icons, a field of four icons with two reinforcing items pictured and two blank icons, to a field of four reinforcing items. In vivo preference assessments and correspondence checks were conducted in order to determine if the participants continued to have the same preferred items/activities as at the onset of the study. In the second, third and fourth phases, the locations of the icons were changed in order to assess the participants' ability to discriminate between icons.

Results of this study indicated the participants quickly acquired a discriminated manding repertoire. Interesting findings of this study include the rate of acquisition for the participants when using within stimulus and constant time delay with full physical prompts to teach manding with the iPad as a SGD. This study addressed the limitation of generalization in Lorah et al. (2014a) by evaluating the teaching procedure in a more naturalistic, play-based environment, indicating that within stimulus prompts with response prompts are effective in teaching manding using the iPad mini as a SGD with preschool aged children with ASD. Limitations of this study included a lack of social validity evaluating the interventionists' preference with the device and teaching procedures to determine if the interventionists would continue to use the teaching procedures following the study. Social validity remains under-evaluated in the tablet-based SGD

literature.

In order to further address the lack of studies evaluating the use of the iPad as a SGD in natural settings, Xin and Leonard (2014) researched the use of iPads to teach communication skills to students with ASD in a classroom and at recess. The researchers evaluated the effectiveness of least to most prompting in teaching three minimally vocal ten-year-old participants with ASD to increase spontaneous manding, tacting, and intraverbal responding (i.e., making requests, responding to questions, initiating greetings, and making comments) in the school environment using the iPad and SonoFlex application as a SGD. Using a multiple baseline design with reversal across settings, the researchers used a five second constant time delay prompt with least to most prompting and social praise to turn on the iPad, go to the SonoFlex application, and appropriately use the device under the contrived circumstances. Though the results of the study indicated improved social communication skills such as manding, responding to questions, and making comments, the researchers found less significant improvement in spontaneous commenting.

This study adds to the literature because teaching occurs in the natural school environment, which shows that use of evidence based teaching procedures can be effective in teaching social communication to children with ASD using the iPad as a SGD across the classroom and recess settings. Limitations of this study include a lack of social validity and unorthodox graphical representation, which presents a challenge for visual analysis. Because constant time delay with least to most prompting and reinforcement were shown effective in the classroom and recess settings, a social validity questionnaire would strengthen the applicability of the results by reporting the teachers' and teaching assistants' likelihood of continuing the teaching procedures following the study. Lastly, the results of this study did not show an

increase in manding repertoires, though improvements were noted in tacting and intraverbal repertoires. Participants selected for this study were able to mand prior to the study. Therefore, though these results indicate that social communication skills can be acquired in the school setting, they do not directly reflect an increase in participant manding repertoires in these environments. Replication of this study could address the gap that remains in the manding with an iPad as a SGD literature regarding generalization to natural settings.

In order to address this limitation in the literature and to determine generalizability of acquired manding using a iPad as a SGD across settings, Waddington, van der Meer, Carnett, and Sigafoos (2017) conducted a multiple baseline across settings design to evaluate the effectiveness of graduated guidance in teaching travelling to a communication partner to mand using an iPad and Proloquo2Go as a SGD. The goal of the study was to determine if a skill acquired in one setting (i.e., clinic, home, or school) could generalize to another setting for one eight-year-old boy with ASD. The researchers gradually increased the amount of space between the participant and the communication partner (i.e., other side of table, middle of room, and other side of room). The researchers determined once acquisition of manding with the iPad at the end of the table improved, generalization occurred to the school and home settings when the iPad was placed at the end of the table. Additionally, minimal teaching was required for the participant to mand for preferred items when the communication partner moved farther away from the participant in each setting. Following intervention, the researchers also evaluated whether or not the participant would walk to obtain the iPad, then present it to the communication partner in each setting. The participant required no formal training to engage in this skill (Waddington et al., 2017).

The researchers conducted a social validity assessment to determine parent and teacher

opinions on the teaching procedure used in this study. The assessment determined the mother's preference was higher than was the teacher's for the procedures used. In this study, the participant gained the ability to mand across settings and with different communication partners across settings, though teaching was required in each setting. The researchers conducted generalization probes in a novel area within each of these three settings. This study adds to the literature by addressing more complex operations required to mand for preferred items or activities by including travelling to a communication partner at increasing distances. This study highlights the practical importance of teaching SGD users to travel to a communication partner since it is unlikely a listener will hear the device output from across the room. Additionally, this study addressed the generalizability gap within the literature by incorporating multiple environments and communication partners and by evaluating the generalization of newly acquired skill sets to novel settings. A limitation of this study included the single participant, which does not provide much insight into the broader ASD population. Replication of these findings would be beneficial in increasing the generalizability of these findings to the ASD population. Additionally, the effects of screen layout on the acquisition of multi-step manding were not evaluated in this study, which remains a gap in the SGD literature.

Multi-Step Manding. Few studies have evaluated teaching multi-step manding and advanced operations using tablet-based technologies. Multi-step manding and advanced operations are important topics to consider in order to improve the manding repertoire of the speaker to extend beyond one-word mands. Extending the literature to include multi-step manding could identify effective strategies to teach SGD users more conversational use of the device. Evaluating advanced operations, such as turning on the device, can promote user independence by decreasing the necessity of the listener to initiate opportunities for the speaker

to use the device. One study that addressed this limitation is Achmadi et al (2012). The researchers used choice making and backward chaining to teach manding to two teenage boys with ASD using an iPod Touch® with Proloquo2Go as a SGD. In addition to teaching manding, the researchers taught multi-step mands and turning on the device in order to mand for a preferred item. The researchers used a multiple probe multiple baseline across participants design to evaluate the effectiveness of time delay prompts, gestural prompts, and graduated guidance in the acquisition of manding and more advanced operations of the iPod Touch. The results indicated the participants acquired the ability to mand and use advanced operations, though for one participant, the maintenance probes were inconsistent indicating a potential lack of EO rather than a lack of maintaining the recently acquired skills. The benefits of this study included the participants' gaining the ability to use more advanced operations of the device, potentially leading to more independence with communication. Limitations of this study included lower experimental effect due to lacking a third participant in the study, participants having prior experience with the iPod Touch to make single-step mands, the lack of a discrimination component within the field, and a lack of generalization to natural settings. The researchers taught the participants two behavior chains including multiple steps to request for a *toy* or a *snack* (Achmadi et al., 2012).

This study addressed limitations in the literature by evaluating the acquisition of multi-step manding including turning on the device to mand for a preferred item, which has practical implications that may promote independence in communication for the SGD user. The participants included in this study had prior experience with using the iPod Touch to make single-step requests. Therefore, it would be beneficial to determine if multi-step requests can be taught using these teaching procedures with an individual without previous experience with the

device. The results of this study lack generalizability to other preschoolers with ASD. Lastly, the researchers did not evaluate generalization of the newly acquired skills to other environments or communication partners.

Alzrayer, Banda, and Koul (2017) evaluated the effectiveness of systematic instruction (i.e. constant time delay prompts with graduated guidance) on multi-step manding skills to teach four children ages eight to ten who were diagnosed with ASD and/or developmental delays to use an iPad with Proloquo2Go® as a SGD. The researchers used a multiple probe across participants design for this study. Using graduated guidance with 10-second constant time delay prompts, the researchers taught three-step mands to the participants. Results of the study indicated the participants acquired 3-step manding ability including symbol selection and device navigation indicating high levels of experimental effect for three of the four participants. The fourth participant required a modification to device settings due to his scrolling and not acquiring the target behavior following intervention in order to acquire three-step manding.

Benefits of this study include the participants gained the ability to use multiple steps to mand independently and the researchers taught the participants behavior chains to gaining access to a preferred item/activity. The study depicts the screen layout (e.g. “I Want” folder opens to the “Activities” folder, which opens to icons representing preferred items/activities that when selected, produces the item/activity). Additionally, the icon placement did not vary, which is consistent with the current study. The participants’ acquisition of three-step mands indicates the response effort was not too high for the participants to produce multi-step responses in order to gain access to a preferred item/activity.

Main limitations of this study included a lack of social validity and generalization. Though generalization probes were conducted to determine if the participants

were able to mand for novel items/activities, it is unknown if the participant will be able to generalize these newly acquired skills to make new mands, make more specific mands or make spontaneous mands for the following reasons: (a) the researchers noted the target icons maintained the same placement throughout the study, and the generalization probes included novel items which replaced the previously preferred icons. This could have inflated the generalization data to reflect false acquisition rates since the behavior chain remained the same (though the item/activity requested and received changed); (b) the novel items were only slightly different from those items/activities having been previously taught. For example, one of the preferred activities was a computer game involving a truck, whereas, the novel activity was a computer game involving a car; (c) the icon selection represented a specific item/activity with a descriptor (e.g. "red truck)" instead of teaching the participants to engage in an additional step to add a descriptor. The latter limits the participants' potential ability to generalize his requesting behavior to other kinds of items/activities in other environments (e.g. blue trucks, big trucks, small trucks, red cars).

This study adds to the literature by evaluating multi-step manding sequences and discussing screen layout. However, the effects of screen layout were not directly evaluated. Though the researchers attempted to address the limitations to generalization in the literature by presenting novel items and evaluating multi-step manding for the novel items, the attempt did not succeed. Because the screen remained static and the novel symbols replaced the location of the formally taught symbols, the research findings suggest the participants acquired the ability to mand using a three-step behavior chain (i.e. motor plan) in lieu of gaining a discriminated mand repertoire. These results indicate that more research is warranted in the area of screen layout and motor planning in order to address the additional limitations in the SGD literature.

Motor Planning. Clinicians implementing SGD based interventions require support in motor planning (i.e. icon placement or screen layout) and vocabulary selection when designing an early language development program (Banajee, DiCarlo, and Buras-Stricklin, 2003; Mirenda, 2003). In the SGD literature, examining the effects of screen layout and vocabulary selection must be addressed (Mirenda, 2003). Screen layout (i.e. motor planning) could affect language acquisition, yet these effects are not readily evaluated in the current ASD literature. Research on within stimulus prompting, multi-step requesting, and discrimination training include descriptions of icon placement for replicability; however, the effects of screen layout are not evaluated outside of the discussion of within stimulus prompting (Alzrayer et al., 2017; Lorah et al., 2014a; Lorah, 2016). Many mand training programs for SGD do not evaluate the effectiveness of screen layout as an independent variable, though screen layout often may contribute to the overall effects of the study or to its theoretical implications. Two studies that evaluated screen layout include Gevarter et al. (2017) and Dukhovny & Zhou (2016).

Gevarter et al. (2017) used a multielement design to compare acquisition of manding using various iPad displays on the application *AutisMate* for four children with ASD. The researchers used displays (i.e. conditions) including the photograph of the preferred items (i.e. Photo Image condition), Symbol Grid condition (e.g. a generic picture of the preferred item with the label in text above the symbol), a photograph of the preferred items with generic symbols below the photograph (i.e. Hybrid condition), and two Pop-up Symbol Grid conditions. The Pop-up Symbol Grids include the photograph of preferred items, when selected a pop-up screen with a symbol grid appears, or includes a photograph of a bag that when selected a similar pop-up grid appears. Prior to intervention, the researchers conducted three MSWO preference assessments to determine the items to target for each participant.

The researchers used a six-second constant time delay with least to most prompting to teach manding for preferred items. They conducted correspondence checks and a full physical prompt if the participant did not select the requested item. After reviewing initial data, two participants required modifications to the teaching procedures including a three second constant time delay prompt, a full physical prompt, and discrimination training in order to continue the study. The results indicated that three participants were able to acquire manding using each display in an array of four preferred items. One participant was able to acquire manding in a field of two in the hybrid and photo image conditions. The last participant was not able to discriminate between preferred items in a field of four. Additional implications include that evidence-based teaching procedures supported the acquisition of manding in these participants across a variety of screens and field sizes. A limitation of this study includes its lack of generalization or generalizability to the natural environment. An additional limitation may include teaching multiple conditions to each participant. The exposure to multiple conditions during the study could have affected the acquisition of manding within the next condition (Gevarter et al., 2017).

Dukhovny and Zhou (2016) described that there are two primary methods for screen layout with an early learner: (a) enlarged icons that gradually decrease in size and change in location as more icons are introduced into the field (i.e. size-centered design); (b) icons that remain in a specified location at a specified size as the number of icons in the field gradually increases (i.e. location-centered design). Dukhovny and Zhou (2016) discussed screen layout as it pertains to SGD users' speed and accuracy. This study involved 20 adults without disabilities in order to evaluate speed and accuracy of finding specific icons dependent upon screen layout using the iPad with either the Avaz or Alexicom applications as a SGD. The researchers taught

the participants to find the symbol and select it prior to testing when given a vocal cue. During a pre-testing phase, the researchers conducted trials within which the participants were asked to locate the previously taught symbols within the field provided either a field of six large icons (i.e. size-centered) or a field of six small icons in specific placements. During testing, the researchers increased the number of icons to 40. The size-centered icons decreased in size to be consistent with the size of the location-centered icons and were consistent in placement of those icons. The location-centered icons remained the same size and in the same placement as during pre-testing, but the number of icons in the field increased. The researchers conducted statistical analysis that determined participants in the location-centered group showed on average more accurate selection in less time than those in the size-centered group.

This study provides evidence in support of considering icon location more than icon size when introducing a SGD to a new user. The byproduct of emphasizing icon location is motor planning, which the results of this study suggest improves the fluency of SGD usage. Fluency in a SGD user's search and finding an icon or series of icons decreases the response effort of the SGD user and for the listener (Dukhovny & Zhou, 2016). This discussion of fluency is extremely important to the practical implications of SGD usage. The longer it takes a SGD user to locate the icons to communicate, the more strain is placed on both the speaker and the listener. This strain could potentially affect a SGD user's inclusion. Further, this study evaluated the acquisition of a fluent listener responding repertoire, which cannot predict the acquisition of fluent manding. Therefore, it is important to evaluate the effects of motor planning with a SGD on the acquisition of a manding repertoire. Even so, the results emphasize the importance of considering screen layout prior to beginning mand training using a SGD with an early learner.

The comparison of icon-location and icon-size based screen layout is a comparison of

two types of within stimulus prompts pertaining to screen layout (i.e. modifications to the SGD screen; Dukhovny and Zhou, 2016). Thus, icon-location based, within stimulus prompts could be used as methods for developing motor plans. Few studies evaluate icon-location based, within stimulus prompts (Achmadi et al., 2012; Dukhovny & Zhou, 2016). If using a size-centered design, the icons move as the size of the icon changes (Lorah et al., 2014a; Lorah, 2016). Once the icons move, the motor plan is no longer developed.

Language Acquisition through Motor Planning (LAMP^{TM}). One of the few researchers on the topic of motor planning and SGD includes Halloran and Halloran (2006). They identified a gap in the SGD and ASD literature regarding motor planning and vocabulary selection. To address this gap, they designed Language Acquisition through Motor Planning (LAMP^{TM}). LAMP is a teaching procedure designed to support SGD users with ASD in communication through the use of motor planning with core vocabulary. LAMP is typically associated with the Words for Life or Unity applications (e.g. these can sometimes be referred to as *LAMP devices*). Halloran and Halloran (2006) assert that LAMP teaching procedures are effective in teaching language to individuals with ASD and other disabilities using any SGD. LAMP emphasizes five main components (a) *readiness to learn*; (b) *joint engagement*; (c) *consistent and unique motor patterns* (i.e. motor plans); (d) *auditory signals; and* (e) *natural consequences* (Halloran and Halloran, 2006).

Stuart and Ritthaler (2008) reported two case studies involving the LAMP approach. The families were having difficulty navigating the participants' use of AAC in the school setting. The case studies reviewed the individual's experiences with the schools and with the schools' perspectives on using AAC in addition to the participants' progress. The relevant findings of these case studies include the reports of improved communication in both participants

using the LAMP approach. The researchers discussed the children's progress using the Vantage Minispeak and Mini Mo with the LAMP approach to mand for preferred items. In the first case study one participant was a seven-year-old girl with ASD. By the end of over 30 sessions, the participants were able to engage in social communication including up to five-step sequences. The other participant was a three-year-old boy with ASD and q22 deletion. The researchers reported that after nearly 50 sessions, the participant could engage in up to five-step sequences to communicate. The researchers also indicated that the participant gained vocalizations and could communicate somewhat effectively with speech, though he continued to facilitate his language with the SGD. Because the focus of this study was on the families' challenges with the schools, there was little information regarding the actual procedures used for teaching. Even so, these findings indicate that using the LAMP approach can promote improvement in social communication skills (Stuart & Ritthaler, 2008).

Bedwani et al. (2015) evaluated the LAMP approach in teaching functional communication on the Vantage Lite™ with Minspeak™ to nine children with ASD. They evaluated the participants' use of functional communication including requesting, making comments, asking for attention, and greeting others across natural environments including in school and in the home environment. The researchers also evaluated teacher and parent opinions in order to improve social validity. They conducted a two-year follow-up questionnaire to determine if use of the device and teaching procedure was still occurring without structured teaching. In order to teach functional communication to the participants, the researchers enlisted four speech therapists who were trained in using the LAMP approach. These therapists taught the parents and teachers to implement LAMP with the device. A 5-week evaluation was conducted within which the speech therapists taught the use of the device using incidental teaching. The

speech therapists followed the child's lead to determine preference in the moment and provided one of three levels of prompting including full physical prompt, partial physical prompt, or a gestural prompt. Information as to when each prompt level was used was not provided. The researchers used a reinforcer inventory to support the use of target vocabulary words from both core and fringe vocabularies for the speech therapist-led sessions. The participants had access to the device at school and at home, and data were collected on the participants' use of functional communication skills in both settings.

The results of the study indicated a significant increase in the functional communication of the participants within the study. The greatest change included an increase from 25% to 100% of the participants being able to spontaneously make comments. The participants also improved in areas such as refusal, asking for attention, indicating emotions, and making greetings. Additionally, the researchers determined that 75% of the participants were able to communicate using multiple-step sequences (i.e. phrases) at the end of the study. Results of the social validity survey included responses from seven parents who indicated that most of the participants and their families continued the use of the device with LAMP. The families who reported disuse of the device reported difficulty with technical support as a reason for discontinuing its use. Parents who continued the use also reported technical difficulties arose over the course of two years (Bedwani et al., 2015).

Limitations arise specifically within the design of the study. The researchers presented a multiple-participant, single-case, within-subject design citing Horner et al. (2005). This design methodology is unorthodox and not a design reviewed by Gast and Ledford (2018) in their thorough review of single-subject methodology. Upon further review, the study lacked visual analysis and presented unorthodox graphical representation making it challenging for the reader

to conduct his/her own visual analysis. These limitations are great and challenge the internal validity of the study because experimental effect is difficult to determine. In spite of these limitations, the participants gained the ability to spontaneously use functional communication in school and at home. Further, the success of the participants can be attributed to the use of evidence based teaching procedures such as prompting and reinforcement.

Core Vocabulary. In addition to choosing icon placement and screen design, practitioners are required to select a vocabulary set to teach SGD candidates. Current literature relies on preferences assessments to determine preferred items and use those preferred item labels (e.g. if a learner selects the ball during the preference assessment, the vocabulary taught in the study would be the noun, *ball*; Gevarter et al., 2017; Lorah et al., 2014a; Lorah, 2016;). In *Core vocabulary* is a term used to describe the most frequently used words by groups of people such as adults, adolescents, and preschoolers (Banajee et al., 2003; Halloran & Halloran, 2006). In considering preschool aged SGD users with ASD, a practitioner is required to choose the vocabulary with which to build the learner's language skills. The learner may only have access to the vocabulary selected by a stakeholder, which might limit the user's terminal vocabulary. Core vocabulary traditionally discludes nouns and includes verbs, pronouns, demonstrative adjectives, and prepositions. Nouns are considered fringe vocabulary, which are used less frequently in the language development of neuro-typical toddlers (Halloran & Halloran, 2006.).

Halloran and Halloran (2006) promote the use of core vocabulary when using SGD. They emphasize the applicability of core vocabulary words to various environments within which use of such words would be appropriate. They also note the use of fringe vocabulary is important regarding specific, preferred items, though teaching a fringe word should

follow the overgeneralization of a related core vocabulary word. For example, if a child shows preference for playing ball, LAMP practitioners would encourage the child to show the ability to generalize the word *Play* to a variety of toys prior to teaching *Play Ball* (Halloran and Halloran, 2006). In addition to these strategies, Halloran and Halloran (2006) also describe the benefit of using core vocabulary as providing the learner with access to the most frequently used words for which opportunities may arise more often than for the use of fringe vocabulary (Banajee et al., 2003).

Banajee et al. (2003) studied a sample of 50 preschoolers aged 24-36 months to determine their most frequently used words across a variety of settings in order to determine if core vocabulary words varied as the opportunities and materials varied. The researchers determined there were nine frequently used words by the participants that were consistent across settings. There were 23 total words that were frequently used, though less generalized across both settings and/or materials. Out of these 23 words, none were nouns. The findings of this study are consistent with findings from previous studies conducted to determine frequently used words by preschool aged children. The implications of this study include that use of core vocabulary may align more with the most frequently used words within typical development of speech production. The findings are also consistent with various studies on preschool core vocabulary indicating there are core vocabulary words used consistently in various settings by neuro-typical peers (Beukelman, Jones, Rowan, 1989; Fried-Koen & More, 1992; Halloran & Halloran, 2006).

Across the SGD literature, limitations exist in generalizability of the results and evaluation of social validity (Achmadi, 2012; Alzrayer et al., 2017; Lorah et al., 2014a; Lorah et al., 2016; Waddington et al., 2017; Xin & Leonard, 2014). Additional efforts should evaluate the

effectiveness of teaching procedures in naturalistic environments such as during play. When working with a SGD, it can be important to evaluate the opinions of the interventionists on the teaching procedures, ease of use, and likelihood of future implementation of the device (Horner et al., 2005;). Further information on the applicability and feasibility of procedures could provide guidance for future research that will have greater practical implications. An additional limitation to the research includes the small sample size of the population involved in the single-subject literature. Replication is an extremely important component to single-subject research as it promotes generalization of research findings to a larger population (Gast & Ludford, 2018). Other limitations in the literature include minimal studies addressing multi-step manding using an iPad and Proloquo2Go with preschoolers with ASD (Achmadi, 2012; Alzrayer et al., 2017; Waddington et al., 2017; Xin & Leonard, 2014). Lastly, few studies evaluate motor planning and core vocabulary as interventions in teaching manding with tablet-based technologies as SGDs to individuals with ASD (Banajee et al., 2003; Bedwani et al., 2015; Dukhovny & Zhou, 2016; Halloran & Halloran, 2006; Stuart & Ritthaler, 2008).

Research Questions

The purpose of the current study is to evaluate motor planning with core vocabulary and a prompting package including within stimulus prompts and constant time delay with response prompts as a strategy for teaching manding using the iPad mini and Proloquo2Go™ as a SGD to preschool aged children with autism. This study will add to the literature by emphasizing screen layout and design through motor planning using core vocabulary. Additionally, this study will evaluate a prompting package that includes within stimulus prompts and constant time delay with response prompts for teaching manding to preschool aged children with ASD using motor planning. Lastly, this study will evaluate implementer opinions on the teaching procedures and

use of motor planning with core vocabulary to teach manding using the iPad mini with Proloquo2Go to preschool aged children with ASD. The research questions for this study are as follows:

1. Does motor planning with core vocabulary and the prompting package increase manding using the iPad mini and Proloquo2Go as a speech-generating device to preschool aged children with autism?
2. Does motor planning with core vocabulary and the prompting package increase vocal utterances in preschool aged children with autism?
3. Does motor planning with core vocabulary and the prompting package decrease problem behaviors in preschool aged children with autism?
4. Will implementers gain confidence in the use motor planning with core vocabulary and the prompting package to teach manding using the iPad mini and Proloquo2Go as a speech-generating device to preschool aged children with autism?
5. Will implementers maintain the use of the iPad mini and Proloquo2Go as a speech-generating device, motor planning with core vocabulary, and/or the prompting package following this study?

Chapter Three: Methodology

The purpose of the current study is to evaluate motor planning with core vocabulary and a prompting package including within stimulus prompts and constant time delay with response prompts as a strategy for teaching manding using the iPad mini® and Proloquo2Go™ as a speech-generating device (SGD) to preschool aged children with autism (ASD). This study will add to the literature by emphasizing screen layout and design through motor planning using core vocabulary. Additionally, this study will evaluate a prompting package that includes within stimulus prompts and constant time delay with response prompts for teaching manding to preschool aged children with ASD using motor planning. Lastly, this study will evaluate implementer opinions on the teaching procedures and use of motor planning with core vocabulary to teach manding using the iPad mini with Proloquo2Go to preschool aged children with ASD. The research questions for this study are as follows:

1. Does motor planning with core vocabulary and the prompting package increase manding using the iPad mini and Proloquo2Go as a speech-generating device to preschool aged children with autism?
2. Does motor planning with core vocabulary and the prompting package increase vocal utterances in preschool aged children with autism?
3. Does motor planning with core vocabulary and the prompting package decrease problem behaviors in preschool aged children with autism?
4. Will implementers gain confidence in the use motor planning with core vocabulary and the prompting package to teach manding using the iPad mini and Proloquo2Go as a speech-generating device to preschool aged children with autism?
5. Will implementers maintain the use of the iPad mini and Proloquo2Go as a speech-

generating device, motor planning with core vocabulary, and/or the prompting package following this study?

The following chapter provides a detailed description of the procedures used in this study to evaluate these research questions. Descriptions of the participants, setting, materials, research design, procedures and social validity measures are included.

Participants

As presented in Table 1 on page 89, this study included 3 preschool aged children with Autism spectrum disorder (ASD). These children attended a clinical setting within a University where they received Applied Behavior Analysis (ABA) services 2.5 hours daily, 3 days weekly for a 16-week term. This study occurred for a 15-week period during this time (i.e. 25 sessions total). Participants of this study included children with communication delays, ages 2 to 5, whose language skills were evaluated using the Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP; Sundberg, 2008). These children were determined appropriate candidates for augmentative and alternative communication (AAC) based on their having limited manding (average score, 5.67), tacting (average score, 2.33), intraverbal (average score, 0.17), and echoic (average score, 4) repertoires. The average overall score for the participants on the VB-MAPP was 35.5. The participants' scores on the VB-MAPP assessment can be seen in Table 2 on page 89.

Wright. At the onset of the study, Wright was a 2 year and 11 months old, Caucasian boy with ASD. Wright did not have a past history of ABA services nor did he have exposure to AAC devices. Wright was evaluated using the VB-MAPP. His overall score on the VB-MAPP was 11 out of 170, indicating that at the beginning of the study, Wright was a Level 1 learner. Level 1 skills on the VB-MAPP are consistent with a developmental age of

approximately 0-18 months (Sundberg, 2008). Wright's VB-MAPP scores are presented in Table 2 on page 89. Wright did not display the ability to speak more than occasional babbles during assessment. Because of his VB-MAPP scores and his lack of babbling during his initial assessment, Wright was determined an appropriate candidate for this study.

Roan. At the onset of the study, Roan was a three year and 9 months old, Asian boy with ASD. He has been involved in this university-based ABA program (two previous semesters) where he gained exposure to AAC in the form of the iPad mini® with Proloquo2Go™. Roan's parents reported a lack of independence with the SGD at home, and successful use of the device was not observed during his assessment prior to this semester in the Clinic. Roan was evaluated using the VB-MAPP. His overall score on the VB-MAPP was 27.5 out of 170, indicating that at the beginning of the study, Roan was a Level 1 learner. Level 1 skills on the VB-MAPP are consistent with a developmental age of approximately 0-18 months (Sundberg, 2008). Roan's VB-MAPP scores are presented in Table 2 on page 89. Roan did not display the ability to speak more than occasional babbles during assessment. Due to his parents reporting a lack of independence with his current SGD and the lack of independent responding using his SGD during the initial assessment, it was determined Roan was an appropriate candidate for this study.

Kadeem. At the onset of the study, Kadeem was a 5 years and 1 month old, African American boy with ASD. He has been involved in this university-based ABA program (two previous semesters) where he gained exposure to AAC in the form of the iPad mini® with Proloquo2Go™. Kadeem had previous exposure to a picture exchange system in his home environment. Kadeem was evaluated using the VB-MAPP. His overall score on the VB-MAPP was 68 out of 170, indicating that at the beginning of the study, Kadeem was a Level 2 learner. Level 2 skills on the VB-MAPP are consistent with a developmental age of

approximately 18-30 months (Sundberg, 2008). Kadeem's VB-MAPP scores are presented in Table 2 on page 89. Kadeem spoke during his assessment, though his articulation made it was difficult for the evaluator to determine his responses. Because of his difficulty with articulation and scores below his chronological age on the VB-MAPP, it was determined Kadeem would be suitable for using a speech-generating device (SGD) to facilitate and support his speech.

Consent forms, approved by the University Institutional Review Board, were provided to the children's guardians and included information of the purpose of the study, what the study entailed, the anticipated amount of time the participant would be engaged in the study, the primary researcher's contact information, and the voluntary nature of participating in this research study. Once consent was received, the primary researcher and the implementers began the preliminary preference assessments to identify appropriate targets for each participant.

Setting and Materials

The study occurred during the typical clinic day for the participant. The research occurred within the classroom environment during normal clinic routines. The classroom in this clinic was arranged in centers or stations where different materials were organized. The classroom had two tables with chairs that seat up to eight preschool aged children on one side and accommodated one adult sized chair in the middle on the opposite side. The classroom included multiple stations for circle time, toy play, books, and puzzles. The research occurred at each of the stations and materials were determined by the participant's motivation within that station. Depending upon the designated area, the participant and the implementer sat across from each other on the floor or adjacent to each other at a table. The area included the participant's preferred items for that center, the iPad mini, and the implementer's clipboard.

The materials used in the study included iPad minis$^{(R)}$ protected by cases assigned by the

clinic in which the study took place. Each iPad mini equipped with Proloquo2Go software was organized with the appropriate design layout prior to providing the device to the implementers. The icons were organized with the screen layout as indicated in the Procedures section of this study. Examples of screen layout are included in Figures 1, 2, and 3 found on pages 103-105, for the icon "Read." A potential reinforcer for a participant might have been reading a book during Book Center. The implementer could have taught the participant to request to "Read." Other potential reinforcers could have been "Eat" during Snack, "Go" when playing with cars, "Play" to request a toy or a game, and/or "All Done" to request to finish an activity. These and other core vocabulary word options are depicted in Table 3 on page 90 and Figure 3 on page 93.

Implementers and Training

The primary researcher, a Board Certified Behavior Analyst (BCBA) with experience using the iPad mini and Proloquo2Go as a SGD to teach verbal behavior to children with ASD, oversaw the study and collected interobserver agreement data (IOA). The primary researcher had experience using response prompts, within stimulus prompting, and modeling to teach language acquisition using the iPad as a SGD. The primary researcher attended training provided by Language Acquisition through Motor Planning (LAMP™) professionals in order to gain experience with motor planning and core vocabulary to teach language acquisition using the iPad as a SGD.

The primary researcher provided training on the teaching procedures and data collection to behavior therapists that conducted the study and worked directly with the participants. These therapists were BCBA pursuants, graduate students at the University, and students gaining BACB supervision experience within the Clinic. The therapists are referred to as *implementers*

for the entirety of the study because they implemented the research procedures, data collection, and therapeutic interventions during the sessions. Training of the implementers for this study consisted of a traditional behavior skills training model including: lecture, handouts, modeling, rehearsal, and feedback provided by the primary researcher and conducted within a group setting (Parsons & Reid, 2012). Additionally, the first clinic session was used as training during which the primary researcher observed and provided direct feedback to the therapists as they implemented the Baseline procedures with the participants. The primary researcher was present for over 50% of Clinic sessions to observe fidelity of implementation and conduct interobserver agreement. The primary researcher provided in vivo feedback as needed in order to ensure correct implementation of the procedures.

Dependent Measures

The purpose of this study was to evaluate the effectiveness of motor planning with core vocabulary and a prompting package including within stimulus prompts, constant time delay prompts, and response prompts on the acquisition of manding using a iPad mini and Proloquo2Go with participants with ASD. The primary dependent variable in this study was accurate and independent manding with the iPad mini and Proloquo2Go. An accurate and independent mand was considered digitized vocal output from the iPad consistent with the participant's prelinguistic behaviors indicating motivation (i.e. reaching, eye contact, grabbing a toy) and having correspondence with the preferred item or activity. The effects of motor planning and core vocabulary on vocalizations and problem behaviors were also evaluated. Data were collected on vocalizations and interfering behaviors throughout the study to determine any effects upon implementing the intervention.

Dependent Measurement System

Multiple forms of data were collected during this study. Prior to intervention, the primary researcher and/or implementers conducted a 10-minute observation and Multiple Stimulus Without Replacement (MSWO) preference assessment (Deleon & Iwata, 1996). The 10-minute observation of each participant supported object selections for the MSWO assessment. The MSWO indicated items and/or activities for which the child showed preference or interest and provided a ranking of the items by most preferred to least preferred during the time of the assessment. MSWO preference assessments are conducted regularly in the mand training research in order to evaluate participant preference (Gevarter et al., 2017; Lorah 2016; Lorah et al., 2014a). These data were collected using a preference assessment iPad application called *Preference Assessment*. In addition to the MSWO preference assessments, in vivo preference assessments were conducted throughout each session in order to account for daily and momentary fluctuations in participant preference and potential satiation of a preferred item/activity. These were informal and included choice making opportunities, correspondence checks, and some observation of interaction with items in the play centers.

Additional data were collected on frequency of manding, number of steps required to produce a mand, vocal utterances, and interfering behaviors as necessary. Nominal data were collected on mands throughout the clinic day to indicate what types of different mands the participants acquired during the study. Data were collected by implementers who were trained to use the data forms and to collect any data requested. The Baseline data form can be seen in Figure 4 on page 94, and the Intervention data form can be seen in Figure 5 on page 95. In order to determine the participant's percentage of vocal utterances per session, partial interval data were collected every 30 seconds during the entirety of the clinic session. If a participant produced a vocal utterance, during an interval, the implementer documented "Yes" on the data

form. If a participant did not produce a vocal utterance during an interval, the implementer documented "No" on the data form. This data form can be seen in Figure 6 on page 96.

Interobserver Agreement

Interobserver Agreement (IOA) data was collected by the primary researcher and another BCBA and PhD candidate who had been trained on the procedures. IOA was conducted for over 30% of sessions, for each participant (i.e. 9 sessions each; 27 sessions total). The observers collected IOA data in vivo and by observing recordings of the clinic sessions. Calculating and reporting of IOA included analyzing the percentage of agreement between the implementers' data and the primary researcher's data collected for each participant and session. IOA data for Baseline sessions were collected using the data form seen in Figure 4 on page 94. IOA data for Intervention sessions were collected using the data form seen in Figure 5 on page 95. IOA data were also collected on vocal utterance using the data form seen in Figure 6 on page 96.

In order to determine IOA for percentage, accurate independent manding, the primary researcher calculated percentage of agreement by determining the number of agreed upon mands divided by the total number of mands observed and multiplied by 100 [i.e. agreements/(agreements+disagreements)*100]. The average IOA for percentage of accurate independent manding was 88.31% (range, 65.22-100%).

IOA for percentage of vocal utterances was calculated by determining the number of agreed upon instances of vocal behavior divided by the total number of vocal utterances observed and multiplied by 100 [i.e. agreements/(agreements+disagreements)*100]. The average IOA for daily percentage of vocal utterances was 92.54% (range, 45.67-99.67%).

IOA for percentage of problem behaviors during mand training was calculated by determining the number of agreed upon instances of problem behavior divided by the total

number of problem behavior occurrences observed and multiplied by 100 [i.e. agreements/(agreements+disagreements)*100]. The average IOA for percentage of problem behaviors during mand training was 80.55% (range, 0-100%).

Procedural Fidelity

In order to increase the likelihood of implementation fidelity, a data form including a task analysis of the procedures for the implementer was provided at the beginning of each session, as seen in Figures 7 on page 97 (Baseline) and 8 on page 98 (Intervention). These data forms included self-assessment measures the implementers were required to complete for each session. The overall average procedural fidelity self-assessment score was 94.31% (range, 80-100). The observers completed the procedural fidelity checklist during IOA sessions. If procedural fidelity was less than 80% when the primary researcher was present, the primary researcher provided modeling and feedback on the procedures following the clinic session. If the procedures did not improve, the primary researcher rehearsed with the implementer until he/she was able to complete the procedures at 80% accuracy.

Design

A changing criterion design within a multiple baseline design across participants was selected to evaluate the effectiveness of motor planning using core vocabulary and a prompting package in the acquisition of manding with an iPad with Proloquo2Go as a SGD. The changing criterion design was appropriate in examining experimental effect in the use of within stimulus prompting. Because this study used stimulus fading on a gradient scale from few available icons to many with various background shades, a changing criterion design component was most appropriate in representing these data, which are presented in phases during Intervention. More information on this procedure can be found in the Intervention section of this chapter.

The multiple baseline design across participants was selected to evaluate the effectiveness of the prompting package on the acquisition of manding for each participant. Manding was an appropriate behavior to study using multiple baseline design because the behaviors are functionally independent and similar (Gast and Ledford, 2018). This design was also selected because reversal of manding would be unlikely; therefore, a reversal design would not be a feasible option (Gast and Ledford, 2018).

Data were collected on manding opportunities contrived during the 2.5-hour clinic session and during a variety of different centers excluding discrete trial teaching (DTT). The participants remained at each center for 10-20 minutes. The participants interacted with the materials related to that center and engaged in activities with the interventionist during the center. There were multiple activities available to the participants including books, puzzles, pegboards, dollhouse, play, food, cars, and snacks.

Procedures

Preference Assessment. The selection of preference assessments for this study was consistent with Lorah (2016). In an enriched environment, the primary researcher and implementer observed the participant's behavior for 10 minutes in order to determine in which items the participant showed interest by engagement with the item. Items with which the participant interacted during the 10-minute observation were used in a MSWO preference assessment in order to determine preference for items in rank order (i.e., most preferred to least preferred). The MSWO occurred prior to Intervention. Findings from the preference assessments supported the implementers' selection of preferred items within various play centers. In vivo preference assessments occurred throughout the sessions as needed in order to determine preference for items within each play center. These in vivo preference assessments included

choice making opportunities and correspondence checks to determine if the participant engaged in behaviors indicating motivation for the item.

Screen Layout. The screen layout functions as the motor plan for the participants' devices. On each iPad, the device screen displayed up to 60-core vocabulary icons dependent upon the phase of the study. The device was programmed using core vocabulary, which is the default vocabulary for the Proloquo2Go software. In order to program the device, the researcher added a new user, selected the most appropriate voice for the participant (i.e., child's voice for toddlers), chose the vocabulary set (i.e., Intermediate), and selected the grid size (i.e., 6x10). An example of the home screen can be seen in Figure 3 on page 93. Once the new user was available, the screen displayed multiple color-coded icons on the grid, each designated by a word and a picture. The icons included the most frequently used words in a toddler's vocabulary (Halloran & Halloran, 2006). Halloran and Halloran (2006) recommend choosing words that may be higher frequency for a participant, such as verbs that are more consistent with the participant's favorite items or activities. Some of the icons may be replaced with icons that better support the participant's preferences. For example, *think* is a word that is a default on the device, and because it is more introspective, it will likely be used less in this child's language program than other more child-specific verbs such as *Spin, Potty, or Read*. Therefore, some words were replaced with others the participant may use more frequently based on observations of preference for the participants. For example, *Spin* replaced *Take* on the home screen as each participant consistently engaged with toys or activities with the implementers that included spinning. For example, a spinning chair was in the room, and Wright climbed into the chair and waited. The implementer spun him and he laughed. If the implementer stopped the spinning action, Wright engaged in prelinguistic behaviors consistent with motivation to continue

spinning in the chair such as, looking to the implementer, orienting his body toward the implementer, leaning right and left, and touching the implementer's hands. Each time the spinning chair was in the Free Play center, Wright approached the chair, which indicated preference for this activity. Additional changes made to the home screen "recommended" vocabulary include replacing *Think* with *Read* and replacing *Of* with *Potty*. Once these selections were made, it was assumed the icons would not move so the motor plan can stay the same for the participant.

Though the icon location did not change, the target icon changed throughout the study dependent upon the participants' motivation. For example, a participant may have engaged in prelinguistic behaviors indicating motivation for a book during Book Center. The screen would have included the "Read" icon in isolation. During Snack Time, hunger may increase the value of food and therefore, the icon "Eat" would be used in isolation. The icon available changed as the participants' prelinguistic behaviors identified motivation for a variety of items or activities throughout the clinic session. Using Proloquo2Go settings *Hidden, Dimmed, and Visible*, the available icons to the participant changed across intervention phases. These changes in screen layout were determined by the phase of the study, which determined the within stimulus prompt that was used. When icons were hidden, they were unavailable to be selected and were also displayed as white/clear and were not visible to the user. An example of this screen layout is included in Figure 1 on page 91. When icons were dimmed, they were visible to the user but were a shaded color and could not be selected to evoke sound. An example of the dimmed icon phase is included in Figure 2 on page 92. Visible icons were the normal use icons and could be selected to evoke sound. A depiction of the screen in this phase is included in Figure 3 on page 93. In any of these settings, the grid size did not change, and the icon size did not change.

Additionally, the icon placement did not move, which remained consistent with the motor planning intervention. More detail on within stimulus prompting is provided in the Intervention section of this chapter.

Baseline. At the onset of the session and at the beginning of each center, the implementer conducted in vivo preference assessments to determine if motivation was present for an item by observing prelinguistic behaviors such as the participant reaching for an item or the participant's body orienting or moving toward an item. If the participant did not engage in prelinguistic behaviors that indicate motivation for an item, the implementer attempted to contrive motivation by engaging with items until an indication of motivation occurred. The participant's preferred items were kept within sight but out of reach. During Baseline, the device was present within six inches of the participant and displayed the full field of core vocabulary available (i.e. 60 icons). Figure 3 on page 93 depicts the appropriate screen layout for baseline conditions.

The implementer provided a 5-second constant time delay prompt in order to provide time for the participant to respond. The item was provided to the participant after five seconds following a correct response or an incorrect response, to maintain motivation during baseline. The participant engaged with the item for 30 seconds; after which time, the implementer removed the item and replaced it in the field for the next trial. For example, the participant reached for an item, the implementer waited five seconds and presented the item to the participant. During Baseline, the presentation of the item was dependent upon the time delay instead of the participant's behavior in order to decrease the likelihood of inadvertently reinforcing the participant's behaviors and in order to decrease reinforcement strain that could occur as a result of no feedback.

A correct response was accurate, independent manding and was scored "I." Accurate, independent manding occurred when the participant selected the button corresponding with the participant's motivation with enough force to evoke digitized output. An incorrect response was scored "NA" and was considered not selecting an icon, not using enough force to evoke digitized output, and/or selecting an incorrect icon. 30-50 manding opportunities occurred during each session.

Intervention. Intervention was introduced after a stable baseline had been established (i.e. 3-5 stable data points). The prompting package being evaluated in this study included multiple components such as (a) constant time delay prompts, (b) response prompts, and (c) within stimulus prompts. Constant time delay prompts and response prompts remained consistent across trials and are described in the General Procedures section of this chapter. Within stimulus prompts will be addressed further within the discussion of each training phase.

General Procedures. The implementer determined the participant's motivation for an item by observing prelinguistic behaviors indicating motivation. Once this behavior occurred, the implementer updated the device to show the target icon within the appropriate field. The implementer presented the iPad mini with Proloquo2Go on the floor or on the table within 6 inches of the participant and provided a constant 5-second time delay prompt. If the participant responded by selecting the corresponding icon with enough force to evoke digitized output, the implementer provided the item to the participant. The participant had access to the item for 30 seconds. During this time, the implementer scored the trial as "I." The implementer began the next trial.

If the participant did not mand accurately and independently after 5-seconds, the implementer provided a full physical prompt by gently guiding the participant's hand to select

the appropriate icon with enough force to evoke digitized output. The implementer provided the item to the participant for 30 seconds, during which time the implementer scored the trial as "FPP." The implementer began the next trial.

Phase 1 - Hidden. In each phase of the study, within stimulus prompts were used to gradually expose the participants to more icons within the field. In Phase 1 - Hidden, 1 icon was available and all other icons were hidden. The icon available was specific for each participant once potential motivation had been determined. The device had 1 icon on the screen and the rest of the screen was blank. The icon was the only icon available to select that evoked sound. An example of Phase 1 can be seen in Figure 1 on page 91. Accurate, independent manding in Phase 1 - Hidden was considered mastered at 80% over 3 consecutive sessions. 30-50 manding opportunities occurred during the clinic session.

Phase 2 - Dimmed. In Phase 2 - Dimmed, 1 icon was available and all other icons were dimmed. The device had all the icons on the screen, and the target icon was available and brighter than the rest of the icons. The icon was the only icon available for selection that evoked sound. The dimmed icons were shaded and did not evoke sound if selected. An example of Phase 2 is included in Figure 2 on page 92. Accurate, independent manding in Phase 2 - Dimmed was considered mastered at 80% over 3 consecutive sessions. 30-50 manding opportunities were provided throughout the clinic session.

Phase 3 - Visible. In Phase 3 - Visible, all the icons were visible and available. All icons evoked sound if selected. The target icon remained in the same locations as previously taught. A depiction of Phase 3 is included in Figure 3 on page 93. Accurate, independent manding in Phase 3 - Visible was considered mastered at 80% over 3 consecutive sessions. 30-50 manding opportunities were provided throughout the clinic session.

Generalization Probes. In order to determine if the participants' newly acquired mands generalized to a novel listener (i.e., the primary researcher), generalization probes were conducted. Probes were conducted following mastery of each phase of the study. The primary researcher evaluated the participants' manding in a field consistent with the previously mastered phase. For example, Kadeem entered intervention into Phase 1-Hidden. The primary researcher conducted a generalization probe consistent with Baseline (i.e., 60 icons available). Further, when Wright entered into Phase 2-Dimmed, the primary researcher conducted a generalization probe consistent with Phase 1-Hidden (i.e., 1 icon available and 59 icons hidden). During each generalization probe session, five trials consistent with Baseline procedures were conducted for each participant. No prompts were used to evoke the mand in the presence of the novel listener. Generalization probes were conducted once a participant entered intervention.

Social Validity Survey. Additionally, a pre/post-test survey was conducted with the implementers to measure social validity of the procedures used in the study (Horner et al., 2005). The survey was modeled after the social validity survey and follow-up questionnaire used by Bedwani et al. (2015). These surveys evaluated implementers' comfort levels with using the teaching procedures proposed in this study and their willingness/likelihood to continue using the teaching procedures in the future. The implementers were provided a pre and post test requesting information on familiarity with the device, ease of use, likelihood of using procedures again, and further comments regarding the use of the proposed intervention to teach manding using the iPad mini with Proloquo2Go in language development programs. The social validity surveys are included in Figures 10 on page 100 and 11 on page 101.

Chapter Four: Results

The results of this study are presented in this chapter. This chapter is organized by dependent measure: percentage of accurate, independent mands; percentage of vocal utterances; and percent occurrence of problem behaviors. These dependent measures represent the first three research questions respectively. Finally, the results of the social validity surveys (i.e., research questions four and five) are presented.

Percentage of Accurate, Independent Mands

As depicted in Figure 12 on page 102, the results of the study indicate that motor planning with core vocabulary and the prompting package is an effective strategy for teaching manding to preschool aged children with autism (ASD) on a iPad mini® with Proloquo2Go™ as a speech-generating device (SGD). All three participants acquired the ability to mand using a variety of core vocabulary words (e.g. *go, stop, all done*, *eat*, *drink*, *etc.*) in Phases 1-Hidden and 2-Dimmed. One participant (Kadeem) mastered Phases 1 and 2 of the study in the minimum amount of sessions required to meet mastery criteria (i.e. three sessions). Additionally, he is the only participant who mastered Phase 3-Visible of the study due to time constraints with the semester ending. Kadeem required four sessions to master Phase 3. In terms of magnitude of effect, the participants required an average of four sessions to master Phase 1 (range, 3-5), an average of eight sessions to master Phase 2 (range, 3-13), and an average of 12 sessions to master both Phases 1 and 2 (range, 6-18). In terms of percentage of non-overlapping data (POND), only one participant (Wright) had overlapping data when comparing baseline to Phase 1. PND for Wright are 80% suggesting the intervention is effective, though the data points overlap. PND for all other participants, comparing baseline to Phase 1, are 100% indicating the intervention is very effective in increasing manding.

Wright. As seen in Figure 12 on page 102, Wright responded at an average of 0.74% independent and accurate mands (range, 0-2.22%) during Baseline. Wright required five sessions to meet criterion in Phase 1 of the study and responded at an average of 62.96% accurate and independent mands (range, 0-94.12%). In Phase 1, the data trend upward on an appropriate path suggesting the intervention is effective. In comparing Baseline to Phase 1, Wright's PND was 80% indicating the intervention was effective. Wright met criterion in Phase 2 after 13 sessions and responded at an average of 66.63% accurate and independent mands (range, 20.83-90.91%). During Phase 2, the data display moderate variability, though the data are trending upward on an appropriate path suggesting effectiveness of the intervention. Due to time constraints of the study, Wright did not meet criterion for Phase 3, though his average responding was 65.1% accurate and independent mands (range, 56.25-69.05%). Wright's data display a high magnitude of change when comparing Baseline to Phase 1 (0-94.12%), which indicates effectiveness of the intervention.

As seen in Figure 13 on page 103, generalization probes were conducted during sessions four, ten, 16, and 22 in order to determine if Wright's manding generalized to a variety of therapists. During session four, a generalization probe was conducted to determine if Wright's manding was consistent with Baseline in the presence of a different therapist. This generalization probe was consistent with his average responding during Baseline at 0% accurate and independent mands. During sessions ten and 16, generalization probes were conducted to determine if Wright's manding was consistent with Phase 1 in the presence of a different therapist. The result was 100% accurate and independent mands each session, which was higher than his average responding in Phase 1 (66.63%). Lastly, during session 22, a generalization probe was conducted to determine if Wright's manding was consistent with Phase 2 in the

presence of a different therapist. The result of this generalization probe was 100% accurate and independent mands, which was higher than his average responding in Phase 2 (65.1%). These data suggest that Wright's manding generalized to different therapists.

Roan. As seen in Figure 12 on page 102, Roan responded at an average of 1.56% independent and accurate mands (range, 0-8.51%) during Baseline. For Phase 1, an immediate increase is noted (from 2.86-33.33%) upon initial implementation of the intervention. This immediacy suggests effectiveness of the intervention. Roan only required four sessions to meet criterion in Phase 1 of the study and responded at an average of 69.44% accurate and independent mands (range, 33.33-82.61%). In comparing Baseline to Phase 1, Roan's PND was 100% indicating the intervention was very effective. Roan met criterion in Phase 2 after eight sessions and responded at an average of 72.94% accurate and independent mands (range, 36.59-91.36%). During Phase 2, the data are trending upward on an appropriate path suggesting effectiveness of the intervention. Due to time constraints of the study, Roan did not meet criterion for Phase 3, though his average responding was 69.19% accurate and independent mands (range, 59.46-75.51%). Roan's responding includes low variability and a high magnitude of change when comparing Baseline to Phase 2 (0-91.36%), which indicates effectiveness of the intervention.

As seen in Figure 13 on page 103, generalization probes were conducted during sessions ten, 16, and 22 in order to determine if Roan's manding generalized to a variety of therapists. During session ten, a generalization probe was conducted to determine if Roan's manding was consistent with Baseline in the presence of a different therapist. The result of this generalization probe was 100% accurate and independent mands, which was inconsistent with his average responding during Baseline (1.56%). During session 16, a generalization probe was

conducted to determine if Roan's manding was consistent with Phase 1 in the presence of a different therapist. The result was 100% accurate and independent mands, which was higher than his average responding in Phase 1 (69.44%). Lastly, during session 22, a generalization probe was conducted to determine if Roan's manding was consistent with Phase 2 in the presence of a different therapist. The result of this generalization probe was 40% accurate and independent mands, which was lower than his average responding in Phase 2 (72.94%). Roan's generalization data suggest that Phase 1 intervention improved Roan's ability to mand independently and accurately in the full field of core vocabulary, which could indicate that Phase 2 of the study is unnecessary to acquire accurate, independent manding in a full field. These data suggest that Roan gained the ability to mand with different therapists in Baseline and Phase 1, yet displayed inconsistent responding with a different therapist at Phase 2.

Kadeem. As seen in Figure 12 on page 102, Kadeem responded at an average of 5.89% independent and accurate mands (range, 0-27.78%) during Baseline. For Phase 1, an immediate increase is noted (from 8.43-96.2%) upon initial implementation of the intervention. This immediacy displays quick acquisition of independent manding and suggests the intervention was very effective for this participant. Kadeem only required the minimum three sessions to meet criterion in Phase 1 of the study and responded at an average of 96.98% accurate and independent mands (range, 96.2-97.87%). In comparing Baseline to Phase 1, Kadeem's PND was 100% indicating the intervention was very effective. Kadeem met criterion in Phase 2 in the minimum three sessions and responded at an average of 95.61% accurate and independent mands (range, 86.84-100%). Kadeem was the only participant to meet criterion in Phase 3 of the study, requiring four sessions and responding at an average of 86.04% accurate and independent mands (range, 70-93.33%). Kadeem's responding includes low variability and a high magnitude of

change when comparing Baseline to Phase 2 (0-100%), which indicates effectiveness of the intervention.

As seen in Figure 13 on page 103, generalization probes were conducted during sessions 16 and 22 in order to determine if Kadeem's manding generalized to a variety of therapists. During session 16, a generalization probe was conducted to determine if Kadeem's manding was consistent with Baseline in the presence of a different therapist. The result of this generalization probe was 40% accurate and independent mands, which was inconsistent with his average responding during Baseline (5.89%). During session 22, a generalization probe was conducted to determine if Kadeem's manding was consistent with Phase 2 in the presence of a different therapist. The result of this generalization probe was 100% accurate and independent mands, which was consistent with his average responding in Phase 2 (95.61%). Kadeem's generalization data suggest that Phase 1 intervention improved his ability to mand independently and accurately in the full field of core vocabulary, which could indicate that Phase 2 of the study is unnecessary to acquire accurate, independent manding in a full field. Additionally, these data suggest that Kadeem's manding generalized to different therapists.

Percentage of Vocal Utterances

Wright. Percentage of vocal utterance data were collected per session in order to determine if the intervention was successful in contributing to an increase in vocalization production across participants. These data are shown in Figure 14 on page 104. During Baseline, Wright's average percentage of vocal utterances was 5.89% per session. During Phase 1, Wright's average percentage of vocal utterances decreased to 4.92%. During Phase 2, Wright's average percentage of vocal utterances decreased to 3.28%. During Phase 3, Wright's average percentage of vocal utterances increased to 3.75%. Though the average percentage of vocal

utterances showed a slight decrease in comparing Baseline to Phase 3, the levels of behavior showed little variation between conditions. There are no indicators of experimental effect when comparing Baseline percentage of vocal utterances to Phases 1-3 percentage of vocal utterance data. These data suggest that the intervention did not produce an increase in vocal utterances for this participant.

Roan. During Baseline, Roan's average percentage of vocal utterances was 10.42% per session. During Phase 1, Roan's average percentage of vocal utterances increased to 12.25%. During Phase 2, Roan's average percentage of vocal utterances decreased to 6.96%. During Phase 3, Roan's average percentage of vocal utterances decreased to 4.73%. In terms of the levels of vocal utterances per session, the data suggest a slight decrease in average vocal utterance production when comparing Baseline (10.42%) to Phase 3 (4.73%). There are no additional indicators of experimental effect, which suggest that the intervention did not affect production of vocal utterances for this participant. These data are depicted in Figure 14 on page 104.

Kadeem. During Baseline, Kadeem's average percentage of vocal utterances was 80.64% per session. During Phase 1, Kadeem's average percentage of vocal utterances increased to 93.75%. During Phase 2, Kadeem's average percentage of vocal utterances slightly decreased to 93.49%. During Phase 3, Kadeem's average percentage of vocal utterances increased to 94.85%. In terms of the levels of vocal utterances per session, the data suggest an increase in average vocal utterance production when comparing Baseline (80.64%) to Phase 1 (93.75%). No additional indicators of experimental effect were determined, suggesting the intervention is not effective in increasing vocal utterances. Additionally, because the data were trending upward during Baseline, confounding variables may have affected vocal utterance production for this

participant. These data are depicted in Figure 14 on page 104.

Percent Occurrence of Problem Behaviors

Wright. During Baseline, Wright's average percentage of problem behaviors during mand training was 0% per session. During Phases 1 and 2, Wright's average percentage of problem behaviors remained stable at 0%. During Phase 3, Wright's average percentage of problem behaviors slightly increased to 0.60%. His problem behavior occurrences were only documented for one session during Phase 3 and occurred for 2.38% of mand training sessions. Because of the stability of Wright's problem behavior occurrences during mand training sessions, it can be determined the intervention did not affect Wright's problem behavior occurrences. These data are shown in Figure 15 on page 105.

Roan. During Baseline, Roan's average percentage of problem behaviors during mand training was 9.26% per session (range, 0-43.75%). During Phase 1, Roan's average percentage of problem behaviors decreased to 3.24% (range, 0-12.94%). An immediate change in problem behavior occurrences can be seen when comparing Baseline (10%) to Phase 1 (0%), though the magnitude of the change was minimal indicating the intervention was not very effective in decreasing Roan's occurrences of problem behaviors during mand training. During Phase 2, Roan's average percentage of problem behaviors increased to 10.66% (range, 0-33.90%). During Phase 3, Roan's average percentage of problem behaviors decreased to 2.70% (range, 0-13.51%). There are no additional indicators of experimental effect, which suggests the intervention did not affect problem behavior occurrences for this participant. These data can be seen in Figure 15 on page 105.

Kadeem. During Baseline, Kadeem's average percentage of problem behaviors during mand training was 0.64% per session (range, 0-3.08%). During Phase 1, Kadeem's average

percentage of problem behaviors increased to 2.79% (range, 0-6.25%). During Phase 2, Kadeem's average percentage of problem behaviors decreased to 0%. During Phase 3, Kadeem's average percentage of problem behaviors increased to 0.31% (range, 0-1.89%). There are no indicators of experimental effect, which suggests the intervention did not affect problem behavior occurrences for this participant. These data are depicted in Figure 15 on page 105.

Social Validity

A social validity survey was conducted prior to and after the study was conducted. The social validity study included eight questions on which the implementers rated their confidence implementing components of the study. The results of the surveys were analyzed by reviewing the pre-test and follow-up scores for each implementer and by determining the average confidence rating for each question prior to and after the study. Although one implementer reported a slight decrease in confidence in implementing motor planning with core vocabulary, it is notable that all the implementers reported an increase in confidence in implementing multiple components of the study. Results for the average confidence rating for each question can be seen in Table 4 on page 90. These results indicated an average increase in confidence rating for the implementers for each question (range, 0.25-1.95).

Additionally, the social validity surveys included anecdotal measures in order to determine if the implementers would choose to use various components of the study in their future practices. Each of the implementers stated they would choose to use the iPad mini with Proloquo2Go as a SGD in language development programs in the future citing ease of use. Additionally, four of the five implementers stated they would continue to use the prompting package in future language development programs. The fifth implementer stated her use of these teaching procedures would be dependent upon the needs of the learner whom she is treating.

Further, two of the five implementers stated they would definitely continue using motor planning with core vocabulary in language development programs; while, two of the five implementers stated their use of this intervention would be dependent upon the needs of the specific learner. The fifth implementer indicated indifference to the use of motor planning with core vocabulary, but she indicated she would be willing to continue to "try it." Finally, four of the five implementers did not experience any difficulties during the study. The fifth implementer cited experiencing difficulty collecting vocal utterance data.

The results of the anecdotal portion of the survey, suggest that the procedures upheld social validity by promoting a practical, effective strategy to teaching manding using an iPad mini and Proloquo2Go as a SGD that the implementers will continue to use in their practices (Horner et al., 2005). Based on the strengths of their responses, the implementers indicated they would be more likely to use the prompting package recommended in future language development programs than they would be likely to use motor planning with core vocabulary, though all of the implementers suggested they would continue to use motor planning with core vocabulary depending upon their circumstances.

Chapter Five: Discussion

The purpose of this study was to evaluate motor planning with core vocabulary and a prompting package including within stimulus prompts and constant time delay prompts with response prompts in teaching manding using the iPad mini® and Proloquo2Go™ application as a speech-generating device (SGD) to three preschool aged children with autism spectrum disorder (ASD). This basic protocol promotes the use of evidence-based practices (EBP) to teach manding on a SGD to individuals with ASD and addresses gaps in the SGD and ASD literature.

One of the limitations in the tablet-based technology literature is that there are few protocols using EBP for teaching verbal behavior using tablet-based technology as a SGD (Halloran & Halloran, 2006; Hedges & AFIRM Team, 2017). For example, the picture exchange communication system (PECS) is a widely known protocol for the implementation of a picture exchange system to teach communication to AAC users (Bondy & Frost, 1994). The most comparable system for tablet-based technologies as a SGD is Language Acquisition through Motor Planning (LAMP™). Halloran and Halloran (2006) developed a protocol that emphasizes motor planning to teach SGD users communication skills. This protocol provides practitioners with recommendations for teaching communication using a SGD. Though some of the recommendations are consistent with EBP for improving communication in individuals with ASD, Halloran and Halloran (2006) did not use terminology consistent with EBP, which limits the accessibility of this protocol to a variety of practitioners who serve the ASD population. Further, there is limited evidence in support of LAMP (Bedwani et al., 2015; Stuart & Ritthaler, 2008).

An additional strategy, technology-aided instruction and intervention (TAII), provides a broad description of potentially applicable EBP for using technology to support a variety of

needs of individuals with ASD (Hedges & AFIRM Team, 2017). One way TAII can be used is in addressing the communication needs of individuals with ASD through the use of SGDs. A limitation of TAII is that it does not provide support using specific types of technology (e.g., an iPad mini®) or identifying appropriate teaching procedures upon introduction of the selected SGD. TAII provides suggestions for practitioners to use EBPs that have been shown to be effective in teaching communication skills such as prompting and reinforcement, but the intervention does not provide details for how to prompt or for reinforcing behavior. It seems there is an assumption that the SGD itself teaches communication, when it is the use of effective teaching procedures and the technology that improve communication. The current study addressed these concerns by emphasizing EBP and specifying teaching procedures in an evaluation of a basic protocol for teaching manding using a tablet-based SGD.

Additional limitations in the SGD and ASD literature include limited discussion of screen layout and vocabulary selection, a lack of evaluation of generalization across people, and a lack of evaluation of social validity. The lack of generalization also applies to the one-to-one, teacher-led instruction that some of the studies include which does not identify how a child may acquire the same skills in a more natural, play-based setting. The current study addresses these limitations by emphasizing screen layout and vocabulary selection (i.e. motor planning with core vocabulary) on the iPad mini with Proloquo2Go as a SGD. Additionally, the study occurred in a play-based environment and included social validity measures.

The goal of this chapter is to provide an analysis of the findings of each research question of this study. Additionally, a discussion of the considerations and limitations of this study is provided. Further, the implications and recommendations for future research are discussed.

Research Question One: Does motor planning with core vocabulary and the prompting

package increase manding using the iPad mini and Proloquo2Go as a speech-generating device to preschool aged children with autism?

The results of this study indicate motor planning with core vocabulary and the prompting package including within stimulus prompts, constant time delay prompts, and response prompts was effective increasing a manding repertoire using the iPad mini and Proloquo2Go in three preschool aged children with autism spectrum disorder (ASD). A visual analysis determined the intervention was very effective in teaching two of the participants (i.e. Roan and Kadeem) and was determined effective in teaching one of the participants (i.e. Wright) to mand using the SGD.

Rates of Acquisition. The average rate of acquisition in Phase 2 for these two participants was 12 sessions. Though for Kadeem, mastery of Phase 2 occurred in three sessions. One potential factor that affected the participants' rates of acquisition included amount of experience with the clinic, ABA, and AAC. Kadeem acquired the ability to mand, meeting criteria for Phases 1-3 (i.e. 10 sessions) most rapidly. Roan mastered Phases 1 and 2 (i.e. 12 sessions) quicker than Wright. Kadeem and Roan had similar ABA and AAC experience prior to the study. Wright had no experience in ABA or AAC, and his acquisition rate of Phases 1 and 2 were the slowest (i.e. 18 sessions). These factors would be interesting to explore further to determine if these characteristics could predict AAC success.

Another consideration for rate of acquisition could be the rotation of implementers that naturally occurred throughout the study. During the study, Wright worked with four implementers and had nine changes to his implementer, which is nearly twice as many changes as Kadeem (5) and two-thirds more changes than Roan (3). The other participants each worked with three (Roan) or four (Kadeem) implementers throughout the study. It would be interesting to explore this consideration further to determine if embedding generalization of implementers is

more effective prior to acquisition of manding with the device or after acquisition has occurred. Generalization probes were conducted to account for generalization to across people; however, the primary researcher conducted the probes and was visible to the participants during most sessions throughout the study. Therefore, the results do not determine how this skill might generalize to unfamiliar listeners.

Additionally, it is interesting to consider that the participants showed improvement in their manding using the device in relation to the short amount of instruction time received. The participants received an average of approximately 42.5 hours total instruction time of this intervention. The speed at which each of the participants acquired manding through their various phases is compelling considering the short amount of instruction time. Traditional EIBI programs for young children with ASD consist of 20-40 hours weekly of intensive instruction, which suggests that if this were the only focus of an EIBI program, a learner could hypothetically complete the protocol in less than a month. Further research on this protocol could provide more evidence for predicted outcomes on manding abilities using this protocol.

Core Vocabulary. Core vocabulary provides the learner access to many available icons more quickly (e.g. 60 icons in this study). Because a learner has access to many icons, it is possible the learner will gain the ability to use some icons without formal teaching to communicate with a listener. In this study, Kadeem engaged in spontaneous, multi-step manding. For example, Kadeem engaged in multi-step manding during this study, though single-step mands were the focus of the study. During Art Center, Kadeem navigated from the home screen into a folder and selected the icons for both *glue* and *glue stick* without formal teaching from the implementer (i.e. three-step mands). Kadeem also manded using two-word phrases (i.e. *Want Who* and *Want This).* Kadeem engaging in this behavior suggested that having access to

core vocabulary icons and folders including fringe vocabulary increased Kadeem's opportunities to mand using fringe vocabulary without formal teaching. In this study, using core vocabulary provided the opportunity to expand the learner's vocabulary from single-step to multiple steps quickly.

Interesting Findings. Roan and Wright met mastery criterion for the second phase of the study, displaying the ability to mand when the icons in the field are dimmed and one icon is highlighted. Although they did not meet mastery criterion in a full field of 60 visible icons (mastery criterion for Phase 3), the participants exhibited noteworthy behaviors during teaching in Phase 2. During observations, the primary researcher noted that both of these participants showed increased abilities to scan the array (i.e. look at the field closely to select an icon). For example, at the onset of the study, Wright did not look toward the device when it was presented. At the outset of the study, he was oriented toward the device and his eye gaze was in the direction of the device. The difference in this behavior at the beginning and end of the study was not a formal measure of the study, though an interesting observation.

Additionally, both participants engaged in selecting appropriate icons on the screen during Phase 2, that while not highlighted, were appropriate icons for selection under the condition. For example, Wright indicated motivation for a puzzle piece. The implementer withheld the puzzle piece, and made visible the icon *Play*. When the device was presented, Wright scanned the array and attempted to select *Get*, which was dimmed. Both of these icons are appropriate ways to request to receive the puzzle piece; however, because *Get* was dimmed, the trial was scored as an error and the error correction procedure occurred to teach *Play*. This behavior was noted by the implementers and primary researcher on multiple occasions, which suggests the second phase of the study may not have been a necessary step in teaching the motor

plans for the various icons.

Moreover, because Kadeem met mastery criteria in the minimum amount of sessions for the first two phases of the study, it can be speculated that the within stimulus prompts may not be necessary for a learner to acquire the ability to mand in the field of sixty visible icons. Other potential variables could include his age and his history with AAC. Depending upon the learner, it would be necessary for the behavior analyst to use his/her professional judgment to determine an appropriate phase within which to begin and to determine an appropriate mastery criterion for his/her individual learner.

Research Question Two: Does motor planning with core vocabulary and the prompting package increase vocal utterances in preschool aged children with autism?

In order to determine the effects of this protocol on vocal production, the current study evaluated percentage of daily vocal utterances in three preschool aged children with ASD. The results of this study indicate that the procedures did not have an effect on vocal utterances. Although the data did not reflect significant increases in vocal utterances as a result of the intervention, the primary researcher noted some improvement in articulation over the course of the study. The measurement system did not evaluate for articulation.

Research Question Three: Does motor planning with core vocabulary and the prompting package decrease problem behaviors in preschool aged children with autism?

The results of the study indicate that this teaching procedure did not have any effect on problem behaviors. It was anticipated that problem behaviors would decrease with the acquisition of a manding repertoire; however, Kadeem and Wright displayed few problem behaviors during mand training, making it difficult to evaluate the effects of the protocol on occurrence of problem behavior for these participants.

Roan engaged in more problem behaviors during mand training than did the other participants; however, his levels of problem behaviors were low (average percentage daily of problem behavior occurrence, 6.58%). Interestingly, Roan's problem behaviors may have been more affected by changes in implementer than the intervention. For example, Roan displayed increases in problem behavior during his last session in Phase 1 and his first two sessions of Phase 2, at which time he had changes in implementers.

Overall, the participants engaged in low levels of problem behaviors during the research procedures, which is consistent with the literature. The lack of occurrence of problem behaviors may be attributed to teaching replacement behaviors (i.e. manding using the SGD) for problem behaviors. For example, if a learner engaged in behaviors indicating disinterest in an activity or item, the implementers were encouraged to teach *All Done* and *Stop* in order to appropriately refuse. All three participants acquired the ability to independently mand for *All Done* in Phase 3 of the study. Teaching these appropriate refusal icons could have replaced functionally similar problem behaviors.

Research Question Four: Will implementers gain confidence in the use motor planning with core vocabulary and the prompting package to teach manding using the iPad mini and Proloquo2Go as a speech-generating device to preschool aged children with autism?

Based on the results of the social validity survey, it was determined that implementers gained confidence in each skill evaluated on the survey, as represented in Figures 10 on page 100 and 11 on page 101. Only one implementer noted a decrease in her confidence rating for implementing motor planning with core vocabulary (i.e. from a 9 to an 8 on a scale of 10). The same implementer responded with the highest confidence on five of the eight confidence ratings at the onset of the study. Her confidence ratings maintained in those areas (i.e. using the iPad

mini and Proloquo2Go, conducting preference assessments, contriving mands, and collecting data) and increased in the others. By the conclusion of the study the other implementers' overall scores on the rating scale increased indicating an increase in confidence regarding the procedures in the protocol.

Research Question Five: Will implementers maintain the use of the iPad mini and Proloquo2Go as a speech-generating device, motor planning with core vocabulary, and/or the prompting package following this study?

Based on the results of the anecdotal portion of the social validity survey, it was determined that implementers would continue to use the iPad mini with Proloquo2Go as a SGD in language development verbal behavior programs. The implementers cited that ease of use and familiarity with the device were reasons for their continuation of this component of the protocol. Additionally, the implementers stated they would continue to use the prompting package presented in this study in future language development programs indicating that they "liked the procedures" and they found them effective while not being "too intrusive."

Next, the implementers were asked if they would continue the use of motor planning with core vocabulary. Two out of the five implementers indicated they would continue the use of motor planning with core vocabulary dependent upon the needs of their learner. Another two implementers indicated they would continue using this component of the protocol because they found core vocabulary "simpler" to enhance a manding repertoire. The final implementer indicated indifference to using motor planning with core vocabulary in the future but said she would "continue to try it." Lastly, the implementers responded to whether or not they experienced difficulty during the study. Most of the implementers did not experience any difficulties with the study; while, one implementer cited difficulty collecting vocal utterance

data. These findings suggest this protocol upholds social validity since the implementers indicated they would continue the use of the components of the protocol in their practices (Horner et al., 2005).

Motor Planning with Core Vocabulary

The current study presented a new discussion to the field of behavior analysis regarding motor planning and core vocabulary. One consideration in teaching verbal behavior using a SGD is the vocabulary selection and placement (i.e. motor planning). One approach to vocabulary selection is the use of core vocabulary words. Core vocabulary is a term used to describe the most frequently used words by groups of people such as adults, adolescents, and in the case of this study, preschoolers. Banajee, DiCarlo, and Buras-Stricklin (2003) indicate that there are consistencies across studies with the most frequently used words by 24-36 month olds. The researchers also note that the 23 most frequently used words for this age group do not include any nouns. Halloran and Halloran (2006) noted core vocabulary provides SGD users the opportunity to use more natural language than other options may offer. Another method of vocabulary selection that is aligned with mand training, is to follow the interest of the speaker and teach the specified term for the item/activity. This vocabulary set is called *fringe vocabulary* (Halloran & Halloran, 2006). The fringe vocabulary can be determined by following a learner's prelinguistic behaviors indicating motivation and/or by conducting preference assessments.

After selecting the vocabulary to teach an SGD user, the practitioner is required to determine icon location or placement. In other words, the practitioner must determine *motor plans* to teach the SGD user how to find each icon on the device. Deficits in motor development can contribute to challenges in motor movement. Individuals with ASD are at increased risk of exhibiting motor development delays (McCleery, Elliott, Sampanis, and Stefanidou,

2013). Motor planning using a SGD includes building a screen layout within which the user is required to do as little discrimination, visual scanning, and *planning* as possible. The planning component is internal and involves problem solving the path one will take to select an icon. Because of the discussion of internal processes, behavior analysts may not find motor planning to be an acceptable practice. However, this study identified that motor planning is not an intervention but a strategy used to determine screen layout and/or icon placement.

Dukhovny and Zhou (2016) provides evidence in support of considering icon location more than icon size when introducing a SGD to a new user. The byproduct of emphasizing icon-location is motor planning, which the results of this study suggest improves the fluency of SGD usage. Fluency in a SGD user's search and finding of an icon or series of icons decreases the response effort of the SGD user and the listener. A discussion of fluency is extremely important to the practical implications of SGD usage. The longer it takes a SGD user to locate the icons to communicate, the more strain is placed on both the speaker and the listener. This strain could potentially affect a SGD user's experience with a listener and as a result, the SGD user's inclusion. Because of the importance of fluency in communication, it is important to evaluate motor planning as it pertains to manding in individuals with ASD. Therefore, the current study used icon location instead of icon size to design the screen layout in order to evaluate the effects of motor planning on the acquisition of manding using a tablet-based SGD.

Considerations.

A consideration of this study is that the mand is not a pure mand. A mand occurs when a state of deprivation or aversion (i.e. establishing operation [EO]) alters the value of a stimulus (e.g. reinforcing item/activity). The speaker mands when the listener is present. The listener provides an item/activity with 1:1 correspondence that matches the request. When the mand is a

pure mand, the controlling variables include the EO and the listener. There are multiple controlling variables to consider with the mand, including the EO, discriminative stimulus (S^D), and other stimuli in the environment that do not signal the availability of a reinforcer (i.e. the S-delta [S^Δ]; Michael, Palmer, & Sundberg, 2011). In terms of this study, the controlling variables may have included the presence of the reinforcer (i.e., non-verbal stimuli), learner's EO, the presence of the implementers (i.e., the listeners [S^Ds]), and S^Δs.) Because the item is present and therefore the speaker's behavior is not only under the control of the EO, the speaker's behavior can be identified as a mand-tact. While the antecedent included some characteristics of a tact, the listener did not mediate the speaker's behavior with generalized conditioned reinforcement, as is consistent with a tact, in order to keep the operant multiply controlled vs a pure tact.

The consideration of multiple control is not a limitation of this study as multiply controlled operants are typical in episodes of verbal behavior (Michael et al., 2011). Multiply controlled operants are verbal operants that are not functionally independent due to multiple controlling variables in the environment. Skinner (1957) indicated it is unlikely for a behavior to occur due to an isolated variable because multiple variables may occasion a behavior at a given time. Because it is difficult to isolate the controlling variables, multiply controlled operants are important to consider for practitioners and researchers as they navigate best practices for teaching verbal behavior using a SGD.

Limitations

Inadvertent prompting. Prompting for this study was identified in the prompting package and included within stimulus prompts, constant time delay prompts, and response prompts. A prompt that has not been addressed includes the positional prompt that occurs within the research procedures to place the iPad mini near the participant following the evaluation of

precursor behaviors indicating motivation. This action taken by the researcher to make the iPad mini available to the participant with the appropriate screen layout and icon selection, may provide an inadvertent prompt to the learner signaling the availability of a reinforcer and/or an opportunity to respond. This is an interesting area to consider as more research is conducted concerning verbal behavior and SGDs because the act of presenting the SGD for each opportunity to respond is not consistent with the way opportunities to speak will occur in naturalistic environments. Ideally, the SGD user will have his device available for use, as he/she requires. Promoting participant-ownership of the device in research settings may encourage more spontaneous use of the device.

Partial Interval Recording. One of the limitations of this studied included the partial interval recording system used to measure percentage of vocal utterances per session. The implementers collected partial interval data for the 2.5-hour session at 30-second intervals (i.e. 300 intervals per session) in order to measure the percentage of intervals during which vocal utterances occurred per session. The difficulty associated with attending to the participant while being required to collect data every 30 seconds is a disadvantage of this recording system. For example, although this study occurred in the natural environment, vocal utterance data continued to be collected during discrete trial instruction (DTI). At times, the implementer would be required to collect partial interval data and conduct a teaching trial simultaneously, at which time either the data would not get collected or the trial would be interrupted in order to collect data. Additionally, one of the implementers noted on the social validity survey that the vocal utterance data were challenging to collect. Errors made by the implementer in scoring decreased the reliability of the vocal utterance data. Additional limitations of partial interval recording include an underestimated rate of the behavior. For example, partial interval recording depicts whether or

not a behavior occurred during an interval. It does not show if the behavior occurred or if it occurred multiple times during an interval. Wright may have engaged in multiple occurrences of vocal utterances during each scored interval; however, his data indicate he engaged in the behavior infrequently.

In order to account for the variability in data collection by the implementers, observers could have collected partial interval in vivo instead of the implementers. Additionally, recordings could have been coded following the sessions. Increasing the intervals to one minute each may have captured similar data and alleviated some of the difficulty associated with collecting partial interval data, but it would have increased the underestimation of the vocal utterances. Last, momentary time sampling could have been used, but it has its own disadvantages including underestimating the occurrence of the behavior.

Procedural Oversight. Another limitation of the current study included a few instances of procedural oversight. For example, Kadeem mastered Phase 3 in four sessions. The primary researcher continued him in Phase 3 instead of considering his manding mastered. Had Kadeem mastered Phase 3, a generalization probe would have been conducted to determine Kadeem's ability to generalize his manding in a full field to a different instructor. Additionally, the primary researcher did not conduct a generalization probe for Kadeem to determine his ability to mand with a different instructor following Phase 1.

Generalizability. Lastly, although this study measured generalizability to different implementers, it did not evaluate generalizability of manding using the SGD to parents/caregivers or other environments. This study was conducted in the natural environment within the clinic setting with ABA practitioners at various experience and education levels as implementers. The results of this study cannot be applied to parent/caregiver implementers or to

the home environment because these areas were not addressed.

Implications

Practice. When introducing a protocol to the literature, it is important to consider the implications for practice. One of the benefits to the protocol includes disseminating specific procedures using EBP to stakeholders or practitioners who may have limited resources or experience with teaching manding with a SGD. A potential limitation of using a protocol is that it does not account for individualization of procedures based on learner needs. In other words, the protocol provides a specific teaching procedure that does not identify learner characteristics as considerations for decision making. This protocol can be used as a guide for practitioners who can use professional judgement to determine appropriate prompting procedures based on learner needs. Additionally, the current study promoted individualization by conducting preference assessments in order to account for preferred items or activities the learner may require. The results of the preference assessments supported vocabulary selection.

Further, this study addressed topics that are new to the behavior analytic literature. The multidisciplinary approach (i.e., speech language pathology, education disciplines, occupational therapy, applied behavior analysis) to treating individuals with ASD creates challenges for researchers to disseminate information to multiple fields working with the ASD population. Variations in jargon and underlying assumptions across disciplines can create barriers to collaborating with practitioners of other fields (Dillenburger et al., 2014). For example, it is likely practitioners remain current on research within their specific fields, though it may be less likely for practitioners to seek information from other fields to address the complex communication needs of their clients with ASD. It is important for researchers and practitioners

to consider multidisciplinary collaboration and potential strategies from other disciplines in order to best serve this population.

Screen Layout. Further implications for practice include a discussion of screen layout (i.e., motor planning). The current study introduced motor planning to the behavior analytic literature as a strategy for SGD use. Because motor planning is inherently mentalistic, behavior analysts may hesitate to use the strategy. However, motor planning can be described by observing the behavior, which identifies its product, *motor plans*. In terms of SGD, motor plans can be developed using the screen design or layout of the device or application. The creation of this protocol provides practitioners a resource for teaching manding using the iPad mini and Proloquo2Go application that includes device setup and evidence based teaching procedures. Practitioners require support in making determinations such as how to design the screen, where to place the icons, and what vocabulary set to use. In this study, selections for the screen layout included the grid size (i.e., 60 icons), constant, icon placement, and the use of core vocabulary. This protocol can benefit practitioners by providing a guideline to device setup, screen layout, and vocabulary selection that was shown effective when paired with the prompting package evaluated in this study.

For the SGD user, motor planning can promote fluency of icon use. Holding icon location constant can produce faster rates of responding, which can promote more fluent communication (Dukhovny & Zhou, 2016). Fluency in SGD use is important to both the speaker and the listener as it can decrease the response effort for both communication partners. A discussion of fluency is extremely important to the practical implications of SGD usage because the longer it takes a SGD user to locate the icons to communicate, the more strain is placed on

both the speaker and the listener. This strain could potentially limit the SGD user's inclusion in the community.

Future Research

Horner et al (2005) described important components of single-subject procedures, including emphasizing social validity. The authors promoted the use of measures that are acceptable to the implementers as a way of accentuating the applicability of an intervention to more natural settings and potential implementation by non-experts. Social validity measures were included in this study in order to determine if implementers would continue to use this protocol as needed with SGD candidates in their practice. It was determined the implementers found the protocol acceptable to continue using in future practice. Future research could promote the social validity of this protocol by including parents/caregivers as practitioners and/or implementing the procedures in the home environment and other more naturalistic settings in order to determine if this protocol is a practical option. For example, future research could include evaluating the effectiveness of this protocol in home and familiar community environments using parents as implementers. Further, researchers could evaluate if manding using the iPad mini and Proloquo2Go can be acquired with parents/caregivers as implementers of this protocol. Lastly, future research could determine if parents can be effective implementers of these procedures and if parents find the procedures acceptable for implementation without researcher oversight.

In addition to increasing the social validity of these procedures, evaluating parental implementation of these procedures can also increase the generalizability of this protocol. Future research could determine if acquired mands in the contrived environment generalize to the home or community. Additionally, it could determine if acquired mands generalize to parents as

implementers. This study conducted generalization probes in order to determine if the skill generalized to other practitioners. Future research could have parents conduct these generalization probes to determine if these procedures effectively generalize to parents as implementers. It is important for future researchers to emphasize the generalizability of these procedures in order to determine to what extent formal teaching is required in each setting and with each new listener.

A component analysis could benefit future practitioners by determining which components of the study were most beneficial in increasing the manding repertoire using the iPad mini and Proloquo2Go. Future research could emphasize the use of the within stimulus prompts without the additional prompting package in order to determine if the within stimulus prompts were beneficial in teaching preschool aged children with ASD to mand using the iPad and Proloquo2Go. Determining the effectiveness of the within stimulus prompts in isolation could support non-expert implementation in that the procedures may be easier to implement. For example, eliminating response prompts decreases the amount of opportunities the implementer has to make an error. By removing response prompts from the protocol, the SGD serves as the interventionist in shaping the required responding while the implementer only provides the requested item/activity (Lorah, Crouser, Gilroy, Tincani, & Hantula, 2014a). Additionally using only stimulus prompts is less intrusive than using response prompts to teach manding with the SGD, which may make these teaching procedures more favorable for practitioners and the participant.

Further, the component analysis could consider negating the within stimulus prompts to determine if the response prompts are effective in isolation. Within stimulus prompts were embedded in order to promote effective systematic instruction; however, further research may

determine three phases are just as effective as using response prompts in a full field from the onset of the study. Decreasing the amount of phases in the study may produce more rapid acquisition of manding using the SGD for the participants.

Future research could also benefit from further developing protocols for vocabulary selection in relation to tablet-based SGD research. Currently, few studies address vocabulary selection outside the parameters of the study. For example, this study used core vocabulary in order to provide the learner access to more icon choices than may be available by tablet-based SGDs that emphasize icon size over icon placement (Dukhovny & Zhou, 2016). Using core vocabulary and Proloquo2Go provides practitioners with a guide for initial vocabulary selection. This study and the current literature do not address vocabulary selection outside of the scope of the use of core vocabulary. Additional research is needed in order to determine a research best practice for the appropriate time to introduce fringe vocabulary, increase the response effort for the mand (i.e. from single-step to multiple steps), and how to organize the layout of the fringe vocabulary.

Conclusion

It was determined that motor planning using core vocabulary and the prompting package including within stimulus prompts and constant time delay prompts with response prompts was an effective protocol in teaching manding using the iPad mini and the Proloquo2Go application as a SGD with three preschool aged children with ASD. This study highlights the importance of applying multidisciplinary approach when working with individuals with ASD. The ASD treatment community includes practitioners from numerous backgrounds and philosophical perspectives (e.g., behavior analysts, educators, speech language pathologists, occupational therapists, mental health practitioners, etc.) that must work together in order to benefit the ASD

population. Evidence-based practices (EBP) include interventions that have been determined effective for improving the core deficits exhibited by individuals with ASD (NAC, 2015). The field of behavior analysis requires the use of EBP when treating an individual with ASD (BACB, 2014).

Because of its emphasis of EBP, behavior analysts are often resistant to practices that use differing terminology or those practices not specifically identified as EBP. One of the goals of this study is to provide a behavior analytic perspective of motor planning, the inner process of determining how to move (Halloran & Halloran, 2006). A discussion of motor planning revealed that though the inherent characteristics of motor planning are not behavior analytic, the practice of motor planning can be defined behavior analytically by emphasizing the product of the motor plan (i.e. behavior) instead of the covert motor planning process. In this study, designing the screen of the device to hold the icon placement constant supported the participants' development of motor plans to promote acquisition of manding using the iPad mini and Proloquo2Go as a SGD.

The protocol presented in this study promotes the use of motor planning with core vocabulary and EBP in teaching manding using the iPad mini with Proloquo2Go as a SGD to preschool aged children with ASD. The teaching procedures included a prompting package including within stimulus prompts and constant time delay prompts with response prompts. The intervention was determined effective in teaching manding and was determined to have no effect on collateral behaviors including vocal utterances and problem behaviors. This study adds a different perspective to the behavior analytic literature when teaching manding using tablet-based technology by introducing the topics of motor planning and vocabulary selection to the literature. This study addresses additional gaps in the literature by including both

generalizability and social validity measures. Implications of introducing a protocol for use in teaching manding with a tablet-based SGD include benefits to practitioners and stakeholders. Further research should be conducted in order to determine if this protocol is effectively implemented by parents or other stakeholders, if it is effective in more natural settings, and/or which components of the protocol is most effective.

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Appendix

UNIVERSITY OF ARKANSAS

To:	Alison Judith Karnes
From:	Douglas James Adams, Chair IRB Committee
Date:	08/27/2018
Action:	**Exemption Granted**
Action Date:	08/27/2018
Protocol #:	1808135183
Study Title:	Evaluating the Effectiveness of Motor Planning: A Behavior Analytic Account

The above-referenced protocol has been determined to be exempt.

If you wish to make any modifications in the approved protocol that may affect the level of risk to your participants, you must seek approval prior to implementing those changes. All modifications must provide sufficient detail to assess the impact of the change.

If you have any questions or need any assistance from the IRB, please contact the IRB Coordinator at 109 MLKG Building, 5-2208, or irb@uark.edu.

cc: Elizabeth R Lorah, Investigator

Table 1

Participant Demographics

	Wright	Roan	Kadeem
Gender	Male	Male	Male
Age	2 years, 11 months	3 years, 9 months	5 years, 1 month
Ethnicity	Caucasian	Asian	African American
AAC Experience	None	Proloquo2Go	Proloquo2Go Picture Exchange

Note. Age at onset of the study.

Table 2

Participant VB-MAPP Scores

	Wright	Roan	Kadeem
Overall	11	27.5	68
Mands	0	8	9
Tacts	0	3	4
Intraverbals	0	0	0.5
Vocal Imitation	0	3	9

Table 3

Acquired Mands by Participant

Wright	Roan	Kadeem
Play	Play	Play
Get	Want	All Done
All Done	Get	Get
Drink	Eat	Want
Eat	Drink	Eat
Want	Out	Read
Spin	More	Help
Put	Read	Go
	All Done	Glue*
	Stop	Put
	Go	Glue Stick*
	This	Want Who
	Like	Want This
		Want Go

Note. The participants acquired a variety of mands using core vocabulary. These data indicate independent mands in Phase 3-Visible (i.e. full, available field of 60 icons).

**These vocabulary words were not formally taught as part of the procedures as these words are considered fringe vocabulary. The participant navigated into the folder to find glue and glue stick during Art Center.*

Table 4

Social Validity Survey Average Confidence Ratings by Question

Question Number	Pre-Test	Follow-Up	Difference
1	8.5	9.6	1.1
2	7.75	9.6	1.85
3	7.75	9	1.25
4	7.25	9.2	1.95
5	8.5	8.75	.25
6	8.25	9.8	1.55
7	8.75	9.6	0.85
8	8.75	9.6	0.85

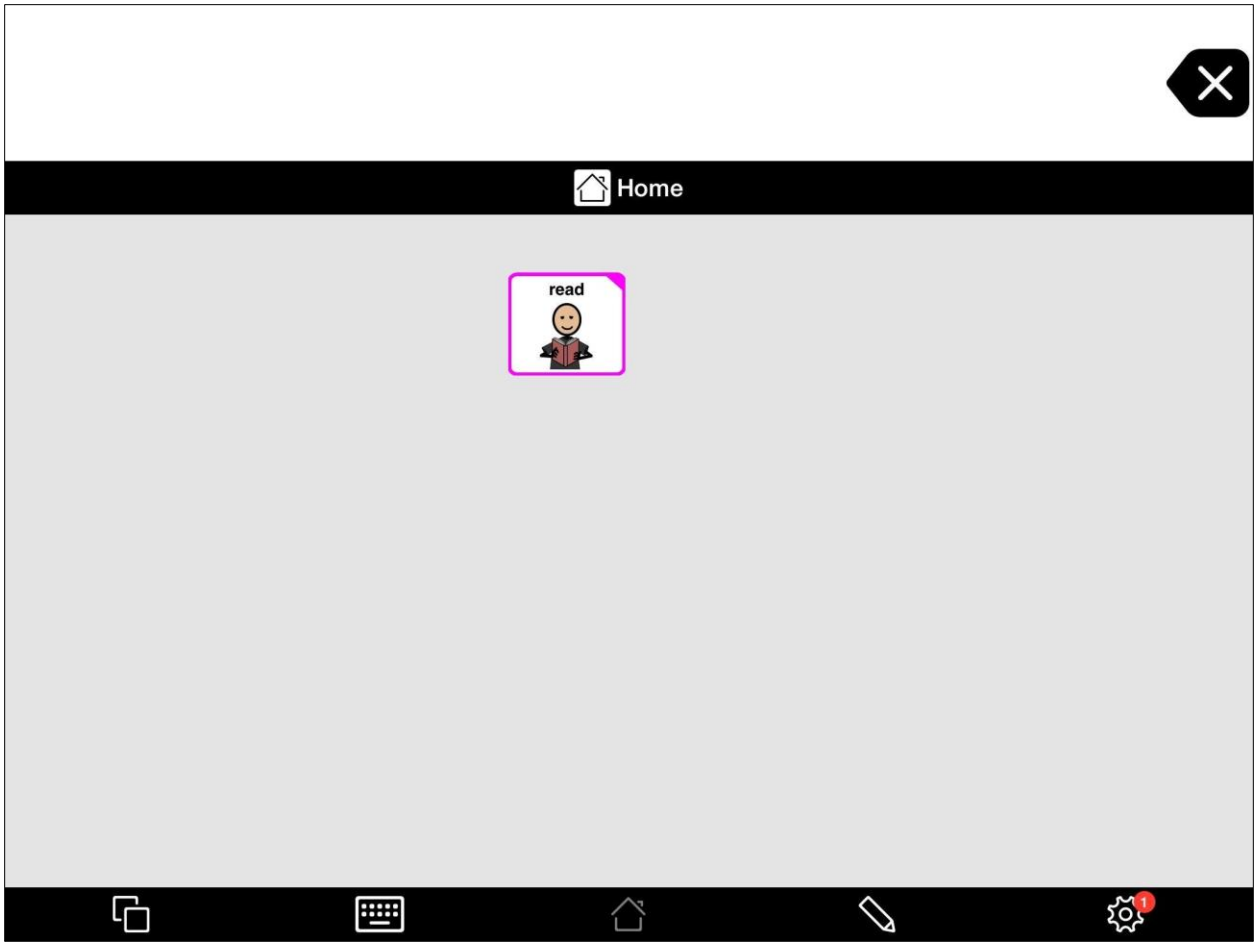


Figure 1. Screen Layout for Phase 1 – Hidden. This figure depicts the screen layout for Phase 1 – Hidden and includes an example of the icon *Read*, which is the only available icon for selection.

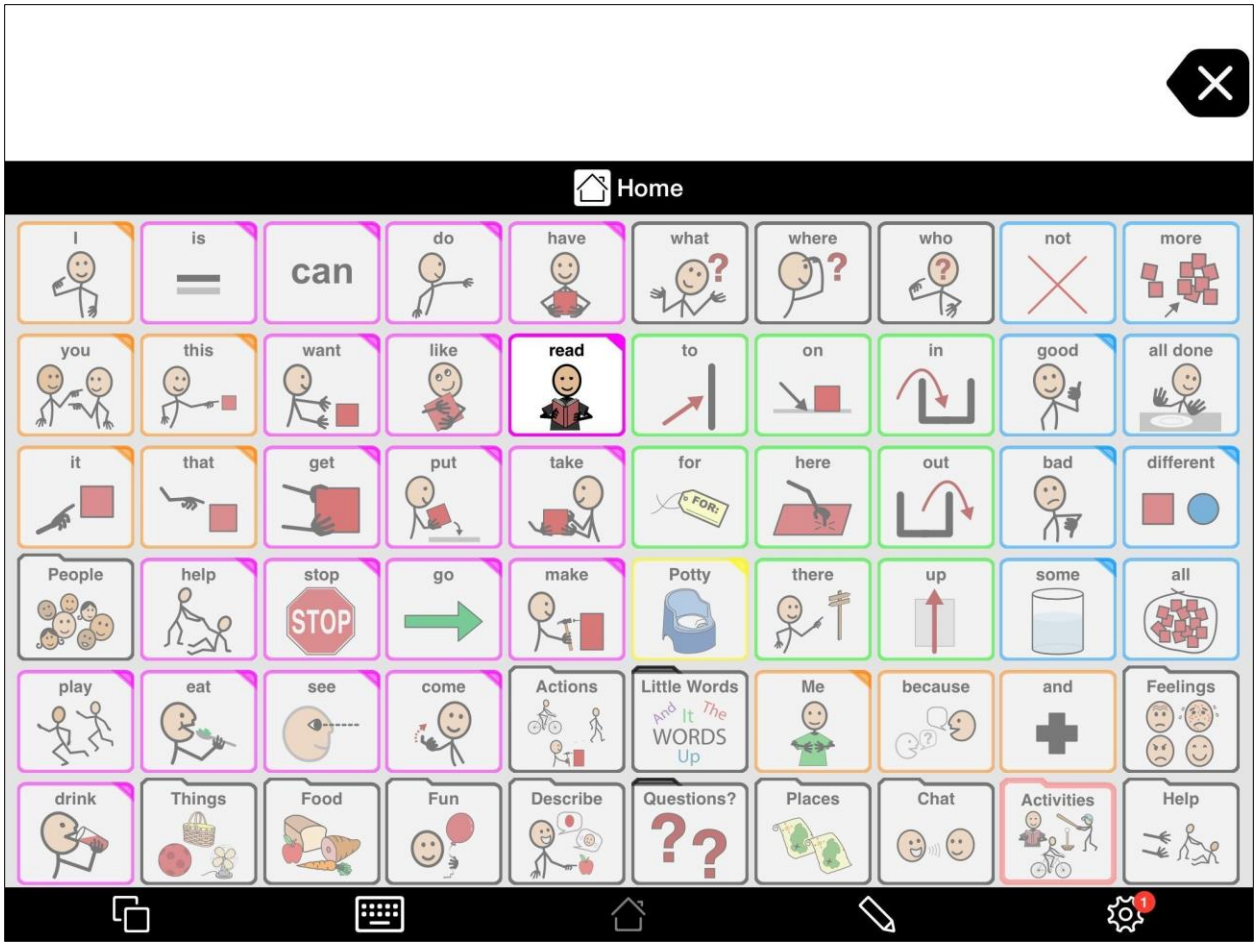


Figure 2. Screen Layout of Phase 2 – Dimmed. This figure depicts the screen layout for Phase 2 – Dimmed and includes an example of the icon *Read* as available while the other 59 icons are dimmed and unavailable for selection.

Figure 3. Screen Layout for Phase 3 – Visible. This figure depicts the screen layout for Phase 3 – Visible, which includes a full screen with 60 icons available for selection. This figure also depicts the screen design for Baseline and Maintenance phases.

Baseline Data Form

Participant Identifier:	Implementer:	Date:	Session #:	IOA: YES / NO	% Ind. Mands:

Mand *Preferred word or phrase indicated on iPad*	**Prompt Level** *circle one*	**Frequency** *number mands at indicated prompt level (use tally marks)*	**# of Steps** *How many steps were involved in this mand?*	**Center** *In which center does the behavior occur?*	**Vocal Utterance** *Document vocal utterance*	**Problem Behavior** *indicate interfering behaviors (complete documentation on FBA Form)*
	I / NA					
	I / NA					
	I / NA					
	I / NA					
	I / NA					
	I / NA					
	I / NA					
	I / NA					
	I / NA					
	I / NA					
	I / NA					

General Procedures for Baseline:

1. Determine/contrive motivation.
2. Present participant with the iPad® within 6 inches, all icons visible.
3. Provide 5-second time delay prompt and provide item to the participant for 30 seconds.
    a. If the participant mands independently, document "I" for independent under *Prompt Level* and add a tally mark under *Frequency*.
    b. If the participant does not respond or mands incorrectly, document "NA" under *Prompt Level* and "NA" under *Frequency.*
4. Document the number steps involved in the mand, any occurrences of vocal utterance, and/or problem behaviors.
5. Begin next trial.

Figure 4. Manding Research Data Form-Baseline. This figure depicts the data form used during Baseline to collect nominal data, frequency of manding data, steps of response, prompt levels, vocal utterances, problem behavior occurrences, and interobserver agreement for these skills.

Intervention Phases 1-3 Data Form

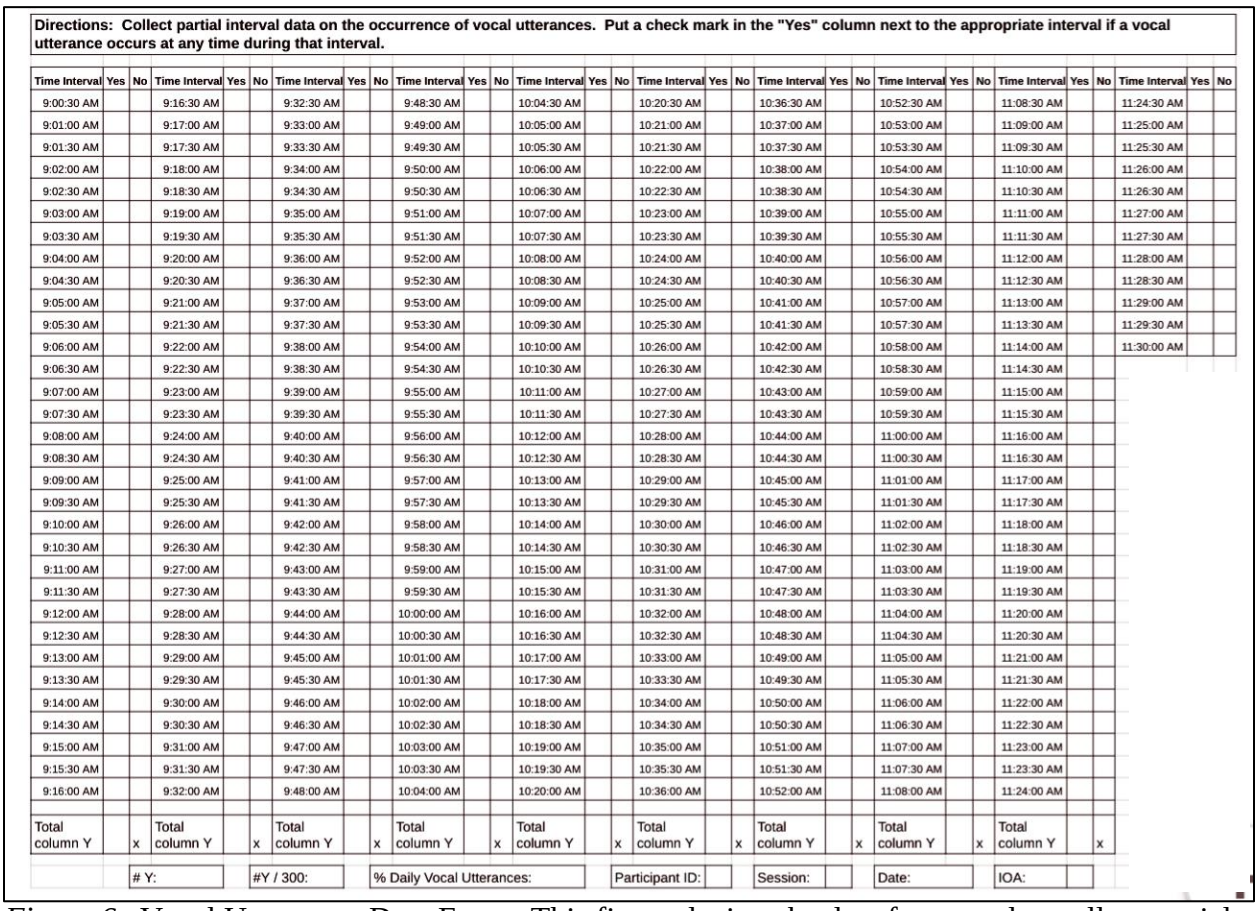
Participant Identifier:	Implementer:	Date:	Session #:	% Ind. Mands:
Circle One: Phase 1 (1 icon, all hidden)	Phase 2 (1 icon, all dimmed)	Phase 3 (All visible)	IOA: YES / NO	

Mand *Preferred word or phrase indicated on iPad*	**Prompt Level** *circle one*	**Frequency** *number mands at indicated prompt level (use tally marks)*	**# of Steps** *How many steps were involved in this mand?*	**Center** *In which center does the behavior occur?*	**Vocal Utterance** *Document vocal utterance*	**Problem Behavior** *indicate interfering behaviors (complete documentation on FBA Form)*
	I / FPP					
	I / FPP					
	I / FPP					
	I / FPP					
	I / FPP					
	I / FPP					
	I / FPP					
	I / FPP					
	I / FPP					
	I / FPP					
	I / FPP					

General Procedures for Intervention (Mastery = 80% accurate and independent mands per session across 3 consecutive sessions):

1. Determine/contrive motivation.
2. Present participant with the iPad® within 6 inches, icons appropriate by Phase (indicated above).
3. Provide 5-second time delay prompt
    a. If the participant mands independently, provide the item to the participant for 30 seconds. Document "I" for independent under *Prompt Level* and complete data sheet as appropriate.
    b. If the participant does not respond or mands incorrectly, the implementer will guide the participant's hand to select the appropriate icon. Document "FPP" under *Prompt Level* and complete data sheet as appropriate.
4. Document the number steps involved in the mand, center, any occurrences of vocal utterance, and/or problem behaviors

Figure 5. Manding Research Data Form-Intervention. This figure depicts the data form used during Intervention Phases 1-3 to collect nominal data, frequency of manding data, steps of response, prompt levels, vocal utterances, problem behavior occurrences, and interobserver agreement.



Directions: Collect partial interval data on the occurrence of vocal utterances. Put a check mark in the "Yes" column next to the appropriate interval if a vocal utterance occurs at any time during that interval.

Time Interval	Yes	No	Time Interval	Yes	No	Time Interval	Yes	No	Time Interval	Yes	No	Time Interval	Yes	No	Time Interval	Yes	No	Time Interval	Yes	No	Time Interval	Yes	No	Time Interval	Yes	No
9:00:30 AM			9:16:30 AM			9:32:30 AM			9:48:30 AM			10:04:30 AM			10:20:30 AM			10:36:30 AM			10:52:30 AM			11:08:30 AM			11:24:30 AM		
9:01:00 AM			9:17:00 AM			9:33:00 AM			9:49:00 AM			10:05:00 AM			10:21:00 AM			10:37:00 AM			10:53:00 AM			11:09:00 AM			11:25:00 AM		
9:01:30 AM			9:17:30 AM			9:33:30 AM			9:49:30 AM			10:05:30 AM			10:21:30 AM			10:37:30 AM			10:53:30 AM			11:09:30 AM			11:25:30 AM		
9:02:00 AM			9:18:00 AM			9:34:00 AM			9:50:00 AM			10:06:00 AM			10:22:00 AM			10:38:00 AM			10:54:00 AM			11:10:00 AM			11:26:00 AM		
9:02:30 AM			9:18:30 AM			9:34:30 AM			9:50:30 AM			10:06:30 AM			10:22:30 AM			10:38:30 AM			10:54:30 AM			11:10:30 AM			11:26:30 AM		
9:03:00 AM			9:19:00 AM			9:35:00 AM			9:51:00 AM			10:07:00 AM			10:23:00 AM			10:39:00 AM			10:55:00 AM			11:11:00 AM			11:27:00 AM		
9:03:30 AM			9:19:30 AM			9:35:30 AM			9:51:30 AM			10:07:30 AM			10:23:30 AM			10:39:30 AM			10:55:30 AM			11:11:30 AM			11:27:30 AM		
9:04:00 AM			9:20:00 AM			9:36:00 AM			9:52:00 AM			10:08:00 AM			10:24:00 AM			10:40:00 AM			10:56:00 AM			11:12:00 AM			11:28:00 AM		
9:04:30 AM			9:20:30 AM			9:36:30 AM			9:52:30 AM			10:08:30 AM			10:24:30 AM			10:40:30 AM			10:56:30 AM			11:12:30 AM			11:28:30 AM		
9:05:00 AM			9:21:00 AM			9:37:00 AM			9:53:00 AM			10:09:00 AM			10:25:00 AM			10:41:00 AM			10:57:00 AM			11:13:00 AM			11:29:00 AM		
9:05:30 AM			9:21:30 AM			9:37:30 AM			9:53:30 AM			10:09:30 AM			10:25:30 AM			10:41:30 AM			10:57:30 AM			11:13:30 AM			11:29:30 AM		
9:06:00 AM			9:22:00 AM			9:38:00 AM			9:54:00 AM			10:10:00 AM			10:26:00 AM			10:42:00 AM			10:58:00 AM			11:14:00 AM			11:30:00 AM		
9:06:30 AM			9:22:30 AM			9:38:30 AM			9:54:30 AM			10:10:30 AM			10:26:30 AM			10:42:30 AM			10:58:30 AM			11:14:30 AM					
9:07:00 AM			9:23:00 AM			9:39:00 AM			9:55:00 AM			10:11:00 AM			10:27:00 AM			10:43:00 AM			10:59:00 AM			11:15:00 AM					
9:07:30 AM			9:23:30 AM			9:39:30 AM			9:55:30 AM			10:11:30 AM			10:27:30 AM			10:43:30 AM			10:59:30 AM			11:15:30 AM					
9:08:00 AM			9:24:00 AM			9:40:00 AM			9:56:00 AM			10:12:00 AM			10:28:00 AM			10:44:00 AM			11:00:00 AM			11:16:00 AM					
9:08:30 AM			9:24:30 AM			9:40:30 AM			9:56:30 AM			10:12:30 AM			10:28:30 AM			10:44:30 AM			11:00:30 AM			11:16:30 AM					
9:09:00 AM			9:25:00 AM			9:41:00 AM			9:57:00 AM			10:13:00 AM			10:29:00 AM			10:45:00 AM			11:01:00 AM			11:17:00 AM					
9:09:30 AM			9:25:30 AM			9:41:30 AM			9:57:30 AM			10:13:30 AM			10:29:30 AM			10:45:30 AM			11:01:30 AM			11:17:30 AM					
9:10:00 AM			9:26:00 AM			9:42:00 AM			9:58:00 AM			10:14:00 AM			10:30:00 AM			10:46:00 AM			11:02:00 AM			11:18:00 AM					
9:10:30 AM			9:26:30 AM			9:42:30 AM			9:58:30 AM			10:14:30 AM			10:30:30 AM			10:46:30 AM			11:02:30 AM			11:18:30 AM					
9:11:00 AM			9:27:00 AM			9:43:00 AM			9:59:00 AM			10:15:00 AM			10:31:00 AM			10:47:00 AM			11:03:00 AM			11:19:00 AM					
9:11:30 AM			9:27:30 AM			9:43:30 AM			9:59:30 AM			10:15:30 AM			10:31:30 AM			10:47:30 AM			11:03:30 AM			11:19:30 AM					
9:12:00 AM			9:28:00 AM			9:44:00 AM			10:00:00 AM			10:16:00 AM			10:32:00 AM			10:48:00 AM			11:04:00 AM			11:20:00 AM					
9:12:30 AM			9:28:30 AM			9:44:30 AM			10:00:30 AM			10:16:30 AM			10:32:30 AM			10:48:30 AM			11:04:30 AM			11:20:30 AM					
9:13:00 AM			9:29:00 AM			9:45:00 AM			10:01:00 AM			10:17:00 AM			10:33:00 AM			10:49:00 AM			11:05:00 AM			11:21:00 AM					
9:13:30 AM			9:29:30 AM			9:45:30 AM			10:01:30 AM			10:17:30 AM			10:33:30 AM			10:49:30 AM			11:05:30 AM			11:21:30 AM					
9:14:00 AM			9:30:00 AM			9:46:00 AM			10:02:00 AM			10:18:00 AM			10:34:00 AM			10:50:00 AM			11:06:00 AM			11:22:00 AM					
9:14:30 AM			9:30:30 AM			9:46:30 AM			10:02:30 AM			10:18:30 AM			10:34:30 AM			10:50:30 AM			11:06:30 AM			11:22:30 AM					
9:15:00 AM			9:31:00 AM			9:47:00 AM			10:03:00 AM			10:19:00 AM			10:35:00 AM			10:51:00 AM			11:07:00 AM			11:23:00 AM					
9:15:30 AM			9:31:30 AM			9:47:30 AM			10:03:30 AM			10:19:30 AM			10:35:30 AM			10:51:30 AM			11:07:30 AM			11:23:30 AM					
9:16:00 AM			9:32:00 AM			9:48:00 AM			10:04:00 AM			10:20:00 AM			10:36:00 AM			10:52:00 AM			11:08:00 AM			11:24:00 AM					
Total column Y		x	Total column Y		x	Total column Y		x	Total column Y		x	Total column Y		x	Total column Y		x	Total column Y		x	Total column Y		x	Total column Y		x			

# Y:	#Y / 300:	% Daily Vocal Utterances:	Participant ID:	Session:	Date:	IOA:

Figure 6. Vocal Utterances Data Form. This figure depicts the data form used to collect partial interval data on vocal utterances throughout each session.

Baseline Procedural Fidelity

Participant Identifier:	Implementer:	Date:	Session #:	IOA: YES / NO
% Fidelity:		Training Duration:		% Fidelity After Training:
Training Provided:				

	Baseline	1 Always	2 Often	3 Sometimes	4 Never	5 N/A	Comments
1	During a trial, I placed the items within view and out of reach.	1 Always	2 Often	3 Sometimes	4 Never	5 N/A	
2	I followed the reach (motivation) of the participant.	1 Always	2 Often	3 Sometimes	4 Never	5 N/A	
3	The iPad was present and available.	1 Always	2 Often	3 Sometimes	4 Never	5 N/A	
4	The iPad screen layout included all icons.	1 Always	2 Often	3 Sometimes	4 Never	5 N/A	
5	I provided the preferred item/activity contingent upon the 5 second delay (not the child's behavior).	1 Always	2 Often	3 Sometimes	4 Never	5 N/A	
6	I allowed access to item/activity for up to 30 seconds.	1 Always	2 Often	3 Sometimes	4 Never	5 N/A	
7	I collected data as indicated by the guidelines.	1 Always	2 Often	3 Sometimes	4 Never	5 N/A	
8	I did not use social praise.	1 Always	2 Often	3 Sometimes	4 Never	5 N/A	
9	I did not provide any prompts.	1 Always	2 Often	3 Sometimes	4 Never	5 N/A	
10	I contrived 30-50 mands today.	1 Always	2 Often	3 Sometimes	4 Never	5 N/A	

Figure 7. Procedural Fidelity Data Form-Baseline. This figure depicts the data form used by the implementers to evaluate her daily procedural fidelity during Baseline and used by the observer to collect interobserver agreement on procedural fidelity.

Intervention Phases 1-3 Procedural Fidelity

Participant Identifier:	Implementer:	Date:	Session #:	IOA: YES / NO
% Fidelity:		Training Duration:		% Fidelity After Training:
Training Provided:				

	Intervention Phases 1-3	1 Always	2 Often	3 Sometimes	4 Never	5 N/A	Comments
1	During a trial, I placed the items within view and out of reach.	1 Always	2 Often	3 Sometimes	4 Never	5 N/A	
2	I followed the reach (motivation) of the participant.	1 Always	2 Often	3 Sometimes	4 Never	5 N/A	
3	The iPad was present and available.	1 Always	2 Often	3 Sometimes	4 Never	5 N/A	
4	The iPad screen layout included the appropriate number of icons**	1 Always	2 Often	3 Sometimes	4 Never	5 N/A	
5	I provided a five second opportunity for the participant to mand.	1 Always	2 Often	3 Sometimes	4 Never	5 N/A	
6	I employed full-physical prompt after 5 seconds.	1 Always	2 Often	3 Sometimes	4 Never	5 N/A	
7	I allowed access to item/activity for up to 30 seconds.	1 Always	2 Often	3 Sometimes	4 Never	5 N/A	
8	I collected data as indicated by the guidelines.	1 Always	2 Often	3 Sometimes	4 Never	5 N/A	
9	I did not use social praise.	1 Always	2 Often	3 Sometimes	4 Never	5 N/A	
10	I did not provide any prompts other than 5 second constant time delay and FPP.	1 Always	2 Often	3 Sometimes	4 Never	5 N/A	
11	I contrived manding opportunities in each play-based center and during snack.	1 Always	2 Often	3 Sometimes	4 Never	5 N/A	
12	I contrived 30-50 mands today.	1 Always	2 Often	3 Sometimes	4 Never	5 N/A	

Phase 1 - Hidden = 1 icon; Phase 2 - Dimmed = 1 available icon, 59 dimmed icons; Phase 3 - Visible = All

Figure 8. Procedural Fidelity Data Form-Intervention. This figure depicts the data form used by the implementers to evaluate her daily procedural fidelity during Intervention Phases 1-3 and used by the observer to collect interobserver agreement on procedural fidelity.

Generalization Probe Data Form

Information	Mand	Prompt	# of Steps	Vocal Utterance	Center	Problem Behavior
Participant ID:		I / NA				
Session #:		I / NA				
Phase Completed:		I / NA				
Date:		I / NA				
% Ind Mands:		I / NA				

Information	Mand	Prompt	# of Steps	Vocal Utterance	Center	Problem Behavior
Participant ID:		I / NA				
Session #:		I / NA				
Phase Completed:		I / NA				
Date:		I / NA				
% Ind Mands:		I / NA				

Figure 9. Generalization Probe Data Sheet. This figure depicts the data form used to collect the generalization probes during the study.

Therapist Pre-Test Questionnaire

Demographic Information:

Age: _____

ABA Experience (in years): _____

ABA Intervention Settings (include relevant details): _____

_____

Experience with iPad as SGD (How long, what types, teaching procedures used): _____

_____

_____

Pre-Test										
Question	**Confidence Scale**									
	Not that Confident									**Very Confident**
How confident do you feel implementing the device (i.e iPad™ Mini with Proloquo2Go®)?	1	2	3	4	5	6	7	8	9	10
How confident do you feel implementing the prompting package?	1	2	3	4	5	6	7	8	9	10
How confident do you feel implementing motor planning with core vocabulary?	1	2	3	4	5	6	7	8	9	10
How confident do you feel teaching another interventionist?	1	2	3	4	5	6	7	8	9	10
How confident do you feel with conducting preference assessments (i.e. MSWO, in vivo, free operant)?	1	2	3	4	5	6	7	8	9	10
How confident do you feel with contriving manding opportunities?	1	2	3	4	5	6	7	8	9	10
How confident do you feel with data collection?	1	2	3	4	5	6	7	8	9	10
How confident do you feel that the device will help your client?	1	2	3	4	5	6	7	8	9	10

Bedwani et al. (2015)

Figure 10. Pre-Test Questionnaire. This figure depicts the pre-test questionnaire that will be provided to the interventionists implementing the study to determine confidence ratings and further use of the procedures at the onset of the study (Bedwani et al., 2015).

Therapist Follow-up Questionnaire

1. Will you continue to use the iPad™ Mini with Proloquo2Go® as a SGD in language development programs? Why or why not?

2. Will you continue to use the prompting package (i.e. within stimulus prompts, constant time delay prompts, and response prompts) presented in this study in language development programs? Why or why not?

3. Will you continue to use motor planning with core vocabulary in language development programs? Why or why not?

4. Did you experience any difficulties during the study?

Post-Test										
Question	**Confidence Scale**									
	Not that Confident									**Very Confident**
How confident do you feel implementing the device (i.e iPad™ Mini with Proloquo2Go®)?	1	2	3	4	5	6	7	8	9	10
How confident do you feel implementing the prompting package?	1	2	3	4	5	6	7	8	9	10
How confident do you feel implementing motor planning with core vocabulary?	1	2	3	4	5	6	7	8	9	10
How confident do you feel teaching another interventionist?	1	2	3	4	5	6	7	8	9	10
How confident do you feel with conducting preference assessments (i.e. MSWO, in vivo, free operant)?	1	2	3	4	5	6	7	8	9	10
How confident do you feel with contriving manding opportunities?	1	2	3	4	5	6	7	8	9	10
How confident do you feel with data collection?	1	2	3	4	5	6	7	8	9	10
How confident do you feel that the device will help your client?	1	2	3	4	5	6	7	8	9	10

Bedwani et al. (2015)

Figure 11. Follow-up Questionnaire. This figure depicts the follow-up questionnaire that will be provided to the interventionists implementing the study to determine confidence ratings and further use of the procedures at the outset of the study (Bedwani et al., 2015).

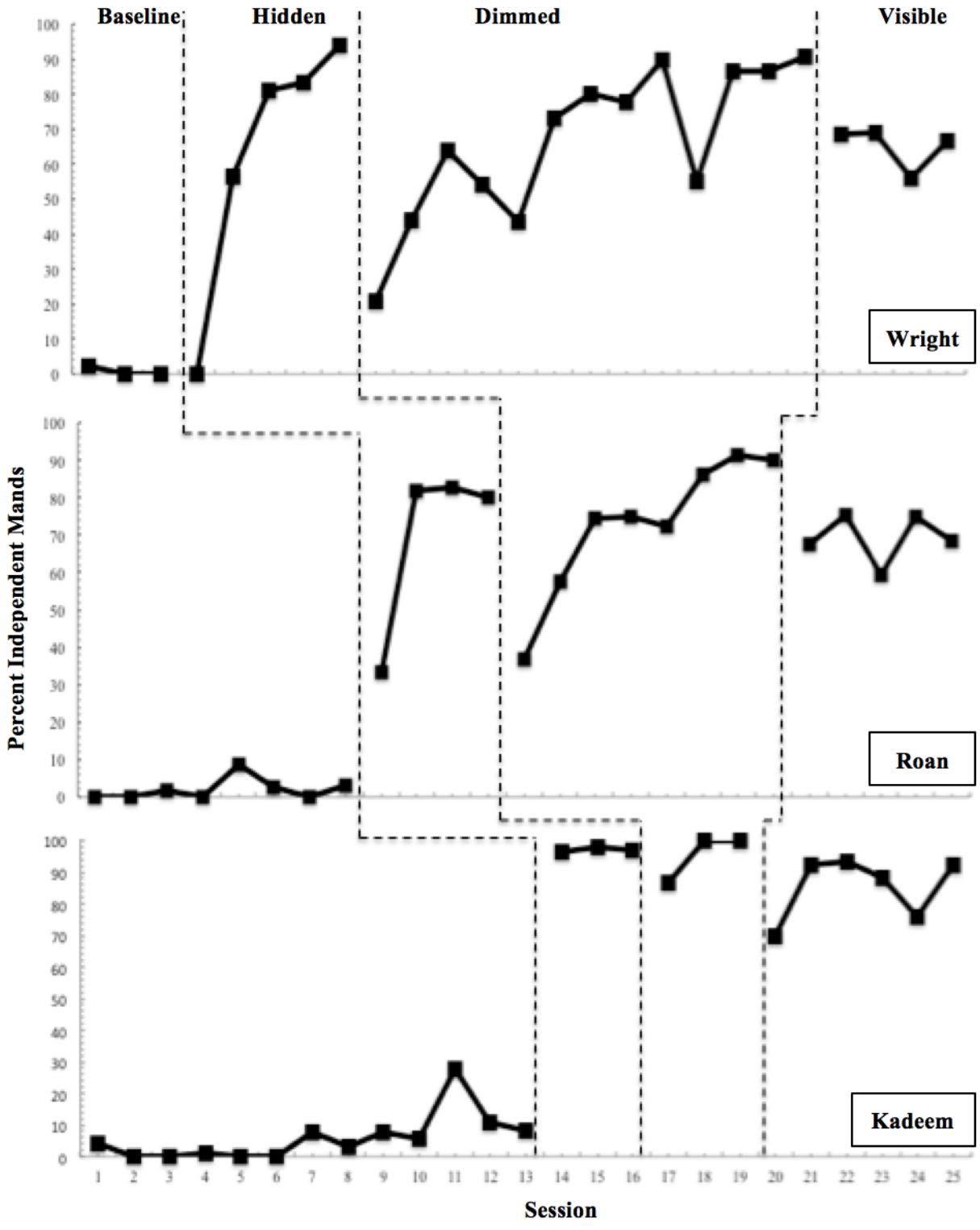


Figure 12. Percentage of Independent Mands. This figure depicts the percentage accurate, independent manding by participant.

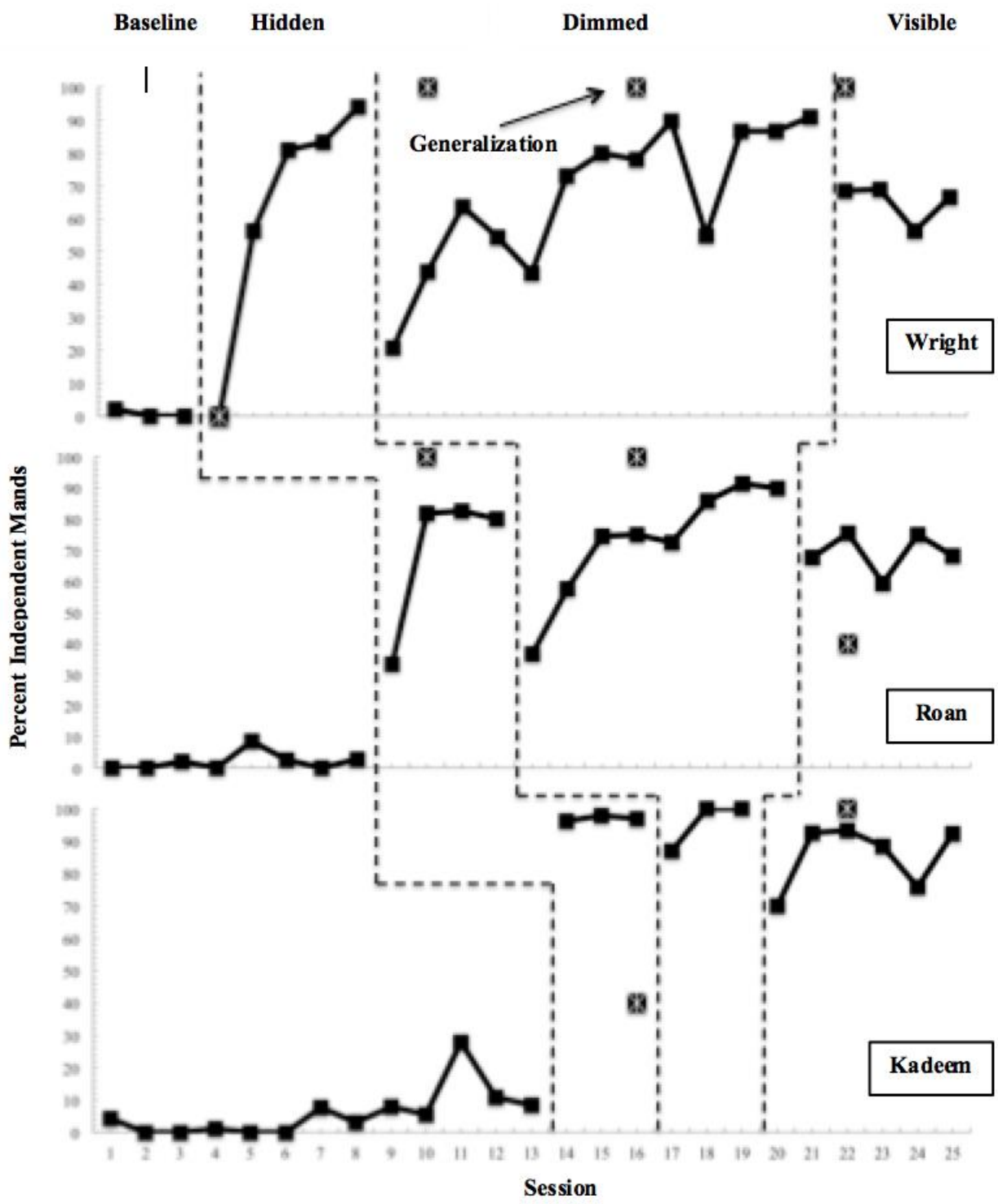


Figure 13. Percentage Independent Mands with Generalization Probes. This figure depicts the percentage accurate, independent manding by participant and includes the generalization probes conducted.

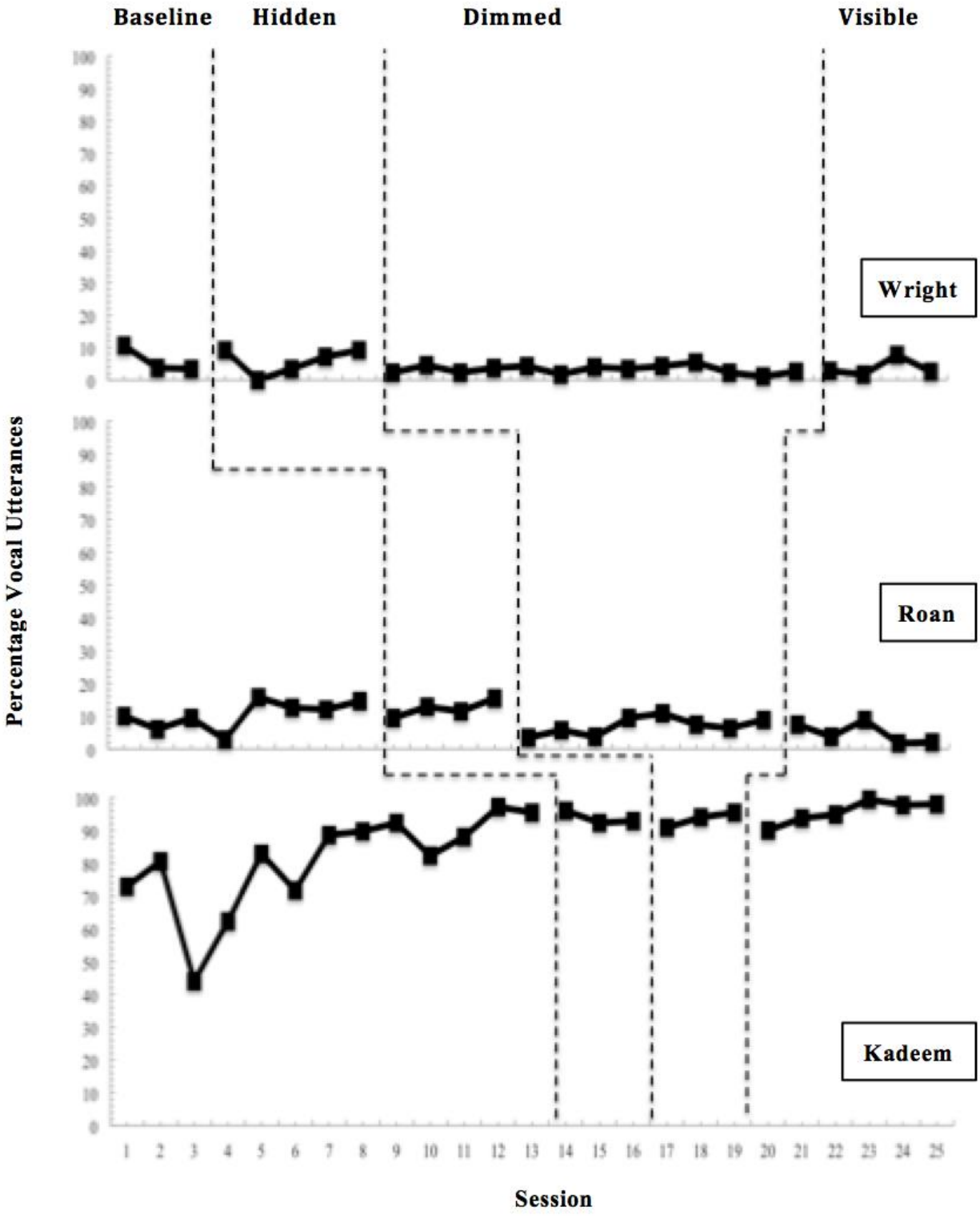


Figure 14. Percent Occurrence of Vocal Utterances. This figure depicts the percentage of daily occurrence of vocal utterances.

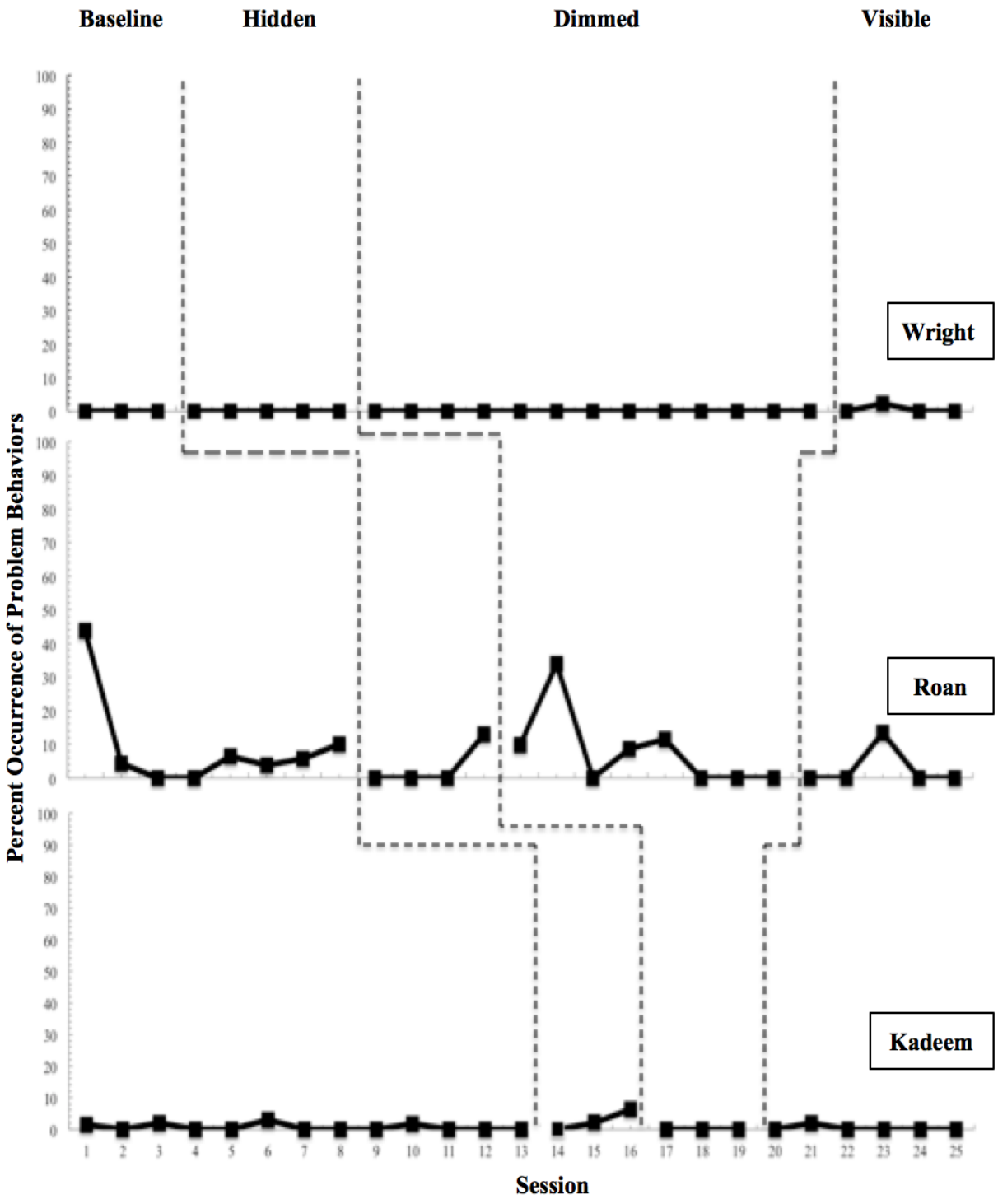


Figure 15. Percent Occurrence of Problem Behaviors. This figure depicts the percentage of daily occurrence of problem behaviors.