Understanding Mediators and Moderators of an Adaptive Communication Intervention for Young Children with Autism Spectrum Disorders

By

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CHAPTER 1

INTRODUCTION

1.1 Background

Autism spectrum disorder (ASD) is a developmental disorder characterized by deficits in social communication and restricted or repetitive interests (American Psychological Association, 2013). According to the Centers for Disease Control, about 1 in 59 children under the age of 8 are diagnosed with ASD (Baio et al., 2018). Investigating the development of communication in children with ASD and examining the outcomes of interventions designed to improve communication in this population are particularly important because communication is a core deficit observed in individuals with ASD. Deficits in communication are strongly correlated with poor academic performance, increased problem behaviors, and difficulties forming relationships with others (Koegel, Koegel, & Surratt, 1992; Bauminger, & Kasari, 2000; Sigman, Mundy, Sherman, & Ungerer, 1986). Deficits in language and communication in young children with ASD are predictive of communication abilities into adulthood (Gillespie-Lynch, et al., 2012).

The association between early skills and later development is especially important in the domain of social communication. Social communication is defined as the sharing of information, thoughts, or ideas with another person (Mundy et al., 1986). Although social communication overlaps with expressive language, social communication specifically requires intentional interaction with another person. Social communication includes gestures such as pointing, showing, giving, and coordinated eye gaze, as well as social verbal utterances. Correlational studies have found significant associations between early social communication and later language abilities, such that children with more frequent early joint attention behaviors show better long-term expressive language outcomes (Mundy, Sigman, & Kasari, 1990; Sigman &

Ruskin, 1999; Charman, 2003). Moreover, children who receive early intervention programming specifically focused on joint attention demonstrate better long-term spoken language outcomes (Kasari, Paparella, Freeman, & Jahromi, 2008).

Understanding the early communicative development of children with ASD is an important step toward reducing the prevalence of individuals with ASD who are minimally verbal. As many as 30% of children diagnosed with ASD are classified as nonverbal or minimally verbal at age five despite access to early intervention (Tager-Fluberg & Kasari, 2013). Persistent minimal verbal status is associated with poor long-term prognoses for social and adaptive functioning (DeMyer et al., 1973; Liss et al., 2001). The Interagency Autism Coordinating Committee set a long-term goal of reducing the percentage of children with ASD who are minimally verbal at age 5 to 10% (Department of Health and Human Services, 2004). In the context of this goal, the preschool period is a critical period for targeted language and communication interventions to teach social communication skills as a foundation for spoken language. The development of intervention procedures that effectively teach critical foundational social communication skills and early expressive language skills could ultimately reduce the number of children with ASD who fail to develop meaningful language.

1.2 Interventions

A number of early interventions have been developed to teach language and communication skills to individuals with ASD. In a comprehensive review of the literature, Wong and colleagues (2015) reviewed 456 studies, from which they identified and described 27 evidence-based practices for children with ASD. An evidence based practice was defined as a practice that had supportive evidence from: "(a) two high quality experimental or quasi-experimental design studies conducted by two different research groups, or (b) five high quality

single case design studies conducted by three different research groups and involving a total of 20 participants across studies, or (c) a combination of research designs that must include at least one high quality experimental/quasi-experimental design, three high quality single case designs, and be conducted by more than one researcher or research group" (Wong et al., 2015, p. 1956). Of the 456 studies included in their review, 182 intervention studies specifically targeted language and communication outcomes, using 26 of the 27 identified practices. The evidenced-based practices described in the review employed a wide range of strategies and included highly structured interventions, such as discrete trial training (DTT) and prompting strategies, and more unstructured or embedded interventions, such naturalistic interventions and modeling. The identified evidence-based interventions also included interventions delivered by natural communication partners such as parents and peers. Lastly, the review identified several evidence-based communication support strategies that could be used in combination with intervention programs; these included visual supports and technological supports, such as speech-generating devices (SGD).

The effectiveness of early interventions on language and communication outcomes was analyzed in two recent meta-analyses. The effects of early intervention on spoken language outcomes in children with ASD was examined in a systematic review and meta-analysis conducted by Hampton and Kaiser (2016). The review included 1738 child participants under age 8 from 26 group design experimental studies. In general, early intervention had positive effects on spoken language for children with ASD. A significant aggregated effect size of g=0.26 was found for spoken language outcomes. Standardized mean difference effect sizes reported in the 26 studies ranged from g=-0.56 to g=1.57. Largest effect sizes (g=0.42) were observed in studies that used a parent-plus-therapist implementation model of intervention. A second

systematic review and meta-analysis of social communication outcomes from early interventions for children with ASD was conducted by Fuller and Kaiser (submitted). This review included 1442 child participants under age 8 from 29 group experimental design studies and reported a significant aggregated effect size of g=0.37 for social communication outcomes. Standardized mean difference effect sizes of the included studies ranged from g=-0.39 to g=1.22. In this meta-analysis, largest effect sizes were reported when children were 3.81 years old and when the intervention was specifically targeted to treat social communication behaviors. Outcomes for interventions were largest when implemented by clinicians but did not differ significantly compared to interventions that were implemented by parents or teachers. Based on the results of these meta-analytical reviews, it appears that, on average, early interventions are effective at increasing language and communication outcomes for young children with ASD. The intervention studies included in both reviews varied greatly in the intervention dosage, intervention strategies, and participant characteristics, which resulted in high amounts of between study heterogeneity. Further, the effects sizes for individual studies varied, as observed in the ranges reported in both meta-analyses; not all interventions resulted in increasing language and social communication for young children with ASD.

Despite the noted heterogeneity among the individual studies, both meta-analyses found a range of targeted and comprehensive intervention strategies that were associated with positive outcomes. In general, interventions associated with statistically significant effect sizes fell on a continuum that ranged from DTT (Smith 2011) to Naturalistic Developmental Behavioral Interventions (NDBI; Schriebman, et al., 2015). While both DTT and NDBI interventions are based in behavioral principles, these two approaches differ in terms of the intervention context, teaching style, and types of reinforcement.

DTT. DTT uses highly structured, adult-led direct teaching that includes a relatively high number of teaching trials during the instructional period and systematic reinforcement of child responses with social and tangible consequences. DTT teaches children to respond to discriminative stimuli or task directions and provides systematic reinforcement for correct responses (Smith, 2001). Systematic reinforcement could include social consequences, such as a high-five or praise, or access to tangible reinforcement, such as a preferred toy or snack. DTT occurs in a structured environment that minimizes potential distractions and delivers a large number of trials in a relatively short period of time. Simplified and consistent instruction is used to teach novel behaviors and novel discriminations. Systematic prompting procedures and well-defined criteria for correct responses, along with a pre-planned sequence of skills, are used to teach specific skills. The primary benefit of a direct behavioral instruction is that teaching can be efficient and effective while minimizing errors. DTT has been shown to be effective to teach social, communication, academic, and self-help skills to children with ASD (Smith, 2001). DTT interventions also have been shown to result in increases on standardized measures of IQ and school readiness (Lovaas, 1987; Lord et al., 2005; Smith, 2011).

There are, however, some important limitations associated with DTT. Newly-learned skills may be highly context-dependent and may not generalize to untrained partners and contexts in the natural environment. Schreibman et al., (2015) argued that the use of DTT and other direct behavioral instruction methods to teach social communication skills has sometimes led to (1) a failure to generalize skills to untrained contexts and partners, (2) the presence of challenging behaviors to escape or avoid instruction, (3) limited initiated communication, and (4) an over-reliance on prompts (Schreibman et al., 2015, p. 2413). Smith (2011) recommended the use of DTT in conjunction with other interventions to reduce these issues.

NDBI. In contrast to the highly-structured context of DTT, NDBIs are implemented in naturally occurring settings and use child preference and interest to select routines and activities for the intervention context. While NDBIs do include the use of reinforcement, reinforcement is based on naturally occurring consequences. Examples of reinforcement in NDBI include positive adult attention, access to requested toys or activities, and continuation of a preferred activity. By teaching in everyday routines and using naturally-occurring reinforcement during instruction, skills are more likely to generalize to other everyday interactions and contexts. Further, instruction within child-led routines and the use of child preferred materials and activities reduces the prevalence of escape/avoidant challenging behaviors sometimes observed in response to DTT interventions (Schreibman, et al., 2015).

One example of an evidence-based NDBI is Enhanced Milieu Teaching (EMT). Kaiser and Roberts (2013, p. 296) describe EMT as a "naturalistic model of early language intervention in which child interests and initiations are used as opportunities to model and prompt language use in everyday contexts." EMT includes six key strategies: environmental arrangement, matched-turn responsiveness, modeling target language, expanding communication, time delays, and milieu episodes (Kaiser & Hampton, 2016). EMT is implemented during on-going interactions with a trained partner to support the functional use of communication skills. EMT uses responsive interactions and systematic prompting to engage children and support language development in daily play and routines. Over 50 studies have demonstrated the effectiveness of variations of milieu teaching and similar naturalistic interventions with a range of children from diverse racial and economic backgrounds and a variety of language delays and disabilities, including ASD (Hancock & Kaiser, 2006; Kaiser & Roberts, 2013).

A second example of an NDBI is Joint Attention, Symbolic Play, Engagement, and

Regulation (JASPER; Kasari, Freeman, & Paparella., 2006). JASPER uses toy play as a context for increasing joint attention and engagement behaviors that are considered to be foundational in ultimately improving social communication. JASPER specifically teaches symbolic play skills and the use of communicative gestures (point, show, give) for commenting and requesting. Children with ASD have shown significant improvements in social communication following the JASPER intervention delivered by researchers (Kasari, et al., 2006; Kasari, Paparella, Freeman, & Jahromi, 2008), parents (Kasari, Gulsrud, Wong, Kwon, & Locke, 2010), and school staff (Chang et al., 2016; Lawton et al., 2014).

EMT and JASPER interventions have been blended into a single intervention (J-EMT; Kasari et al., 2014) to teach both basic social communication and expressive language. J-EMT uses the language support strategies of EMT (e.g., modeling, expansions, milieu teaching episodes) combined with JASPER strategies to teach symbolic play and joint engagement (e.g., modeling progressively higher levels of play, scaffolding joint engagement). The J-EMT intervention implemented by therapists and parents has been shown to be effective in increasing social communicative utterances that include verbal communication and nonverbal communication (e.g., gestures) in minimally verbal children with ASD (Kasari et al., 2014).

1.3 Interventions for Minimally Verbal Children

Relatively little research has examined early interventions targeting language and communication for minimally verbal or preverbal children with ASD. Three randomized control trials (RCT) have specifically addressed improved spoken language outcomes for this population. Paul and colleagues, in a randomized control trial including preschoolers with ASD and minimal verbal language, compared the effects of a DTT intervention to a naturalistic intervention (Milieu Communication Training; Paul, Campbell, Gilbert, & Tsiouri, 2013).

Parents of children in both groups were given responsivity training. Children in both groups made comparable gains in spoken language, with about half of the children in each group reaching the Level 1 benchmarks for early spoken language. Level 1 benchmarks indicate that the child has a minimum of five spoken words and exhibits at least two communicative functions (Tager-Flusberg et al., 2009). In the Paul et al. (2013) study, children with higher joint attention tended to shower greater improvements in spoken language in response to intervention. Receptive language moderated the effects of both interventions, such that children with higher receptive language made greater gains in the naturalistic intervention and children with lower receptive language made greater gains in the DTT intervention.

A second RCT compared the effects of a Picture Exchange Communication System (PECS) intervention to a Responsive Education and Prelinguistic Milieu Teaching (RPMT) intervention (Yoder & Stone, 2006a, 2006b). Thirty-six preschoolers (mean age = 33.6 months) with ASD who were classified as nonverbal or low verbal (fewer than 10 words across three communication samples) were randomly assigned to receive one of the two 6-month interventions. The PECS intervention used a DTT general teaching approach and the RPMT intervention used an NDBI approach. Children in the PECS group had a higher number of non-imitative spoken communication acts and more diverse non-imitative words compared to children in the RPMT group at posttest. This effect was moderated by object interest such that children with higher object exploration at baseline tended to benefit more from the PECS intervention and children with lower object exploration tended to benefit more from the RPMT intervention.

A third RCT examined the effects of the J-EMT intervention with and without the use of an SGD for adult modeling and child responding during treatment. (Kasari et al., 2014). In this

adaptive sequential multiple assignment randomized trial (SMART; Almirall, Compton, Gunlicks-Stoessel, Duan, & Murphy, 2012), 61 minimally verbal children with ASD between ages 5 and 8 were initially randomly assigned to the J-EMT intervention implemented with spoken language only or the J-EMT intervention with spoken language plus an SGD. After 12 weeks of treatment (Phase 1), children were assessed to determine response to treatment. Children who were identified as non-responders were re-randomized to receive the addition of the SGD in their J-EMT with spoken language only intervention or to receive a more intensive dosage of J-EMT with spoken language only (Phase 2). During Phase 2, parents in both groups were trained to implement the J-EMT intervention. About 25% of children were identified as non-responders and re-randomized in Phase 2 of the intervention. After a total of six months of intervention, children who were initially randomized to receive the J-EMT with SGD intervention showed significantly greater gains in spoken language at the end of intervention compared to the children who received J-EMT with spoken language only. Additionally, non-responders who were re-randomized to receive the SGD in Phase 2 of intervention performed relatively better on measures of spoken language compared to non-responders who received a higher dosage of J-EMT. The results of this study suggest that incorporating an SGD in an NDBI intervention that includes parents as implementers may promote spoken language in children with ASD who have minimal verbal social communication.

1.4 Differential Response to Interventions

Across the three RCTs enrolling children who were minimally verbal or preverbal, there was evidence of varied responses to treatment. A portion of the participants did not show a significant improvement or showed only small improvements on the targeted skills in response to the intervention. In Paul et al. (2013), about half of the children in both groups did not reach the

Level 1 spoken language benchmarks by the end of the study. In Kasari et al. (2014), 25% of participants did not make criterion level progress (a 25% gain on at least 8 of 15 language measures) in spoken language after 12 weeks of intervention. Yoder and Stone found that depending on baseline characteristics, some children made smaller gains in response to intervention than others (2006a). Varied responses to treatment are not uncommon in the literature examining early interventions for children with ASD. For example, in the Lovaas (1987) study, often considered a cornerstone study in establishing evidence for early intensive behavioral interventions for children with ASD, only 9 of 19 participants in the treatment group made significant gains. A range of outcomes is evident in the outcomes of many intervention studies enrolling children with ASD (e.g., McClannahan & Krantz, 1994; Olley, Robbins, & Morelli-Robbins, 1993; Weiss, 1999; Sallows & Graupner, 2005; Cohen, Amerine-Dickens, & Smith, 2006; Rogers et al., 2012).

Identifying the characteristics of children with ASD who are likely to respond to specific interventions to improve social communication and spoken language has been an important approach in early intervention research (Sherer & Schreibman, 2005; Gabriels, Hill, Pierce, Rogers, & Wehner, 2001; Yoder & Stone, 2006 a, b). Identifying profiles of treatment responders and slow responders may be useful in selecting the type of intervention and specific skills to be addressed in intervention. Understanding how child characteristics interact with specific types of intervention is crucial to developing the most efficient and effective treatment plans.

One approach to determine characteristics of children who best respond to a treatment is examining moderators of treatment. Identifying moderators of treatment goes beyond looking at predictors of child outcomes, or participant characteristics that are correlated with later

outcomes. By examining the interaction of treatment condition and child characteristics, moderators may indicate the specific benefit or detriment observed for children with a certain characteristic within a treatment group. Therefore, examining moderators of treatment outcomes may help identify the children for whom certain interventions are most effective based on specific child characteristics. Two potential moderators are object interest and interfering behaviors.

Object interest. Many but not all children with ASD show restricted interest in objects (Bruckner & Yoder, 2007). Object interest is important in the development of early communication because a large part of social communication involves the child coordinating his or her attention between a communication partner and an object. For example, a child might hold out his hands and say "ball" to indicate that he wants his parent to throw the ball. In this instance, the child is coordinating the attention of the adult to the object to gain access to the object. Child interest in objects is important in intervention because object-based routines are an important early language-learning context for children. Object-based routines provide consistent and salient sequences of actions onto which the child and their communication partner can map language (Bruner & Sherwood, 1983). Object interest is a commonly identified predictor of response-to intervention. For example, Sherer and Schreibman (2005) identified toy play, a construct related to object interest, as one of five characteristics of treatment responders in response to a pivotal response training intervention. Children who were considered treatment responders spent an average of 70.8% of observed intervals interacting with objects, compared to children who were considered non-responders who spent an average of 27% of intervals interacting with objects. Yoder and Stone (2006a) found that object interest was a significant moderator of treatment, such that a child's initial object exploration moderated the effect of the PECS and RPMT

interventions. Children with higher object exploration tended to benefit more from the PECS intervention and children with lower object exploration tended to benefit more from the RPMT intervention. The findings from Sherer and Schreibman (2005) and Yoder and Stone (2006a) suggest that object interest is related to communication outcomes in some samples of children with ASD and may function as a potential moderator of intervention effects.

Interfering behaviors. Engagement is a frequently studied construct in the field of ASD. Engagement is associated with long-term language and communication outcomes (Adamson, at al. 2009). Children who are more engaged with communication partners and activities are more likely to learn from their natural environment. Given the concern in this population around the low-frequency of engagement, it is important to understand the behaviors that interfere with engagement. Interfering behaviors reduce the amount of time a child is able to actively engage in interventions. The amount of time actively engaged in intervention differs from dosage of intervention; a child may be in the context of intervention, but he or she may not be truly receiving the intervention due to a lack of engagement with the instructor or the instructional tasks (Ruble & Robson, 2006). Bopp, Mirenda, and Zumbo (2009) classified four types of behaviors that potentially interfere with a child's engagement during an intervention. These behaviors include inattentiveness, socially unresponsive behavior, restricted and repetitive behaviors, and acting out behaviors.

Escape behaviors. Both inattentiveness and social unresponsiveness are behaviors that generally indicate that the child is unengaged or not attending to the intervention agents and procedures, and for the purpose of this study, have been considered generally as *escape behaviors*. These behaviors may include wandering around the room, turning away from communication partners, or failing to engage with the communication partner or activity. For

example, a child staring out of the window while his parent reads a book would be engaged in an interfering behavior; although the child is physically present for the task, without looking at the book or the parent, it is unlikely that he is learning from the book reading activity. These more passively interfering behaviors are predictive of later language outcomes in correlational studies. In a longitudinal correlational study, high scores of inattentiveness and social unresponsiveness in young children with ASD predicted lower rates of change in vocabulary production and language comprehension over two years (Bopp, Mirenda, & Zumbo, 2009). In a second study examining the four-year follow-up outcomes of an early intensive behavioral intervention, children who were rated as rapid learners in both the intervention and control groups tended to be scored lower on parent and teacher reports of attention problems (Sallows & Graupner, 2005). When engaging in these behaviors, children are generally escaping the teaching context of the interaction.

Repetitive behaviors. The second type of interfering behaviors, repetitive behaviors, were not identified by Bopp and colleagues (2009) as having a significant relationship with language outcomes. However, their findings contrast to those of Lam and colleagues (2008), who took a more specific look at repetitive behavior, looking specifically at repetitive motor movements. Repetitive motor movements were correlated with social communication impairments, such that children with higher rates of repetitive motor behaviors scored lower on measures of communication abilities (Lam, Bodfish, & Piven, 2008). Similar to the escape behaviors described above, a high rate of repetitive behaviors might reduce the child's engagement in interventions, and potentially reduce the dosage as received.

Aggressive behaviors. Tantrums and aggressive behaviors are the most commonly identified problem behavior in this population (Horner et al., 2002). These behaviors indicate

that children are socially unengaged with or not attending to the intervention agents and instructional procedures because they are actively participating in other behaviors that prevent engagement. A descriptive study of children with ASD found a significant correlation between aggressive behaviors and expressive language such that children with higher rates of aggressive behaviors scored lower on measures of expressive language (Dominick, Davis, Lainhart, Tager-Flusberg, & Folstein, 2007). Aggressive behaviors are often punishing to the communication partner and therefore socially isolating to the child.

Children who are difficult to engage because of their high-rates of escape, repetitive, and aggressive behaviors are less likely to engage in social interactions at home or in the school environment and thus, less likely to learn language and communication skills from their environment. Children's baseline frequency of these interfering behaviors may have important moderating effects on a naturalistic intervention that provides teaching in response to the child's interests and communication attempts during naturally occurring learning opportunities. Although there is evidence that these behaviors are related to language outcomes, the potential moderating effect of children with ASD's interfering behaviors on outcomes of language interventions has not been tested in previous studies.

1.5 Identifying Foundational Skills

It is also important to determine if improvements in foundational skills, such as joint attention, verbal imitation, and receptive language during intervention are associated with better long-term communication outcomes. Examining mediators of communication outcomes may further the understanding of necessary intervention targets and how these relate to communication outcomes. Measuring intermediate changes in foundational skills during intervention can contribute to understanding the mechanism of change in later or more complex

skills and behaviors.

In order to demonstrate a mediation effect, there must be evidence (a) that the intervention is related to intermediate changes in the foundational skills and (b) the intermediate changes in foundational skills are related to the outcome of interest (Hayes, 2009). Therefore, to identify potential mediators, there should be evidence (a) that foundational skills can be targeted in intervention, and (b) that the foundational skills are related to the outcome measure. In the literature, certain foundational skills for children with ASD have been effectively targeted via early interventions and have been associated with positive language and communication outcomes. These potentially mediating behaviors include joint attention, receptive language, and verbal imitation.

Joint attention. Initiating joint attention refers to behaviors that the child uses to draw another person's attention to an object, such as pointing, showing, or coordinating eye gaze from a person to an object. Responding to joint attention refers to the child's ability to notice and appropriately respond to another person's initiation of joint attention. Examples of responding to joint attention include looking in the direction of a distal point and looking at an object that a partner is showing. Joint attention behaviors in children with ASD have been effectively taught using a range of early intervention strategies including NDBIs and DTT (e.g., Kasari et al., 2006; Whalen & Schreibman, 2003). Correlational studies have found significant associations between joint attention skills and later language abilities, such that children with ASD who have more joint attention behaviors show better long-term expressive language outcomes (Mundy, Sigman, & Kasari, 1990; Sigman & Ruskin, 1999; Charman, 2003). Initiating and responding to joint attention have been shown to be predictive of later language and communication (Luyster, Kadlec, Carter, & Tager-Flusberg, 2008; Yoder, Watson, & Lambert, 2014). Children who

received intervention targeting early joint attention skills have shown greater long-term language improvement than children in a control group (Kasari, Gulsrud, Wong, Kwon, & Locke, 2010). In sum, research has demonstrated that (a) interventions can improve joint attention skills and (b) joint attention skills are related to improved language outcomes, suggesting that joint attention has the potential to mediate intervention outcomes.

Receptive language. Receptive language, or a child's ability to comprehend the meaning of spoken linguistic input, is closely related to expressive language, both in typically developing children and in children with ASD (Mullen, 1995; Zimmerman, Steiner, & Pond, 2004; Dyck, Piek, Hay, Smith, & Hallmayer, 2006). Early receptive language skills are predictive of later language in children with ASD. For example, Paul and colleagues (Paul, Chawarska, Cicchetti, & Volkmar, 2008) found that early receptive language in children with ASD significantly predicted expressive language two years later. This correlation extends to long-term outcomes; Luyster and colleagues found that early receptive and expressive vocabulary at age 2 was related to long-term expressive and receptive language at age 9 (Luyster, Qui, Lopez, & Lord, 2007).

Receptive language has been an intervention target in both DTT (Lovaas, 1987; Kurt, 2011) and NDBIs (McGee, Krantz, Mason, & McClannahan, 1983) for teaching language to children with ASD. Receptive language skills include receptive vocabulary (e.g., identifying a ball from an array of objects in response to the question "Where is the ball?") and receptive understanding of phrases (e.g., following the verbal instruction "Stand up"). Receptive language may be an important foundational skill that mediates the effects of NDBIs. NDBIs frequently include modeling language as an intervention strategy (Schreibman et al., 2015). As children's receptive vocabulary and understanding of phrases improve during intervention, they may benefit more from the language-modeling component of the intervention. In sum, research

demonstrates that (a) interventions can improve receptive language and (b) receptive language is related to better long-term expressive language outcomes. Therefore, receptive language skills may potentially mediate intervention outcomes.

Verbal imitation. Verbal imitation is a commonly identified predictor of language and communication outcomes for children with ASD. Verbal or oral motor imitation is the ability to imitate speech sounds and oral motor movements. Verbal imitation plays an important role in language learning. Verbal imitation allows a child to practice speech sounds and receive feedback from communication partners. Verbal imitation skills in typically developing children has a correlation with language, speech fluency, and social communication (Bates et al., 1988; Alcock, 2006; Uzgiris, 1991). As such, verbal imitation has been significantly correlated with language outcomes (Yoder & Layton, 1988; Gernsbacher, 2008) and with speech fluency (Amato & Slavin, 1998) in children with ASD. Both verbal and gross motor imitation have been a common target of early interventions (Ingersol, 2012; Ingersol & Schreibman 2005). Imitation may be an important mediator in any intervention that includes modeling new language as a key component. In responsiveness-based interventions, children's spontaneous imitation provides partners opportunities to respond with related language or expanded models of language, thus, increasing the dosage of modeling when the children are attending. For example, when a child imitates their parent's use of the word "ball," the parent has the opportunity respond with a language expansion (e.g. "throw the ball"). Because imitation (a) has been shown to improve during language interventions, and (b) is predictive of later language growth, it has the potential to act as a mediator of intervention outcomes.

1.6 Current Intervention

The aims of this adaptive, blended intervention were to provide direct instruction for

specific skills in a structured context to increase children's response to therapist and caregiver implemented naturalistic language intervention and to support generalization of newly-learned communication skills across contexts. Ultimately, the goal of the intervention was to reduce the number of children with ASD who remained minimally verbal at age of five. In order to address the range of skills that young preverbal children present, the intervention combined two early interventions, J-EMT (Kasari et al., 2014) and DTT (Smith, 2001). The intervention incorporating naturalistic and direct teaching components was designed to be adapted to children's skills at entry and to be modified in response to improvements in children's skills during the intervention period, especially as they demonstrated mastered foundational skills related to communication. The intervention included four distinct components; the components and person implementing each component are shown in Figure 1.

First, foundational skills (joint attention, receptive language, imitation), which have been proposed as prerequisites for language learning, were assessed and taught using direct instruction procedures based on Smith et al. (2014)'s core DTT curriculum. (See Appendix A for a curriculum map). Children who showed skill deficits in the identified foundational skill received targeted DTT in that area. The addition of DTT provided for a high number of structured teaching trials for children who might benefit from instruction in identified skill areas.

Second, child communication in naturalistic interactions was targeted using J-EMT. J-EMT is a naturalistic communication intervention that teaches language and social communicative behaviors used for a range of communicative functions (commenting, requesting) as well as symbolic play as a foundation for language. J-EMT uses modeling, expansions, and prompting in play and routines to teach social communication and promote spoken language. J-EMT promotes generalization and maintenance of newly learned skills by

teaching in social interactions across everyday activities and routines.

Third, to increase the dosage of the naturalistic intervention and promote generalization, children's caregivers were trained to use the J-EMT strategies in the context of play and home routines. One third of the intervention sessions (one of three weekly sessions) occurred in the home. A systematic training using an established training protocol, Teach-Model-Coach-Review (Roberts and Kaiser, 2015), was implemented by the same therapist who delivered the DTT and J-EMT intervention to the child.

Lastly, an SGD was used to model and prompt language during the DTT and J-EMT sessions. An iPad programmed with communication software that allowed it to be used as an augmentative communication device was incorporated into the intervention to provide children with an additional mode of communication. Use of the SGD was directly taught during the DTT intervention. An SGD, programmed by the therapist, was given to the families at the beginning of the study to use at home and families were taught basic skills for modifying the programming to fit their child's communication at home. For minimally verbal children with ASD, providing an alternative mode of communication to spoken language may be especially important. There is evidence indicating that the use of AAC devices may promote the development of spoken language. Kasari and colleagues (2014), found that minimally verbal children with ASD who had access to the SGD during intervention produced used an average of 10 more unique spoken words in a 20-minute language sample than children who received J-EMT with spoken language only. Several single case studies also have reported increases in spoken language during SGD-based interventions (e.g. Ganz et al., 2012; Schlosser et al., 2007). Positive effects on expressive language when SGDs are included in interventions has been demonstrated across populations of children with varied disabilities including ASD (Romski et al., 2010).

1.7 Current Study

The purpose of the current study was to examine child characteristics and foundational skills that potentially moderated and mediated communication outcomes in a randomized trial of an adaptive communication intervention compared to business as usual. Object interest and interfering behaviors were examined as moderators; joint attention, receptive language, and verbal imitation were examined as mediators. Four child communication outcomes, representing a continuum of measurement contexts from context-bound proximal measures to generalized distal measures were selected. The measures included: (a) social communication with a caregiver, (b) social communication with an unfamiliar partner, (c) initiations of joint attention during a structured assessment, and (d) expressive language on a standardized assessment.

In two recent reviews of communication interventions for young children with ASD (Yoder, Bottema-Beutel, Woynaroski, Chandrasekhar, & Sandbank, 2014; Fuller & Kaiser, 2017), researchers observed that studies that measured behavior in a context that shared most features with the intervention context reported effect sizes almost twice as large as studies that measured social communication outcomes in contexts that differed from the intervention context. This finding suggests that children with ASD may not generalize newly-learned communication skills to novel contexts and partners. Further, both reviews concluded that studies that report only proximal outcomes may overestimate the positive effects of intervention on children's functional use of communication. Examining children's response to intervention across measurement contexts that capture both context bound communication behaviors and generalized use of language and communication in novel contexts is important to fully understand the extent to which intervention improves communication in young children with ASD.

Objective 1. The first objective of the current study was to investigate moderators of

child language outcomes in four types of measurement contexts by answering the following questions: (1) Does pretest object interest moderate the effect of group assignment (treatment or control) on children's social communication outcomes? (2) Does pretest frequency of interfering behaviors (escape, aggression, and repetitive) moderate the effect of group assignment on children's social communication outcomes?

Objective 2. Objective 2 examined how children's foundational skills targeted as a part of an adaptive intervention potentially mediated children's social communication outcomes by answering the following questions: (1) Does joint attention mediate the effect of group assignment on social communication outcomes? (2) Does receptive language mediate the effect of group assignment on social communication outcomes? (3) Does verbal imitation mediate the effect of group assignment on social communication outcomes?

CHAPTER 2

METHODS

2.1 Recruitment

Data for this analysis were collected from participants enrolled in an RCT (R40MC27707) of a communication intervention for young minimally verbal children with ASD. Participants were recruited in Nashville, TN through a variety of sources including the local metropolitan and rural school districts, the university autism center, and local speech pathologists between January 2014 and July 2017. Participants were first screened for inclusion criteria via a phone interview following a standardized protocol. After passing the phone screening, potentially eligible children were evaluated in a university clinic setting, accompanied by their caregivers. Inclusion criteria were as follows: (1) a chronological age between 36 and 60 months; (2) a confirmed diagnosis of autism spectrum disorder on the ADOS (Lord et al., 2008); (3) a visual reception score of at least 18 months on the Mullen Scales for Early Learning (Mullen, 1995); (4) fewer than 20 different words used spontaneously during a 20-minute language sample with a trained member of the research staff; (5) the child's primary caregiver used English as the spoken language in the home environment; and (6) no indicated secondary medical or developmental diagnosis. A total of 84 children were screened. Eleven children did not meet eligibility criteria. Five children met inclusion criteria but their families declined to participate due to scheduling constraints. A total of 68 children and their primary caregivers were randomized to treatment (34) or control (34) and were included in the analysis. Seven participants (two from the intervention group, five from the control group) withdrew from the study prior to posttest and an additional three participants from the control group withdrew prior to the follow-up time point. The complete description of the enrollment of participants

throughout the study is shown in the consort chart in Figure 2.

2.2 Participants

Characteristics of the 68 child participants and their caregivers are shown, by group assignment, in Table 1. Children were on average 43.06 months (SD=5.16). Children had a mean cognitive score of 51.79 (SD=8.77) based on the Early Learning Composite on the Mullen Scales of Early Learning (Mullen, 1995). Children had an autism severity score of 7.68 (SD=1.69) based on the ADOS severity scale (range for the ADOS is 0-10, with higher scores indicating more severe ASD symptomology). The child participants were 64% white and 85% male. Eighteen percent came from households that were considered low income, defined as falling below 200% of the federal poverty line based on the government's income-to-needs ratio for the year in which the child entered the study.

Each child participant had one primary caregiver who consented to participate in the study. The primary caregiver provided demographic and developmental information about the child and participated in the caregiver-child interaction observations (described below). For children assigned to the intervention group, the primary caregiver was required to attend all intervention sessions. Caregivers were mothers (n=57), fathers (n=8), and grandmothers (n=3).

2.3 Randomization

Following the initial screening visit, participants were randomized to the intervention or the control group. Randomization was completed using the randomization tool of Redcap (Harris et al, 2009) and research personnel were blind to the allocation process.

2.4 Setting and Timeline

All assessments were completed in a small clinic room in a different location than the clinic rooms where the participants received the intervention. The clinic room was equipped with

a child-sized table and chairs, a play mat, an open shelf for assessment materials, a video camera, and a two-way mirror so the caregiver could watch. All assessments were completed by a trained assessor who was blind to the group assignment of the participants.

Following the initial screening assessment, the full battery of initial assessments was administered over two days within a two-week period. The participants randomized to the intervention group began intervention sessions following the second day of testing. Posttest assessments were also completed over two days within a two-week period, approximately four months after the completion of pretest. Follow-up assessments were completed four months after the posttest. The pretest, posttest, and follow-up tests occurred in the same clinic setting. Assessment staff were trained to criterion fidelity on all measures prior to the beginning of the study. Fidelity of assessment administration was monitored throughout the study and direct assessments of fidelity occurred for at least 20% of the non-standardized assessments. Fidelity of assessment administration was completed by a trained coder blind to the assignment of participants to conditions and time points of the assessments. Assessment fidelity is reported in Table 2. Assessment fidelity protocols are in Appendices B-D.

2.5 Intervention

The participants randomly assigned to the intervention received three intervention sessions (two clinic and one home) per week for 12 weeks (36 sessions) and their caregivers participated in three workshops in which the J-EMT intervention strategies were taught. Each session lasted 45-60 minutes. The multi-component intervention included the following: a) therapist implemented J-EMT during play and routines with the child in the clinic and at home, b) caregiver training to implement J-EMT in the clinic and at home, c) therapist-implemented DTT to teach foundational skills, and d) use of an SGD throughout all phases of the intervention.

J-EMT. The primary component of the intervention was J-EMT implemented by therapists and caregivers described above and in Kasari et al. (2014). A list of the J-EMT strategies used in the intervention is in Table 3. Each child received 30 minutes of therapist-implemented play-based J-EMT intervention during each session (home and clinic). Sessions were conducted with the child and therapist either sitting at a table or on the floor, depending on the child's engagement, toy play skills, and interests. Developmentally appropriate toys were selected for the play sessions based on child interest and play level as determined during the pretest Structured Play Assessment (SPA, Ungerer & Sigman, 1981). Target level language was determined based on the child's number of different words observed during the initial language sample and the caregiver-reported words on the MacArthur Bates Communication Development Inventory (MCDI; Fenson et al., 1993). Children with fewer than 20 different words on the NLS, fewer than 50 words reported on the MCDI, and fewer than 10 verbs reported on the MCDI began intervention with one-word targets. The therapist modeled one-word phrases (spoken and using the SGD) in about 50% of her utterances and used short grammatically correct sentences during the remaining 50% of her utterances. Initial language targets and play levels were adjusted across the intervention period in response to children's acquisition of play and language skills. Typically, children began with single word targets and combination or pre-symbolic play skills. The SGD was incorporated into the J-EMT intervention, as described below.

Caregiver training. The strategies used in the J-EMT intervention were introduced to the primary caregiver during three didactic workshops, occurring before the first intervention session, between sessions 12 and 18, and between sessions 24 and 30. Timing of the second and third workshops was determined by the caregiver's acquisition of the skills taught in the preceding workshops. During each workshop, the therapist explained each J-EMT strategy, gave

a rationale for use of the strategy and presented video examples of the therapist or caregiver using the strategy with the child. Role playing, discussion of adaptations for the child's skill level and interests, and opportunities for the caregiver to ask questions were also included in the workshops. Typically, workshops lasted approximately 45 minutes and were delivered in the clinic setting. Table 3 shows which J-EMT strategies were addressed in each workshop.

During each intervention session with caregivers, a systematic strategy for teaching the J-EMT strategies was used. The Teach-Model-Coach-Review framework for training caregivers and professionals has been demonstrated as an effective training approach (Roberts et al., 2014). The therapist began each session by reviewing two specific intervention strategies (e.g., modeling and expanding language) with the caregiver. The therapist then modeled these strategies with the child for a minimum of 10 minutes while the caregiver watched. While modeling with the child, the therapist verbally highlighted her use of those strategies at least twice for each strategy (e.g., "When he vocalized while playing with the car, I said 'car' and activated the SGD"). After the therapist modeled with the child, the caregiver practiced the strategies with the child and was coached by the therapist. During the coaching, the therapist provided materials to support play and engagement, made suggestions for using the J-EMT strategies, praised the caregiver's use of the two specific strategies and gave corrective feedback as needed. The therapist ended the session by reviewing with the caregiver, pointing out specific instances in which the caregiver used the intervention strategies and verbally linking the caregiver's use of specific J-EMT strategies to the child's play and communication behaviors.

Across the 36 intervention sessions, the amount of time the caregiver practiced the intervention strategies with the child systematically increased across sessions. At the beginning of intervention, the caregiver practiced for a minimum of five minutes and at the end of

intervention (session 30-36) the caregiver practiced for 20 minutes. The combined time for therapist plus caregiver implementation of J-EMT in each session was 30 minutes throughout the intervention.

In addition to caregiver training in the context of play, each home session (12 sessions) included two home-based routines in which the caregiver practiced the use of J-EMT strategies in order to ensure that that caregiver and child generalized across contexts. Typical routines included mealtimes, hand washing, outdoor play, bath time, dressing, and book reading and were selected by the caregiver. Each routine lasted between 5 and 20 minutes and caregiver training followed the TMCR framework described above. The therapist first reviewed the target J-EMT strategies and discussed with the caregiver how those strategies could be used in the selected routine. The therapist then modeled using J-EMT in the routine while highlighting her use of the strategies, coached the caregiver in using the strategies, and reviewed the use of strategies and the effects of the strategies on the child's communication with the caregiver.

DTT. Each clinic-based session (24 sessions) included up to 20-minutes of therapist-implemented DTT. Based on their performance during DTT baseline assessments, child participants received instruction in one to four programs: (1) joint attention, (2) imitation, (3) receptive language, and (4) SGD-related skills. Instruction in each program lasted 5 minutes. A curriculum map showing the sequence of skills is in Appendix A. The four programs were chosen to teach foundational skills that could potentially maximize benefits of the J-EMT intervention. When a child demonstrated criterion levels of each skill in an individual program (80% correct over two consecutive sessions), that program was dropped from the intervention sessions, resulting in a 5-minute reduction in DTT session length.

SGD. Each caregiver was given an iPad with the Proloquo2Go app (Sennott &

Niemeijer, 2008) to use as an SGD with the participating child. Families kept the iPad throughout the intervention and follow-up period. Caregivers were taught to program the device prior to the start of intervention. Caregivers were instructed to bring the SGD to every intervention session. The therapist and the caregiver used the iPad to model communication and to provide the child with a nonverbal response mode throughout each intervention session in the clinic and at home. The therapist also used the iPad during the DTT instructional component. The therapist modeled 50% of her verbal utterances on the SGD (spoken and activated the SGD) and included the SGD in at least 50% of milieu prompting episodes. The therapist modeled for and coached the caregivers in the use of the iPad during home and clinic sessions.

The SGD display was individualized for each child. Field sizes were selected for children based on their ability to scan a visual field. Children's ability to scan a visual field on an SGD and identify an object in incrementally larger fields was tested in the initial assessments to identify the best visual field size (4, 9, 16, or 25 icons). Children who identified the object (ball) in three out of four possible locations on each field size were advanced and assessed on the next larger field size. For example, if children identified the ball on a field of nine during three trials, they were then assessed using a field of 16. Examples of SGD pages used in the assessment are shown in Appendix E.

The therapist then worked with the caregiver to set up vocabulary pages for each child. Caregivers identified daily routines and relevant vocabulary and pages for each routine were programmed. Each word was represented both by a printed word and a picture, either a line drawing or a photograph of the item. Pages were organized to facilitate use of phrases or simple sentence structures, with pronouns in the left-hand columns, verbs in the middle columns, and nouns in the right-hand columns (see Appendix F).

2.6 Business as Usual Control Group

Caregivers and children assigned to the business as usual control group also received an iPad with the Proloquo2Go app to use throughout the study. A project staff member provided a brief training on programming the device and how to use it for communication during daily routines. Trainings typically lasted 45-minutes and occurred in the clinic setting. The same process of selecting a field size and setting up routine-specific vocabulary pages described above was implemented with the control group. Participants were not instructed in the use of J-EMT procedures or how to use the SGD during play interactions with their children. In addition, each family was referred to community-based services and provided a list of local resources for children with ASD.

2.7 Fidelity

Fidelity of intervention sessions was measured from video recordings of 17% intervention sessions. The six fidelity (four clinic, two home) sessions for each family were randomly selected and were distributed across the intervention period. Fidelity checklists were based on coded observational data and completed for each of the following components of intervention: (a) DTT, (b) therapist implementation of J-EMT, (c) therapist implementation of caregiver training (TMCR) and (d) therapist implementation of home-based routines. Copies of the forms used for rating fidelity are in Appendix G (clinic sessions) and Appendix H (home sessions). Fidelity protocols were developed to measure intervention *as received*; if circumstances (e.g., the child cried and refused to respond when a milieu teaching prompt was presented) resulted in a component of the intervention not being delivered as prescribed, that item was rated as a zero. This approach to fidelity was intended to measure actual dosage each received rather than the therapist or parent's attempt to use the teaching strategies. For example,

if the therapist was not able complete a milieu prompt because of repeated tantrums or refusals as described above, a score of zero was given for use of prompting. As a result, a wide range of scores was observed across sessions, particularly for home sessions where contextual variables (e.g., difficulties maintaining child in the area, siblings interrupting sessions, caregiver illness) often could not be controlled. Fidelity assessments were completed and reviewed on a continuous basis; therapists with low levels of fidelity were given feedback and re-trained. Overall fidelity was 82.52% for home sessions and 90.80% for clinic sessions; a summary of fidelity data is in Table 2.

2.8 Measures

Primary outcome measures. Four measures of language and communication were used as outcome measures to index child communication behaviors across four measurement contexts: a) social communication with a caregiver, b) social communication with an unfamiliar partner, c) initiations of joint attention, and d) generalized expressive language. A list of measures, constructs, contexts, and time points for these measures is shown in Table 4.

Social communication with a caregiver. The total number of socially communicative utterances (SCU) with a caregiver was measured during a 10-minute video-recorded sample of caregiver-child interaction (CCX). Caregivers were instructed to play with their children using a standard set of toys (different from the toys used in intervention). The protocol for the CCX is in Appendix I. All samples were video recorded then transcribed and coded using the Systematic Analysis of Language Transcripts software (SALT; Miller & Iglesias, 2008). Socially communicative utterances were defined as spoken, AAC, or gestural requests and comments that included a secondary indicator that confirmed the social intention of the utterance. Examples of secondary indicators included eye contact with the caregiver or referent, physical interaction

with a referent, or the pairing of a spoken or AAC utterance with a gesture. Gestures alone were counted for pointing, showing, and giving behaviors. Reaches and eye contact alone were not counted as socially communicative utterances. Because the caregivers of children in the intervention group were trained in J-EMT intervention strategies, there is a risk that this measure has correlated measurement error.

Social communication with an unfamiliar partner. The total number of SCU with an adult partner was measured during a 20-minute naturalistic language sample (NLS); the partner was a trained research staff member blind to the group assignments of participants in the study. Samples were 20-minutes in length, video recorded and included six standardized sets of toys and activities. The protocol for the NLS is in Appendix J. The NLS provided a generalized measure of social communication by observing children in a novel context and with an adult who was untrained in J-EMT strategies. All samples were video recorded then transcribed and coded using the SALT software (Miller & Iglesias, 2008). Socially communicative utterances were defined as spoken, AAC, or gestural requests and comments that included a secondary indicator that confirmed the social intention of the utterance. Examples of secondary indicators included eye contact with the assessor or referent, physical interaction with a referent, or the pairing of a spoken or AAC utterance with a gesture. Gestures alone were counted for pointing, showing, and giving behaviors. Reaches and eye contact alone were not counted as socially communicative utterances.

Initiations of joint attention. The total number of initiations of joint attention (IJA) was measured during the Early Social Communication Scales (ESCS; Mundy et al., 2003). The ESCS is a short (20-minute) assessment with specific materials and probes to elicit initiations of joint attention, including eye contact, coordinated gaze, pointing toward an object, or showing an

object to another person for the purpose of sharing or drawing attention; these acts were not prompted or imitated. The assessment was administered by an assessor blind to group assignment. IJA was coded from video recordings by a coder who was also blind to group assignment.

Expressive language. Global expressive language was measured using the expressive language subscale of the Preschool Language Scales, 5th Edition (PLS-Expressive; Zimmerman, Steiner, & Pond, 2011). This standardized assessment was administered by a speech language pathologist who was blind to group assignment. As recommended for moderation analyses, raw scores on the subscale were used in the analysis (Yoder & Compton, 2004). Raw scores on the PLS-5 range from 0 to 67.

Child moderators. Object interest and interfering behaviors were assessed at pretest and were tested as potential moderators of treatment based on their theoretical importance to language learning in children with ASD.

Object interest. Object interest was coded from the Structured Play assessment (SPA; Ungerer & Sigman, 1981). The SPA is a brief assessment of children's most frequent and most complex play during exposure to five age-appropriate toy sets: puzzles, a tea set, self-grooming toys, dollhouse furniture and dolls, and a barn set. Each toy set was presented for 3-5 minutes to provide children opportunities to interact and play with the toys in a variety of ways. The examiner presented each toy set and invited children to play with the toys but did not model play acts. The total number of different functional play acts was coded. A functional play act was defined as play that is not classified as "indiscriminate" play based on the play levels identified by Ungerer and Sigman (1981). Thus, actions such as mouthing, throwing, and banging toys are not coded as functional play; actions such rolling a ball, pretending to drink from a cup, or

stacking blocks are coded as functional play.

Interfering behaviors. Interfering behaviors were coded from a second naturalistic language sample (NLS2). This language sample was identical in administration to the first language sample used to measure social communication with an unfamiliar partner but occurred on a different day (within two weeks of the first sample). Using a separate sample avoided issues of shared variance possible when two different behaviors are measured from the same observation.

A direct observational coding system was developed to measure three types of interfering behaviors: escape behaviors, aggressive behaviors, and repetitive behaviors. The coding system used Procoder (Tapp & Walden, 2003) to measure the total percent of intervals in which one of the behaviors of interest was observed. Behaviors were not mutually exclusive; more than one behavior could be coded for each 5-second interval. All three types of behaviors were coded during a single pass through; coders watched each interval a maximum of three times. Escape behaviors were coded as the total percent of intervals in which the child engaged in wandering, turning away from the testing materials, or laying down on the floor or table. Aggressive behaviors were coded as the percent of intervals in which the child engaged in screaming, crying, throwing toys, or aggression toward the self, an object, or another person in the testing room. Repetitive motor behaviors including repetitive stereotypic hand movements and body rocking. Operational definitions are provided in Appendix K.

Child mediators. Joint attention, receptive language, and verbal imitation were assessed at pre and posttest as potential mediators of social communication outcomes.

IJA. IJA was used as a putative mediator in this study because it was specifically targeted in the DTT curriculum. As described above, IJA was coded from the ESCS (Mundy et al., 2003)

administered at posttest. IJA was defined as eye contact, alternating eye contact, pointing toward an object, or showing an object to another person for the purpose of sharing or drawing attention. IJA was coded at frequency of initiations during the structured assessment; these acts were not prompted or imitated.

Receptive language. Receptive language was measured from the auditory comprehension subscale of PLS-5 (Zimmerman, et al., 2011). Raw scores were used in the analysis as recommended by Yoder and Compton (2004). The range of possible raw scores on the PLS-auditory subscale is 0 to 65.

Verbal imitation. Children's ability to verbally imitate was measured as the number of attempted verbal imitations of words produced during the Profiles of Early Expressive Phonology (PEEPS; Stoel-Gammon & Williams, 2013). The number of attempted verbal imitations was used as a measure of willingness to imitate rather than a measure of ability to imitate. An attempted imitation was considered any verbal response that included at least one consonant and one vowel sound of the modeled word. All coding of imitation was completed by a speech language pathologist.

Additional child variables. Additional measures administered at pretest were examined to describe other child characteristics. Child participants were evaluated for symptoms of autism severity using the ADOS-2 (Lord, et al., 2008), for cognitive ability based on the Early Learning Composite of the Mullen Scales of Early Learning (Mullen, 1995), and for caregiver–reported vocabulary using the MacArthur Bates Communication Development Inventory (MCDI; Fenson et al., 1993). Demographic information about the children and their families including socioeconomic status (SES) and participation in therapies in the community were obtained from a questionnaire (See Appendix L). The community therapies and intervention questionnaire

included the number of hours per week each child received outside therapies including speech, occupational therapy, behavioral therapies, and sensory-based therapies, the number of hours per week each child attended school or childcare programs, and each child's participation in dietary or medical therapies (e.g. medications, elimination diets, vitamin supplements).

2.9 Coding and Inter-Observer Agreement

All variables were coded by trained individuals blind to the participants' group assignment. Inter-observer agreement (IOA) for the observational assessments was completed by having a second, independent coder score the video recorded measures for 20-33% of the assessments distributed across time points (pre, post, follow-up) and group assignment. Intraclass correlation coefficients were calculated for the ESCS as suggested by the coding manual (Mundy, 2003) and consistent with the published literature. All other reliabilities were calculated using point-by-point agreement. IOA was calculated as the total agreements divided by the sum of agreements and disagreements. IOA for each measure is reported in Table 5.

2.10 Analysis

Data cleaning and transformations. Prior to beginning the proposed analyses, scores for each variable were examined for outliers and non-normal distributions. Outlying scores were verified for accuracy. Data that were non-normally distributed were transformed to adjust for normality. All variables that did not have a skew between -1 and 1 and a kurtosis between -2 and 2 were transformed using square roots prior to imputation so that all variables fell within this acceptable range of normality (George & Mallery, 2010). All proposed baseline covariates were examined using a correlation matrix. Correlations between variables were closely examined. None of the proposed moderators, mediators, or covariates had a correlation greater that r=0.90, thus mitigating the concern of collinearity.

Multiple imputation for missingness. Multiple imputation of missing data was used to complete the proposed intent-to-treat analysis so that all participants who completed the screening assessments (Mullen, ADOS, and NLS) were analyzed regardless of their completion of posttest and follow-up assessments. SPSS was used to impute missing values. Fully conditional specification using an iterative Markov chain Monte Carlo method with 10 iterations was used. This model uses regressions analyses to predict missing values using all other possible variables in the model as predictors. In addition to the independent variable, dependent variables, putative mediating and moderating variables, and covariates, additional auxiliary variables were included to increase the precision of imputation (White et al., 2011), including gender, Repetitive Behavior Scales total score (Bodfish, Symons, & Lewis, 1999), and the Mullen Scales of Early Learning total raw score (Mullen, 1995). Control and intervention groups were imputed separately. Given the range of missing data for each variable of interest (0%-21%), 20 imputations were created as recommended (Graham, Olchowski, & Gilreath, 2007). Once the multiply imputed data set was created, all analyses were completed on each of the 20 imputed data sets, and inferences were based off of the pooled results using Rubin's Rules (Rubin, 1987). The percentage of missingness by variable is shown in Table 6.

Base models. Base models for each of the dependent variables were used for this analysis to align the results to the main effects (Hampton, Fuller, & Kaiser, in progress). Base models used a model building approach to test the model fit of four possible covariates (age, autism severity, nonverbal IQ, and pretest scores of the dependent variable), identified *a priori.* Covariates were included in the order listed. Across the four dependent variables of interest, the inclusion of autism severity and pretest scores resulted in improved model fit, as measured by increases in R^2 and a significant change in the F statistic. Autism severity and pretest score of the

dependent variable were maintained in all of the following models as covariates.

Objective 1. The purpose of Objective 1 was to examine how child pretreatment characteristics moderated child language outcomes post treatment using a multiple regression moderation analysis (Aiken & West, 1991). Multiple regression analyses were used to examine the putative moderators across the four measures of language and communication. Moderators were examined using an interaction term of each identified child characteristic and group assignment. By including an interaction term of the child pretest characteristic and the group assignment, the potential differential effect of the treatment and control groups for children with different levels of the identified characteristics at pretest could be examined. This approach differs from an analysis of predictors of language and communication growth, which does not account for changes that are occurring that are not related to the intervention (e.g., history effects; Shaddish, et al., 2002). For significant interaction terms, the Johnson–Neyman method (Aiken & West, 1991) was used to determine areas of significance. This method identified the bounds of the moderating variable that are significant. Preacher, Curran, and Bauer's (2006) online tool was used to identify and visualize regions of significance. Separate models were fit for each proposed moderator across the four communication outcomes. All analyses were conducted using SPSS for Mac (IBM, 2011). The moderation model is shown in Figure 3.

Objective 2. Objective 2 assessed whether child skills at the posttest mediated child language outcomes at the four-month follow-up using mediation analyses (Hayes, 2009). Group assignment was measured at pretest. The three putative mediators of treatment (joint attention, receptive language, and verbal imitation) were measured at posttest immediately following the intervention period. The dependent variables of child communication were measured at the 4-month follow-up time point. Using the posttest and follow-up timepoints allow for the temporal

precedence necessary for a mediation analysis. The statistical testing of the indirect effects allows for understanding if the relationship between group assignment and later language abilities is mediated by changes in foundational skills as a result of the intervention (Hayes, 2009). The two indirect effects tested were (a) the relation between group assignment and foundational skills at posttest and (b) the relation between the foundational skills at posttest and child social communication at follow-up while controlling for group assignment. The product of coefficients of these two indirect effects were used to measure the indirect effect and test for a mediation effect. The program PRODCLIN was used to compute confidence intervals of the indirect effects. A 95% confidence interval that does not include zero was considered indicative of a significant mediator. PRODCLIN was selected over other estimations of the indirect effect because of its ability to calculate confidence intervals based on the asymmetrical distribution of the product term. Asymmetric confidence intervals are more exact compared to estimations based on normal distributions and, thus, are more powerful and have more accurate Type 1 error rates (MacKinnon, Fritz, William, & Lockwood, 2007). This method was selected because it requires a low number of participants to achieve the highest power, relative to other tests of mediation effects (Fritz & MacKinnon, 2007). A figure of the mediation model is shown in Figure 4.

CHAPTER 3

RESULTS

Means and standard deviations of all observed covariates, moderators, mediators, and outcome variables are shown in Table 7. Independent sample t-tests indicated no significant between-group differences at baseline for any included variables. Imputed and norm-transformed means for all observed covariates, moderators, mediators, and outcome variables are shown in Table 8. All of the following analyses used imputed data.

3.1 Main Effects

The full main effects are reported in Hampton, et al., (in preparation) and are included here, for reference. There was a significant effect of group assignment on IJA at posttest (β=0.644, SE=0.270 p=0.017); group assignment predicted an increase in the number of initiations of joint attention immediately following the intervention when controlling for autism severity and pretest IJA. On average, group assignment predicted increases in SCU-CCX (β=0.631, SE=0.355, p=0.076), SCU-NLS (β=0.288, SE=0.429, p=0.502), and PLS-Expressive (β=1.434, SE=0.760, p=0.059), but these increases were not significant. At the follow-up timepoint, group assignment significantly predicted an increase in SCU-CCX of 0.838 utterances (SE=425, p=.049). However, there were no significant between-group differences on IJA (β=0.203, SE=0.259, p=0.432), SCU-NLS (β=0.211, SE=0.505, p=0.418), or PLS-Expressive (β=-0.447, SE=0.864, p=0.605) at follow-up. Main effects models for posttest and follow-up are shown in Table 9 and Table 10.

3.2 Objective 1

Correlations (Pearson's r) for all proposed covariates, putative moderators, and pre and posttest values of the dependent variables are presented in Table 11.

Object interest. To test the hypothesis that object interest moderated response to intervention, separate linear regression analyses were completed for the four dependent communication variables of interest. Object interest significantly moderated the effect of group assignment on IJA, such that children in the intervention group who had lower object interest at pretest had significantly more initiations of joint attention at posttest (β=-0.053, SE=0.022, p=0.016). When controlling for the moderated effect of object interest, there was a significant main effect of group assignment such that children assigned to the intervention group had significantly more initiations of joint attention at posttest (β=1.655, SE=0.479, p=0.001). There was not an observed direct effect of object interest on IJA (β=0.006, SE=0.017, p=0.716). The Johnson–Neyman method (Aiken & West, 1991) was used to test for regions of significance; object interest had a significant moderated effect when object interest was below 20.798 and above 162.254. In this sample, the range of scores for object interest was 0 to 58, with 44 of the 68 children having a score below 20.798. Thus, there was a significant moderated effect of object interest on IJA for 65% of the observed sample, or for children who engaged in 20 or fewer toy-based play behaviors in a 15-minute observation. Figures 5 and 6 show the interaction and regions of significance. The significant interactions were not observed for the remaining measures of communication: object interest did not significantly moderate SCU-CCX (β=-0.001, SE=0.034, p=0.974), SCU- NLS (β=0.003, SE=0.039, p=0.937), or PLS-Expressive (β=0.012, SE=0.071, p=0.860). Full results are shown in Table 12.

Escape behaviors. To test the hypothesis that escape behaviors moderated response to intervention, separate linear regression analyses were completed for the four dependent communication variables of interest. Escape behaviors significantly moderated the effect of group assignment on IJA; children in the intervention group who had more escape behaviors at

pretest had significantly more initiations of joint attention at posttest (β=0.320, SE=0.129, p=0.013). When controlling for the moderated effect of escape behaviors, there was not a direct effect of escape behaviors on IJA (β=-0.057, SE=0.102, p=0.578) or a significant effect of group assignment on posttest IJA (β=-0.066, SE=0.388, p=0.865). The Johnson–Neyman method (Aiken & West, 1991) was used to test for regions of significance; escape behaviors had a significant moderated effect when escape behaviors above 2.099 (or children who engaged in problem behavior in more than 4.40% of observed intervals). This region of significance included 43% of the observed sample (29 of the 68 participants), specifically those participants who were observed to have high levels of escape behaviors. Figures 7 and 8 show the interactions and regions of significance. There were no observed moderated effects of escape behaviors on the remaining measures of communication: escape behaviors did not significantly moderate SCU-CCX (β=0.017, SE=0.19,1 p=0.927), SCU-NLS (β=-0.107, SE=0.229, p=0.640), or PLS-Expressive (β=0.019, SE=0.400, p=0.962). Full results are in Table 13.

Aggressive behaviors. To test the hypothesis that aggressive behaviors moderated response to intervention, separate linear regression analyses were completed for the four dependent communication variables of interest. There were no significant moderated effects of aggressive behaviors for any of the four measures of communication: IJA (β=-0.001, SE=0.129, p=0.997), SCU-CCX (β=0.227, SE=0.264, p=0.391), SCU-NLS (β=0.106, SE=0.317 p=0.739), PLS-Expressive (β=0.139, SE=0.593, p=0.814). Complete results for the moderation analyses are in Table 14.

Repetitive behaviors. To test the hypothesis that repetitive behaviors moderated response to intervention, separate linear regression analyses were completed for the four dependent communication variables of interest. There were no significant moderated effects of

repetitive behaviors for any of the four measures of communication: IJA (β=-0.006, SE=0.221, p=0.979), SCU-CCX (β=0.087, SE=0.087, p=0.762), SCU-NLS (β=-0.049, SE=0.359, p=0.891), PLS-Expressive (β=0.731, SE=0.632, p=0.248). Full results are in Table 15.

3.3 Objective 2.

Correlations (Pearson's *r*) of all proposed covariates, putative posttest mediators, and follow-up values of the dependent variables are presented in Table 16.

Receptive language. Posttest receptive language raw scores on the PLS were examined as a putative mediator of treatment effects on communication outcomes four months following the end of the intervention. Separate mediation models were analyzed for each of the four dependent variables. For SCU-CCX outcomes, when controlling for ASD severity and pretest score of the dependent variable, study group predicted a significant increase in receptive language at posttest (β=2.239, SE=1.060, p=0.035) and posttest scores of receptive language predicted a significant increase in SCU-CCX at follow-up (β=0.112, SE=0.050, p=0.025). There was not an observed mediation effect of receptive language on SCU-CCX, as indicated by a confidence interval that includes zero (CI: -0.005, 0.650). For SCU-NLS, group assignment did not predict receptive language at posttest (β=1.700, SE=1.186, p=0.152), but receptive language did significantly predict SCU-NLS at follow-up (β=0.201, SE=0.049, p<0.01). There was not an observed mediated effect of receptive language on SCU-NLS (CI: -0.112, 0.902). The same pattern was observed for PLS-Expressive; group assignment did not predict posttest receptive language (β=1.949, SE=1.070, p=0.069), but receptive language was significantly related to follow-up PLS-Expressive (β=0.381, SE=0.094, p<0.001). There was not an observed mediation effect (CI: -0.052, 1.744). For the IJA outcome variable, both the relationship between group and posttest receptive language (β=2.013, SE=1.264, p=0.111) and the relationship between

receptive language and follow-up IJA (β=0.014, SE=0.025, p=0.577) were non-significant and there was not a mediated effect (CI: -0.053, 1.744). Full results are in Table 17.

Joint attention. Posttest initiations of joint attention during the ESCS were examined as putative mediators of treatment on communication outcomes four months after the end of the intervention. Separate mediation models were analyzed for each of the four dependent variables. For SCU-CCX, study group predicted a significant increase in IJA at posttest (β=0.683, SE=0.262, p=0.009), but posttest scores of IJA did not predict a significant increase in SCU-CCX at follow-up (β=-0.196, SE=0.22, p=0.379). There was no observed mediation effect of IJA on SCU-CCX, as indicated by a confidence interval that included zero (CI: -0.517, 0.168). For SCU-NLS, group assignment significantly predicted IJA at posttest (β=0.662, SE=0.265, p=0.012), but IJA did not significantly predict SCU-NLS at follow-up (β=0.040, SE=0.260, p=0.154). There was not an observed mediated effect of IJA on SCU-NLS (CI: -0.349, 0.419). The same pattern was observed for the PLS-Expressive outcome variable, such that group assignment significantly predicted posttest IJA (β=0.677, SE=0.263, p=0.010), but posttest IJA did not significantly predict PLS-Expressive scores at follow-up (β=0.311, SE=0.477, p=0.515). There was not a mediated effect (CI: -0.449, 1.002). For the posttest outcome of IJA, group assignment significantly predicted posttest IJA (β=0.644, SE=0.270, p=0.048), and posttest IJA was significantly related to follow-up IJA (β=0.272, SE=0.124, p=0.029). There was a significant mediation effect, as observed by a confidence interval that does not contain zero (CI: 0.002, 0.438). Full results are in Table 18.

Verbal imitation. Posttest verbal imitation scores were examined as putative mediators of treatment on communication outcomes four months after the end of the intervention. Separate mediation models were analyzed for each of the four dependent variables. For SCU-CCX

outcomes, study group was not significantly related to verbal imitation at posttest (β=-1.184, SE=5.980, p=0.843) and verbal imitation at posttest was not significantly related to SCU-CCX at follow-up (β=0.007, SE=0.009, p=0.434). There was not an observed mediated effect (CI: -0.168, 0.131). For SCU-NLS, when controlling for pretest, group assignment did not predict verbal imitation at posttest (β=-5.337, SE=6.155, p=0.386), but verbal imitation did significantly predict SCU-NLS at follow-up (β=0.034, SE=0.009, p<0.001). There was not an observed mediated effect of verbal imitation on SCU-NLS (CI: -0.655, 0.231). For the outcome of IJA, group assignment did not predict posttest verbal imitation (β=-1.497, SE=7.016, p=0.831), and verbal imitation was not related to follow-up IJA (β=0.003, SE=0.004, p=0.549). There was not an observed mediation effect (CI: -0.087, 0.067). For the PLS-Expressive outcome variable, there was not a significant relationship between group assignment and posttest verbal imitation (β=-2.988, SE=5.618, p=0.595), but there was a significant relationship posttest verbal imitation and follow-up PLS-Expressive (β=0.066, 0.017, p<0.001). There was not a mediated effect (CI: -1.005, 0.546). Full results are in Table 19.

Summary. In sum, object interest and escape behaviors significantly moderated IJA at posttest. The remaining outcome measures (SCU-CCX, SCU-NLS, PLS-Expressive) were not significantly moderated by any of the tested moderators (object interest, escape behaviors, aggressive behaviors, or repetitive behaviors). IJA at posttest significantly mediated the relationship between group assignment and IJA at follow-up. The remaining outcome measures were not significantly mediated by any of the tested mediators (IJA, receptive language, verbal imitation).

CHAPTER 4

DISCUSSION

The purpose of this study was twofold: the first objective was to examine child characteristics that moderated response to an adaptive, blended communication intervention; the second objective was to understand if intermediate changes in foundational skills mediated longer term communication outcomes.

4.1 Moderation Effect

The results of the moderation regression analyses indicated that two behaviors moderated the treatment outcome of joint attention. Object interest significantly moderated IJA, such that children with lower object interest who were randomly assigned to the intervention group had more joint attention behaviors at posttest than children assigned to the control group. Given the regions of significance, this finding is significant for children who had 20 or fewer play actions in a 15-minute observation. This finding is consistent with previous findings (Yoder & Stone, 2006b) and suggests that children who have low interest in toys may benefit more from an intervention that teaches language and toy play using naturalistic strategies than children with higher object interest at the beginning of the intervention. Possibly, children who have greater object interest and engage in play with toys may already be benefiting from engagement in their natural environment and this does not change as a result of a play-based intervention.

Escape behaviors also moderated joint attention as a treatment outcome. Although escape behaviors in the total sample were negatively associated with posttest joint attention, children with more frequent escape behaviors assigned to the intervention group had significantly more joint attention behaviors at posttest compared to children in the control group. This finding suggests that the intervention may have reduced escape behaviors in children with initially

higher levels of these behaviors and, thus, may have increased their engagement with the environment. Based on examining the regions of significance, this moderating effect was significant for children who were engaging in problem behavior in more than 4.4% of the observed intervals. Escape behaviors may be especially important in considering dosage as received. Children with higher levels of escape behaviors may be receiving less linguistic input during the intervention because they spend less time in proximity to people and the intervention strategies being used. The intervention may have decreased escape and increased engagement by teaching children to: 1) attend to and engage with partners and learning tasks during the DTT programs, and 2) engage in play with partners during the therapist and caregiver implemented J-EMT component. Teaching attending, engagement, and play skills may have reduced escape behaviors in children with initially high levels of these behaviors, thus increasing their access to language learning opportunities.

It is important to note that moderated effects were observed for only one of the four communication outcomes measured in this study. Of the four outcome measures, joint attention showed the largest between-group effect size (Cohen's $d = 0.341$.) Significant increases in joint attention likely occurred for three reasons. First, the protocol used to assess joint attention (the ESCS) was relatively structured and provided discrete opportunities for children to demonstrate joint attention skills compared to the less structured naturalistic communication samples (CCX and NLS) which did not provide discrete opportunities. Structured measures, in general, are more stable measures of communication because these types of protocols reduce the presence of extraneous variables and offer more discrete opportunities for the behaviors of interest (Yoder & Symons, 2010). The effect of discrete opportunities to respond may be especially important for children with ASD, who have difficulty initiating communication. The ESCS provides a context

with clearer opportunities to communicate compared to the less structured measures (NLS and CCX), potentially making it more likely that children will exhibit initiated joint attention if they have this skill. Roos, McDuffie, Weismer, and Gernsbacher (2009) reported that children demonstrated three times as much initiated joint attention during the ESCS than they demonstrated during an unstructured language sample. In this sample, the two structured measures (ESCS and PLS) showed the least variability compared to the less structured measures (NLS and CCX). Second, joint attention behaviors were specifically taught in both the DTT and the J-EMT components of the intervention. Because the ESCS measures IJA in a way that overlaps with the behaviors that were taught in the DTT component of the intervention, the ESCS is a proximal measure. Third, joint attention is a skill that typically develops before verbal communication. For children with emerging communication skills, it is likely that changes in joint attention will occur before observable changes in spoken language and higher level social communication. All of the participants who were assigned to the intervention group initially qualified for joint attention DTT programming, indicating that none of the participants included in the intervention group had joint attention skills that were typically developing. Additionally, forty-four of the included 68 children had fewer than 10 unprompted verbal utterances in a 20-minute language sample. For 23 of the 68 participants, their caregiver reported on the MCDI that their child spoke fewer than 10 different words throughout the day. The current study targeted children who were low-rate verbal communicators with delays in joint attention behaviors. Joint attention was significantly correlated with PLS-Expressive and SCU-NLS at pretest. Therefore, specifically targeting preverbal skills as a part of this intervention was appropriate. The findings of the moderation analyses show that children with the largest skill deficits in object interest and engagement made larger improvements on this measure of preverbal communication. It may be

that these children are not yet making changes on measures of more complex communication skills. It is logical then that the children who began the intervention with the largest skill deficits tended to benefit the most from specific teaching in this early communication skill.

Aggression and repetitive behaviors did not moderate the effects of intervention. These two behaviors were hypothesized to act in a similar manner to escape behaviors in that these types of behaviors were likely to reduce the amount of time the child was actively engaged with a communication partner. However, this hypothesis was not supported in this sample. There were relatively low rates of aggressive behaviors observed during the assessments (an average of 4.0% of intervals, range 0-40.8%). Further, because this construct included both verbal aggression (e.g. screaming, crying) and physical aggression (e.g. hitting, biting, kicking), it may be that these behaviors were functionally different behaviors. However, given the low rates of aggressive behaviors, further dividing these behaviors for this analysis would be problematic.

The finding that repetitive motor movements did not moderate treatment outcomes is consistent with the mixed findings about the relationship between language and repetitive motor movement in the literature (Bopp et al., 2009, Lam et al., 2008). In the current study, the correlations between repetitive behaviors and the four communication outcome measures were very low ranging from -0.173 to 0.116 and did not show a consistent pattern. The role that repetitive behaviors play in early interventions remains unclear.

4.2 Mediation Effect

Joint attention at posttest significantly mediated changes in joint attention at follow-up. Changes in joint attention skills in response to group assignment at the posttest predicted long-term changes on the same measure at follow-up. This finding is not surprising because joint attention was targeted in both the DTT and J-EMT components intervention and was the

outcome variable with the largest observed effects. Joint attention was not a significant mediator of the other communication outcomes (SCU-NLS, SCU-CCX, PLS-Expressive). Receptive language and verbal imitation at the posttest did not mediate communication outcomes at follow up, but these measures were correlated with follow-up outcome measures. These findings suggest that, while these putative mediators are likely related to long-term language and communication outcomes, as indicated both by the significant correlations in the current study and by the literature (Paul et al., 2008; Luyster, et al., 2007; Mundy, et al., 1990; Sigman & Ruskin, 1999; Charman, 2003; Yoder & Layton, 1988; Gernsbacher, 2008), the intervention did not result in large enough changes in the mediating variables to influence long-term communication outcomes. Although previous studies have examined mediating variables of early communication interventions for young children with ASD, these studies have predominantly examined the mediating effects of parent behaviors on response to intervention (Gulsrud, Hellemann, Shire, & Kasari, 2016; Aldred, Green, Emsley, & McConachie, 2012). Understanding the relationship between changes in children's foundational skills in response to intervention and long-term communication outcomes is an important area of research to understand the underlying mechanisms of change within interventions. Many intervention components are based on assumptions from developmental and correlational studies; the next step it to directly study these underlying mechanisms of change to understand how intervention components and intervention targets are affecting long-term outcomes.

4.3 Limitations

The three major limitations of this analysis were measurement, dosage, and variability. The issue of measurement, discussed above, is relevant to many studies in this population. Across the literature, there is a consistent observed effect where studies of early interventions for

the ASD population show larger effects on measures that are context bound and proximal (Yoder, et al., 2014; Fuller & Kaiser, submitted). In the current study, a similar pattern of effects was observed: the largest effect sizes were observed using a measure that was relatively more structured and more similar in structure to teaching trials employed in the DTT curriculum (i.e., IJA measured in the ESCS). In order to fully understand changes in IJA in response to intervention, it would be necessary to measure IJA across contexts. A second issue related to measurement is in the CCX. Because the caregivers in the intervention group were trained in J-EMT strategies, this measurement is subject to correlated measurement error. It cannot be determined if child changes in this measure were due to increases in communication as a result of the intervention or due to the caregivers providing different support in the measurement context following training in J-EMT strategies. Rather, the CCX measures the dyadic behavior changes of the caregiver-child pair in response to intervention.

Dosage was a major limitation of this study, particularly in the case of the mediation analysis. In order to detect a significant mediation effect, relatively large effect sizes for the mediating variables and the dependent variables are needed. In the current study, small effect sizes were observed across the putative mediators and outcome measures. PRODCLIN was chosen as the analysis approach for detecting a mediation effect because it allows for the highest power with the lowest sample sizes, relative to most other approaches. However, even with this approach, to detect a mediation effect with 68 participants, at least medium effect sizes (0.39) are required for both the *a* path (the independent variable predicting the mediating variable) and *b* path (the mediating variable predicting the dependent variable while controlling for the independent variable) (Fritz & McKinnon, 2007). The small effect sizes for the mediating variables observed in this study may be in part due to limited dosage of the DTT intervention,

which was designed to specifically target these skills at a higher rate. Each child in the intervention group received up to two 20-minuted DTT sessions per week, or a total of 10-minutes per week for each identified program (receptive language, imitation, joint attention, and SGD use). This is an extremely low dosage, particularly for children who are particularly delayed in these skills. Further, the intervention dosage of the whole intervention (J-EMT and DTT) was approximately 3 hours per week. The American Academy of Pediatrics Council on Children with Disabilities recommends a minimum of 25 hours per week in ASD related interventions (Myers & Johnson, 2007). It is clear that this was not an adequate amount of intervention to make meaningful improvements in this population that was specifically selected for having the lowest verbal abilities. It is likely that a much higher dosage is needed to detect mediation effect.

The variability in this relatively small sample was an important limitation. High variability widens confidence intervals and reduces statistical power, thus making it less likely to detect statistically significant differences between groups in both mediation and moderation analyses. The population of minimally or preverbal children with ASD in this study was extremely variable. Across all measures for both the control and intervention groups, there were wide ranges in the observed scores. Although the children in the study were similar in their low rates of spoken language at entry, they varied widely in other communication-related skills, including receptive language, object interest, nonverbal IQ, and verbal imitation abilities. Participants also varied in terms of the number of hours of community services they were receiving during the study (0-38 hours), although there was not a significant difference between groups. The observed variability in this sample was greater than the variability observed in previous studies of older minimally verbal children with ASD on which power analyses for the

current study were based (Kasari et al., 2014). To fully explore the effects of intervention and to test moderators and mediators of intervention with this highly variable population, larger sample sizes are necessary.

4.4 Implications

Implications for research. Future research should examine if a higher dosage, multi-component intervention can result in greater changes in communication for preverbal children with ASD. This would include measuring child communication outcomes at more distal time points to understand if higher-dosage interventions are related to the verbal communication of children at age five. This is important to understand if the goal of reducing the prevalence of children with ASD who remain persistently minimally verbal is being accomplished (Department of Health and Human Services, 2004). The findings of the current study could inform the development and testing of a decision-making framework for early intervention targets, including establishing characteristics of children who would be more likely to respond to multi-component, blended interventions. Given the significant moderated effects observed for object interest and escape behaviors in this sample, understanding how these behaviors change in response to intervention should be explored in order to fully understand how the intervention affected these skills and potentially mediated long-term communication skills. Further, in the current study, the putative mediators were associated with most long-term communication outcomes, but these mediating variables were not improved enough as a result of intervention to mediate outcomes at follow-up. Additional research should focus on determining the levels of behavior change needed during naturalistic intervention to mediate long-term communication outcomes and how these levels can be achieved.

Implications for practitioners. Understanding more about how and for whom

interventions are effective may allow practitioners to improve treatment plans to effectively address the social communication deficits associated with ASD. The results of this analysis identified that this intervention was more effective for increasing joint attention behaviors in children with lower object interest and higher escape behaviors. This is an important finding because it indicates that intervention can be effective in improving joint attention in children with ASD who lack critical engagement skills (i.e. low object interest and high escape behaviors) at the entry to treatment. This is a promising finding as it suggests that a multi-component, blended intervention may be effective for treating the sub-population of minimally verbal children who have the largest skill deficits in early communication and related skills.

Summary and Conclusions

Object interest and the frequency of escape behaviors moderated the effects of intervention on initiating joint attention, such that children with lower frequency play behaviors and higher frequency escape behaviors at pretest who were randomly assigned to the intervention group demonstrated significantly more initiations of joint attention at posttest. This finding is important because it shows that children with ASD who exhibited low rates of object interest or high rates of escape behaviors benefited from a multi-component, blended intervention. Future research should continue to build on this finding in order to understand better the underlying mechanisms of change in response to communication intervention. Developing a better understanding of how and for whom these interventions are effective would assist practitioners in formulating and delivering systematic and individualized treatment plans which ultimately could improve communication outcomes for minimally verbal children with ASD.

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Table 1

Child Characteristics

	Control (n=34)	Intervention (n=34)
Percent male	80%	70%
Percent white	65%	64%
Age at entry (months)	42.94 (5.51)	43.18 (4.96)
Mullen visual reception subscale	26.53 (3.87)	26.21 (3.092)
ADOS total score	19.59 (4.78)	21.06 (4.85)
Caregiver education level		
High school degree or less	12%	8%
Some college	9%	26%
College degree	54%	47%
Graduate or professional	24%	17%
Percent low income	18%	18%

Note. Cognitive score measured from the Mullen visual reception subscale (Mullen, 1995), Autism Severity measured from the ADOS (Lord et al., 2008). Low income was defined as a household income falling below 200% of the income to needs ratio specified by the Federal Poverty Line during the year of entry into the study. There were no significant differences between groups on any baseline variables.

Table 2

Fidelity of Assessments and Intervention Sessions.

Session type	Percent Correct	SD	Range
Assessments			
NLS	97.27%	3.20	80.10 – 100%
SPA	97.27%	4.11	82.21 – 100%
ESCS	93.30%	4.01	80.43 – 100%
Intervention components			
Therapist use of J-EMT	89.45	14.27	58.33-100%
Caregiver training	86.31	9.49	60.00-100%
Home routines	78.21	21.12	33.33-100%
DTT	96.63	9.93	81.82-100%
Overall intervention session fidelity by intervention type			
Clinic sessions	90.80%	4.79	77.73-98.81%
Home sessions	82.52%	9.00	61.85-98.33%

Note. NLS: Naturalistic language sample. SPA: Structured Play Assessment (Ungerer & Sigman, 1981), ESCS: Early Social Communication Scales (Mundy, 2003). Fidelity percentages are based off of rating scales with different numbers of items. Home routines is based off of 5 items on the fidelity checklist, and thus was subject to more extreme scores. See Appendices F (clinic fidelity sessions) and G (home fidelity sessions).

Table 3

J-EMT Strategies and Corresponding Workshops When Strategies Were Taught to Caregivers

Strategies addressed	Workshop number	Session number
Environmental arrangement	Workshop 1	1
Noticing and responding to communication		
Mirroring and mapping		
Target-level language		
Engagement strategies		
Play levels		
Joint attention and gestures	Workshop 2	12-18
Expanding play and routines		
Expanding communication		
Time delays	Workshop 3	24-30
Milieu prompting		

Note. The therapist used all strategies during all sessions, but coached caregivers in strategies specific to the workshop for each phase.

Table 4.

Variables, Constructs, and Assessments

Variable type	Construct (Variable name)	Assessment	Pretest	Posttest	Follow Up
Dependent variables	Socially communicative utterances with a caregiver (SCU-CCX)	Number of socially communicative utterances during the 10-minute CCX		Objective 1	Objective 2
	Socially communicative utterances with an unfamiliar partner (SCU-NLS)	Number of socially communicative utterances during the 20-minute NLS		Objective 1	Objective 2
	Initiations of joint attention (IJA)	Number of initiations of joint attention during ESCS		Objective 1	Objective 2
	Global expressive language score (PLS-Expressive)	Expressive language subscale of the PLS-5		Objective 1	Objective 2
Moderators	Object interest	Number of play acts during the SPA	Objective 1		
	Interfering behaviors (escape, aggressive, and repetitive behaviors)	Percent of intervals with interfering behaviors during the second NLS	Objective 1		
Mediators	Initiations of joint attention (IJA)	Number of initiations of joint attention during the ESCS		Objective 2	
	Receptive language	Auditory Comprehension subscale of the PLS-5		Objective 2	
	Verbal imitation	Number of attempted verbal imitations during the PEEPS		Objective 2	

Note. SCU: Social communicative utterances. CCX: Caregiver-child interaction. NLS: Naturalistic language sample. IJA: Initiations of joint attention. ESCS: Early Social Communication Scales (Mundy, 2003). PLS-5: Preschool Language Scales (Zimmerman et al., 2011). SPA: Structured Play Assessment (Ungerer & Sigman, 1981). PEEPS: Profiles of Early Expressive Phonology (Stoel-Gammon & Williams, 2013).

Table 5

Inter-Observer Agreement

Measure	Percent agreement	SD	Range	Percent of observations measured
SCU-CCX	89.21%	7.01	73.0%-100%	21.00%
SCU-NLS	91.00%	5.12	71.1-100%	20.00%
ESCS IJA	0.903		CI: (0.83-0.94)	28.17%
Object interest	86.26%	17.90	67.0-100%	34.32%
Escape behaviors	97.38%	3.69	87.5-100%	31.34%
Aggressive behaviors	99.26%	0.93	97.0-100%	31.34%
Repetitive behaviors	96.25%	3.40	85.4-100%	31.34%

Note. IJA: Initiations of joint attention. SCU: Social communicative utterances. CCX: Caregiver-child interaction. NLS: Naturalistic language sample. IJA: Initiations of joint attention. ESCS: Early Social Communication Scales (Mundy, 2003).

Table 6

Percent of Complete Observations for Each Assessment

	Control	Intervention
Covariates		
Age at entry (months)	100%	100%
Mullen	100%	100%
Autism severity (ADOS)	100%	100%
Moderating Variables		
Object interest	100%	97%
Repetitive behaviors	100%	97%
Aggressive behaviors	100%	97%
Escape behaviors	100%	97%
Mediating Variables		
Receptive language	82%	94%
IJA	79%	94%
Verbal imitations	82%	94%
Pretest Outcome Variables		
SCU-NLS	100%	100%
SCU-CCX	100%	100%
IJA	100%	100%
PLS-Expressive	100%	97%
Posttest Outcome Variables		
SCU-NLS	88%	94%
SCU-CCX	82%	91%
IJA	79%	94%
Expressive language	82%	94%
Follow-Up Outcome Variables		
SCU-NLS	70%	94%
SCU-CCX	61%	94%
IJA	70%	88%
PLS-Expressive	70%	91%

Note. Mullen: Mullen Scales of Early Learning (Mullen, 1995). Autism Diagnostic Observation Schedule: ADOS (Lord et al., 2008). IJA: Initiations of joint attention. SCU: Social communicative utterances. CCX: Caregiver-child interaction. NLS: Naturalistic language sample. IJA: Initiations of joint attention. ESCS: Early Social Communication Scales (Mundy, 2003).

Table 7

Observed Means and Standard Deviations of Covariates, Putative Moderators, Putative Mediators, and Communication Outcomes.

		Pretest		Posttest		Follow Up	
		Control	Intervention	Control	Intervention	Control	Intervention
Proposed covariates	Age at entry (months)	42.94 (5.51)	43.18 (4.96)				
	Mullen visual reception	26.53 (3.87)	26.21 (3.09)				
	ADOS	19.59 (4.78)	21.06 (4.85)				
Putative moderators	Object interest	17.65 (11.54)	18.52 (11.62)				
	Escape behaviors	8.30% (12.81)	8.64% (10.56)				
	Aggressive behaviors	4.45% (6.42)	3.56% (7.70)				
	Repetitive behaviors	4.81% (5.41)	6.55% (7.57)				
Putative mediators	Receptive language	22.50 (4.96)	22.91 (5.99)	24.71 (5.74)	25.75 (7.40)		
	IJA	3.34 (4.10)	4.53 (5.50)	4.00 (5.45)	5.63 (3.99)		
	Verbal imitation	48.32 (35.09)	41.32 (30.06)	56.93 (32.02)	51.93 (32.10)		
Communication outcomes	SCU (CCX)	6.91 (9.91)	6.38 (8.97)	8.93 (10.50)	11.35 (12.66)	7.67 (10.01)	11.34 (12.57)
	IJA	3.34 (4.10)	4.53 (5.50)	4.00 (5.45)	5.63 (3.99)	4.96 (3.89)	5.97 (4.96)
	SCU (NLS)	12.26 (13.70)	12.41 (13.84)	22.33 (26.69)	22.53 (23.07)	24.54 (22.18)	27.19 (26.45)
	PLS-Expressive	22.68 (4.78)	22.44 (4.89)	24.57 (5.21)	25.41 (5.31)	27.04 (5.27)	25.97 (5.75)

Note. Mullen visual reception sub-score used raw scores (Mullen, 1995). ADOS (total score): Autism Diagnostic Observation Schedule (Lord et al., 2008). Object interest measured from the Structured Play Assessment (SPA; Ungerer & Sigman, 1981). Escape, aggressive, and repetitive behaviors measured as the percent of intervals observed during a second language sample (NLS2). IJA: Initiations of joint attention measured on the Early Social Communication Scales (Mundy, 2003). SCU: Social communicative utterances. CCX: Caregiver-child interaction. NLS: Naturalistic language sample. PLS: Preschool language Scales, 5th Edition (Zimmerman et al., 2011).

Table 8

Norm Transformed and Imputed Means of Putative Moderators, Putative Mediators, and Communication Outcomes

		Pretest		Posttest		Follow Up	
		Control	Intervention	Control	Intervention	Control	Intervention
Proposed covariates	Age at entry (months)	42.94	43.18				
	Mullen visual reception	26.53	26.21				
	ADOS Total Score	19.59	21.06				
Putative moderators	Object interest	17.65	18.56				
	Escape behaviors*	2.12	2.18				
	Aggressive behaviors*	1.45	1.32				
	Repetitive behaviors*	1.87	2.20				
Putative mediators	Receptive language	22.50	22.88	24.74	25.76		
	IJA*	1.46	1.71	1.60	2.20		
	Verbal imitation	48.32	41.32	56.98	51.94		
Communication outcomes	SCU-CCX*	2.14	1.95	2.37	2.77	2.05	2.77
	SCU-NLS*	2.76	2.95	3.90	4.11	4.40	4.51
	IJA*	1.46	1.71	1.60	2.20	2.05	2.16
	PLS-Expressive	22.68	22.45	24.55	25.42	27.02	25.95

Note. Asterisk (*) indicates square root transformation for normality. Mullen visual reception sub-score used raw scores (Mullen, 1995). ADOS: Autism Diagnostic Observation Schedule (Lord et al., 2008). IJA: Initiations of joint attention. SCU: Social communicative utterances. CCX: Caregiver-child interaction. NLS: Naturalistic language sample. PLS: Preschool language Scales, 5th Edition (Zimmerman et al., 2011).

Table 9

Main Effects at Posttest

	Study group	SE	p-value
SCU-CCX	0.631	0.355	0.076
SCU-NLS	0.288	0.429	0.502
IJA	0.644*	0.270	0.017
PLS-Expressive	1.434	0.760	0.059

Note. All models controlling for ASD severity and pretest score. SCU: Social communicative utterances. CCX: Caregiver-child interaction. NLS: Naturalistic language sample. IJA: Initiations of joint attention. PLS: Preschool language Scales, 5th Edition (Zimmerman et al., 2011).

Table 10

Main Effects at Follow-Up

	Study group	SE	p-value
SCU-CCX	0.838*	0.425	0.049
SCU-NLS	0.211	0.505	0.418
IJA	0.203	0.259	0.432
PLS-Expressive	-0.447	0.864	0.605

Note. All models controlling for ASD severity and pretest score of the variable of interest. SCU: Social communicative utterances. CCX: Caregiver-child interaction. NLS: Naturalistic language sample. IJA: Initiations of joint attention. PLS: Preschool language Scales, 5th Edition (Zimmerman et al., 2011).

Table 11

Correlations of Pretest Covariates, Pretest Putative Moderators, and Pre and Posttest Outcome Variables

		Covariates			Putative moderators				Communication outcomes: pretest				Communication outcomes: posttest			
		ADOS overall	Age	Mullen VR	Object interest	Escape behaviors	Aggressive behaviors	Repetitive behaviors	SCU (CCX)	SCU (NLS)	IJA	PLS Exp	SCU (CCX)	SCU (NLS)	IJA	PLS Exp
Covariates	ADOS overall	1	.111	-.387**	-.488**	.255*	.075	.165	-.386**	-.532**	-.398**	-.467**	-.381**	-.564**	-.212	-.551**
	Age	.111	1	-.106	-.115	.068	.010	.075	-.155	-.032	.159	-.090	.006	-.164	.233	-.151
	Mullen VR	-.387**	-.106	1	.384**	-.135	-.215	-.277*	.343**	.274*	.023	.376**	.131	.236	-.069	.260*
Putative moderators	Object interest	-.488**	-.115	.384**	1	-.176	.029	-.195	.295*	.397**	.201	.368**	.258*	.286*	-.002	.344**
	Escape behaviors	.255*	.068	-.135	-.176	1	.469**	.096	.022	-.142	-.307*	-.129	-.042	-.139	.096	-.221
	Aggressive behaviors	.075	.010	-.215	.029	.469**	1	.156	.063	-.026	-.061	-.144	.006	-.109	.012	-.215
	Repetitive behaviors	.165	.075	-.277*	-.195	.096	.156	1	-.173	-.134	.116	-.132	-.101	-.060	.018	-.161
Communication outcomes: pretest	SCU (CCX)	-.386**	-.155	.343**	.295*	.022	.063	-.173	1	.667**	.205	.737**	.666**	.606**	.072	.697**
	SCU (NLS)	-.532**	-.032	.274*	.397**	-.142	-.026	-.134	.667**	1	.337**	.679**	.673**	.702**	.205	.668**
	IJA	-.398**	.159	.023	.201	-.307*	-.061	.116	.205	.337**	1	.295*	.263*	.325**	.225	.351**
	PLS-Expressive	-.467**	-.090	.376**	.368**	-.129	-.144	-.132	.737**	.679**	.295*	1	.668**	.707**	.155	.770**
Communication outcomes: posttest	SCU (CCX)	-.381**	.006	.131	.258*	-.042	.006	-.101	.666**	.673**	.263*	.668**	1	.724**	.215	.780**
	SCU (NLS)	-.564**	-.164	.236	.286*	-.139	-.109	-.060	.606**	.702**	.325**	.707**	.724**	1	.233	.833**
	IJA	-.212	.233	-.069	-.002	.096	.012	.018	.072	.205	.225	.155	.215	.233	1	.214
	PLS-Expressive	-.551**	-.151	.260*	.344**	-.221	-.215	-.161	.697**	.668**	.351**	.770**	.780**	.833**	.214	1

Note. ADOS: Autism Diagnostic Observation Schedule (Lord et al., 2008). Mullen VR: Mullen Visual Reception subscale (Mullen, 1995). IJA: Initiations of joint attention. SCU: Social communicative utterances. CCX: Caregiver-child interaction. NLS: Naturalistic language sample. PLS: Preschool language Scales, 5th Edition, expressive language subcale (Zimmerman et al., 2011).

Table 12

Pretest Object Interest as a Moderator of Posttest Communication Outcomes

	Study group	Object interest	Object interest* study group
SCU-CCX	0.659 (0.717) p=0.359	-0.002 (0.023) p=0.919	-0.001 (0.034) p=0.974
SCU-NLS	0.277 (0.826) p=0.738	-0.023 (0.028) p=0.424	0.003 (0.039) p=0.937
IJA	1.655** (0.479) p=0.001	0.006 (0.017) p=0.716	-0.053* (0.022) p=0.016
PLS-Expressive	1.252 (1.502) p=0.405	-0.024 (0.050) p=0.628	0.012 (0.071) p=0.860

Note. All models controlling for ASD severity and pretest score. SCU: Social communicative utterances. CCX: Caregiver-child interaction. NLS: Naturalistic language sample. IJA: Initiations of joint attention. PLS: Preschool language Scales, 5th Edition (Zimmerman et al., 2011).

Table 13

Pretest Escape Behaviors as a Moderator of Posttest Communication Outcomes

	Study group	Escape behaviors	Escape behaviors* study group
SCU-CCX	0.594 (0.548) p=0.279	-0.025 (0.149) p=0.869	0.017 (0.191) p=0.927
SCU-NLS	0.524 (0.664) p=0.430	0.071 (0.175) p=0.683	-0.107 (0.229) p=0.640
IJA	-0.066(0.388) p=0.865	-0.057 (0.102) p=0.578	0.320* (0.129) p=0.013
PLS-Expressive	1.374 (1.171) p=0.241	-0.209 (0.302) p=0.489	0.019 (0.400) p=0.962

Note. All models controlling for ASD severity and pretest score. SCU: Social communicative utterances. CCX: Caregiver-child interaction. NLS: Naturalistic language sample. IJA: Initiations of joint attention. PLS: Preschool language Scales, 5th Edition (Zimmerman et al., 2011).

Table 14

Pretest Aggressive Behaviors as a Moderator of Posttest Communication Outcomes

	Study group	Aggressive behaviors	Aggressive behaviors* study group
SCU-CCX	0.318 (0.488) p=0.515	-0.131 (0.197) p=0.507	0.227 (0.264) p=0.391
SCU-NLS	0.118 (0.619) p=0.848	-0.185 (0.230) p=0.420	0.106 (0.317) p=0.739
IJA	0.650 (0.380) p=0.087	0.041 (0.144) p=0.777	-0.001 (0.129) p=0.997
PLS-Expressive	1.191 (1.121) p=0.288	-0.434 (0.453) p=0.338	0.139 (0.593) p=0.814

Note. All models controlling for ASD severity and pretest score. SCU: Social communicative utterances. CCX: Caregiver-child interaction. NLS: Naturalistic language sample. IJA: Initiations of joint attention. PLS: Preschool language Scales, 5th Edition (Zimmerman et al., 2011).

Table 15

Pretest Repetitive Behaviors as a Moderator of Posttest Communication Outcomes

	Study group	Repetitive behaviors	Repetitive behaviors* study group
SCU-CCX	0.450 (0.682) p=0.590	-0.032 (0.228) p=0.889	0.087 (0.287) p=0.762
SCU-NLS	0.154 (0.855) p=0.857	0.081 (0.273) p=0.766	0.049 (0.359) p=0.891
IJA	0.656 (0.526) p=0.212	0.003 (0.172) p=0.987	-0.006 (0.221) p=0.979
PLS-Expressive	0.009 (1.470) p=0.995	-0.609 (0.497) p=0.221	0.731 (0.632) p=0.248

Note. All models controlling for ASD severity and pretest score. SCU: Social communicative utterances. CCX: Caregiver-child interaction. NLS: Naturalistic language sample. IJA: Initiations of joint attention. PLS: Preschool language Scales, 5th Edition (Zimmerman et al., 2011).

Table 16

Correlations of Covariates, Putative Mediators at Posttest, and Communication Outcomes at Follow-Up

		Covariates (pretest)			Putative mediators (posttest)			Communication outcomes (follow-up)			
		ADOS overall score	Age	Mullen VR	PLS Receptive	IJA	Verbal imitation	SCU (CCX)	SCU (LAN)	IJA	PLS Expressive
Covariates (pretest)	ADOS overall score	1	.111	-.387**	-.607**	-.212	-.419**	-.170	-.498**	-.369**	-.584**
	Age	.111	1	-.106	-.157	.233	-.143	-.234	-.198	.018	-.189
	Mullen VR	-.387**	-.106	1	.271*	-.069	.274*	.125	.250	.120	.219
Putative mediators	PLS-Receptive	-.607**	-.157	.271*	1	.174	.619**	.495**	.699**	.320**	.758**
(posttest)	IJA	-.212	.233	-.069	.174	1	.015	.005	.175	.387**	.198
	Verbal imitation	-.419**	-.143	.274*	.619**	.015	1	.342**	.641**	.221	.721**
Communication	SCU (CCX)	-.170	-.234	.125	.495**	.005	.342**	1	.558**	.104	.553**
outcomes	SCU (NLS)	-.498**	-.198	.250	.699**	.175	.641**	.558**	1	.243	.797**
(follow-up)	IJA	-.369**	.018	.120	.320**	.387**	.221	.104	.243	1	.318**
	PLS-Expressive	-.584**	-.189	.219	.758**	.198	.721**	.553**	.797**	.318**	1

Note. ADOS: Autism Diagnostic Observation Schedule (Lord et al., 2008). Mullen VR: Mullen Visual Reception subscale (Mullen, 1995). IJA: Initiations of joint attention. SCU: Social communicative utterances. CCX: Caregiver-child interaction. NLS: Naturalistic language sample. PLS: Preschool language Scales, 5th Edition (Zimmerman et al., 2011).

Table 17

Posttest Receptive Language as a Mediator of Study Group Predicting Follow-Up Communication Outcomes

	a	b	c'	c	Confidence interval
SCU-CCX	2.239* (1.060) p=0.035	0.112* (0.050) p=0.025	0.588 (0.425) p=0.167	0.838* (0.425) p=0.049	(-0.005, 0.650).
SCU-NLS	1.700 (1.186) p=0.152	0.201** (0.049) p<0.01	-0.129 (0.457) p=0.779	0.211 (0.505) p=0.676	(-0.112, 0.902)
IJA	2.013 (1.264) p=0.111	0.014 (0.025) p=0.577	0.202 (0.119) p=0.091	0.203 (0.259) p=0.432	(-0.083, 0.174)
PLS-Expressive	1.949 (1.070) p=0.069	0.381** (0.094) p<0.001	-1.188 (0.805) p=0.141	-0.446 (0.864) p=0.605	(-0.053, 1.744)

Note. All models controlling for ASD severity and pretest score of the dependent variable. SCU: Social communicative utterances. CCX: Caregiver-child interaction. NLS: Naturalistic language sample. IJA: Initiations of joint attention. PLS: Preschool language Scales, 5th Edition (Zimmerman et al., 2011). Path *a* refers to the effect of group assignment on posttest mediator. Path *b* refers to the effect of posttest mediator on follow-up outcome variable while controlling for group assignment variable. Path *c'* refers to the direct effect of group assignment on follow-up communication outcome controlling for the posttest mediator. Path *c* refers to the direct effect of group assignment on follow-up communication outcome without controlling for the posttest mediator.

Table 18

Posttest Joint Attention as a Mediator of Study Group Predicting Follow-Up Communication Outcomes

	a	b	c'	c	Confidence interval
SCU-CCX	0.683* (0.262) p=0.009	-0.196 (0.222) p=0.379	0.971* (0.442) p=0.028	0.838* (0.425) p=0.049	(-0.517, 0.168)
SCU-NLS	0.662* (0.265) p=0.012	0.040 (0.260) p=0.154	0.184 (0.542) p=0.340	0.211 (0.505) p=0.676	(-0.349, 0.419)
IJA	0.644* (0.270) p=0.017	0.272* (0.124) p=0.029	0.026 (0.262) p=0.920	0.203 (0.259) p=0.432	(0.002, 0.438)*
PLS-Expressive	0.677* (0.263) p=0.010	0.311 (0.477) p=0.515	-0.655 (0.920) p=0.476	-0.447 (0.864) p=0.605	(-0.449, 1.002)

Note. All models controlling for ASD severity and pretest score of the dependent variable. SCU: Social communicative utterances. CCX: Caregiver-child interaction. NLS: Naturalistic language sample. IJA: Initiations of joint attention. PLS: Preschool language Scales, 5th Edition (Zimmerman et al., 2011). Path *a* refers to the effect of group assignment on posttest mediator. Path *b* refers to the effect of posttest mediator on follow-up outcome variable while controlling for group assignment variable. Path *c'* refers to the direct effect of group assignment on follow-up communication outcome controlling for the posttest mediator. Path *c* refers to the direct effect of group assignment on follow-up communication outcome without controlling for the posttest mediator.

Table 19

Posttest Verbal Imitation as a Mediator of Study Group Predicting Follow-Up Communication Outcomes

	a	b	c'	c	Confidence interval
SCU-CCX	-1.184 (5.980) p=0.843	0.007 (0.009) p=0.434	0.846* (0.425) p=0.047	0.838* (0.425) p=0.049	(-0.168, 0.131)
SCU-NLS	-5.337 (6.155) p=0.386	0.034** (0.009) p<0.001	0.394 (0.461) p=0.394	0.211 (0.505) p=0.676	(-0.655, 0.231)
IJA	-1.497 (7.016) p=0.831	0.003 (0.004) p=0.549	0.207 (0.259) p=0.424	0.203 (0.259) p=0.432	(-0.087, 0.067)
PLS-Expressive	-2.988 (5.618) p=0.595	0.066** (0.017) p<0.01	-0.250 (0.788) p=0.751	-0.447 (0.864) p=0.605	(-1.005, 0.546)

Note. All models controlling for ASD severity and pretest score of the dependent variable. SCU: Social communicative utterances. CCX: Caregiver-child interaction. NLS: Naturalistic language sample. IJA: Initiations of joint attention. PLS: Preschool language Scales, 5th Edition (Zimmerman et al., 2011). Path *a* refers to the effect of group assignment on posttest mediator. Path *b* refers to the effect of posttest mediator on follow-up outcome variable while controlling for group assignment variable. Path *c'* refers to the direct effect of group assignment on follow-up communication outcome controlling for the posttest mediator. Path *c* refers to the direct effect of group assignment on follow-up communication outcome without controlling for the posttest mediator.

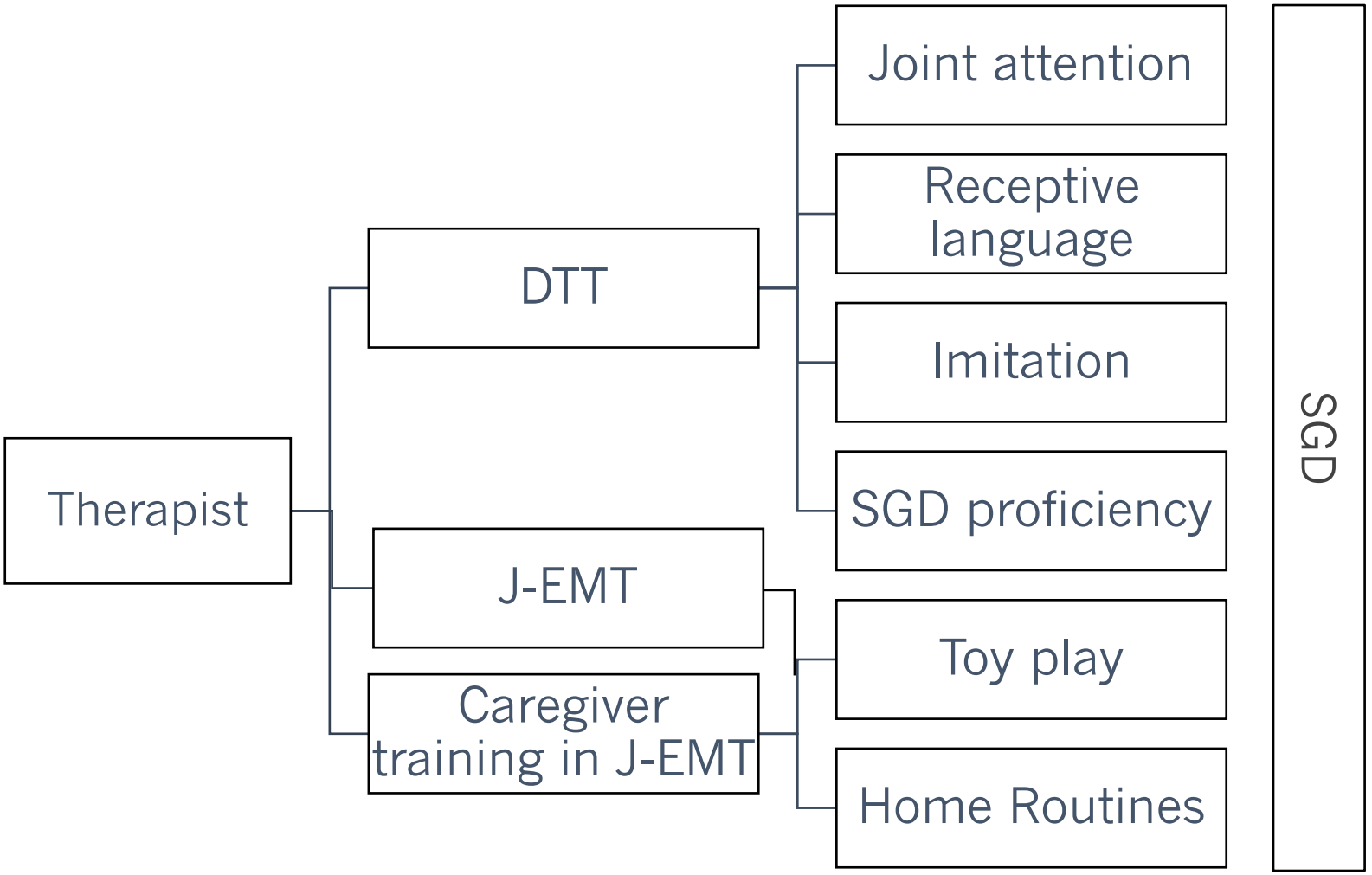


Figure 1. Intervention components.

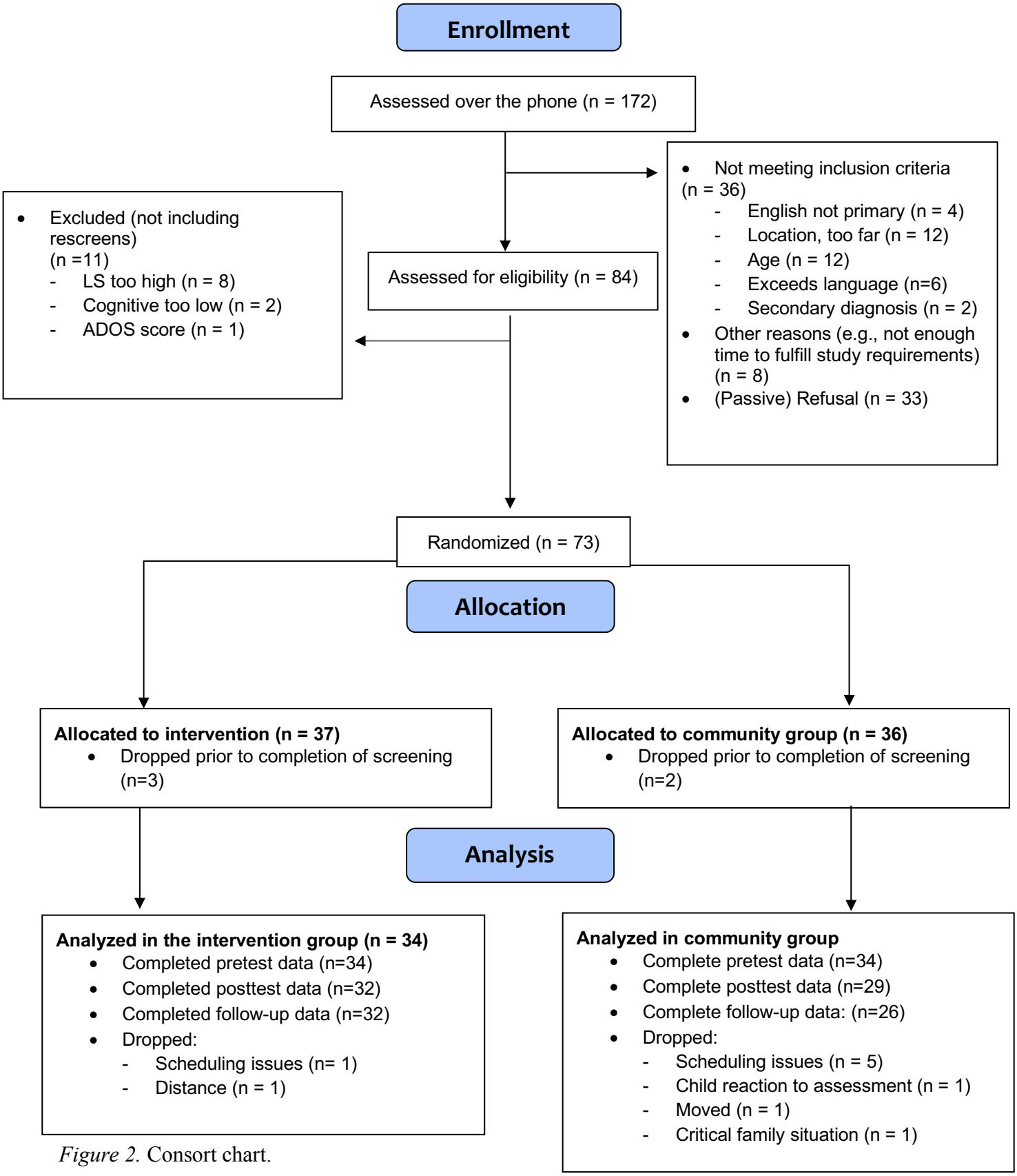


Figure 2. Consort chart.

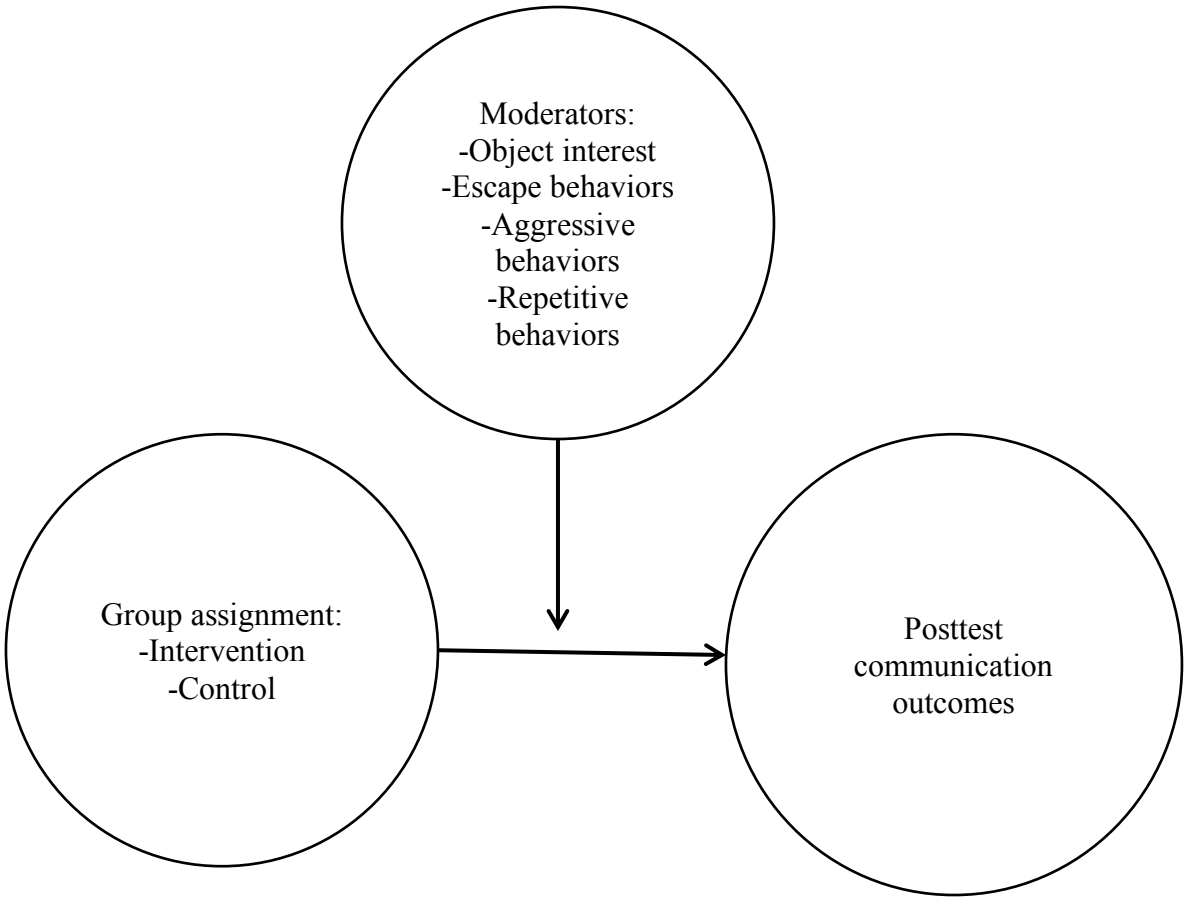


Figure 3. Moderator analysis. Depiction of the how the relationship between the dependent variable (group assignment) measured at pretest, and the dependent variable (communication outcomes) measured at posttest is affected by the proposed moderating variables (object interest, escape behaviors, aggressive behaviors, and repetitive behaviors).

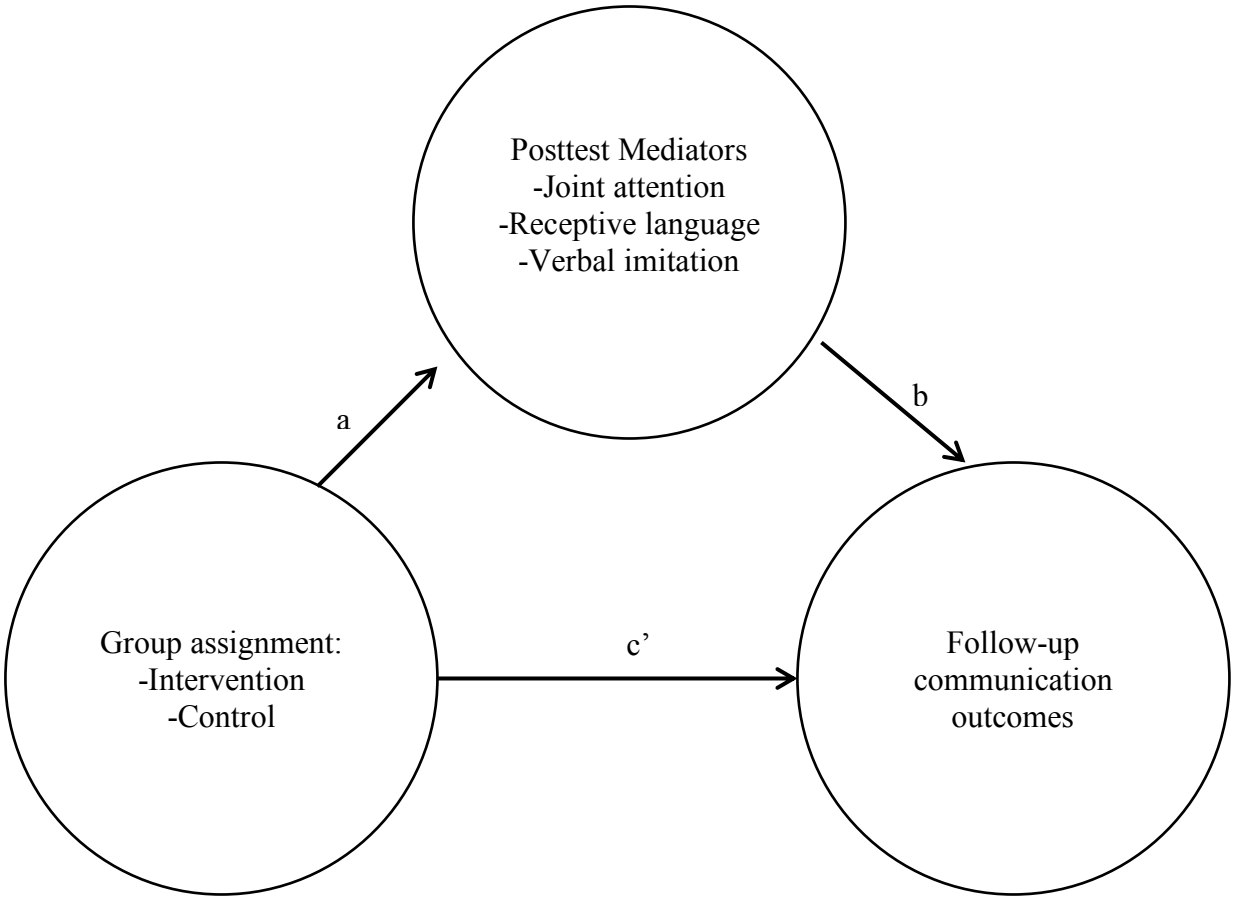


Figure 4. Mediation analysis. Path diagram of independent variable (group assignment) at pretest, putative mediating variables (joint attention, receptive language, and verbal imitation) measured at posttest, and the dependent variable (communication outcomes), measured at the 4-month follow-up. Path *a* represents the relationship between the dependent variable and the mediating variables; Path *b* represents the relationship between the mediating variables and the dependent variables while controlling for the independent variable. Path *c'* represents the effect of the dependent variable on the independent variable while controlling for the mediating variable.

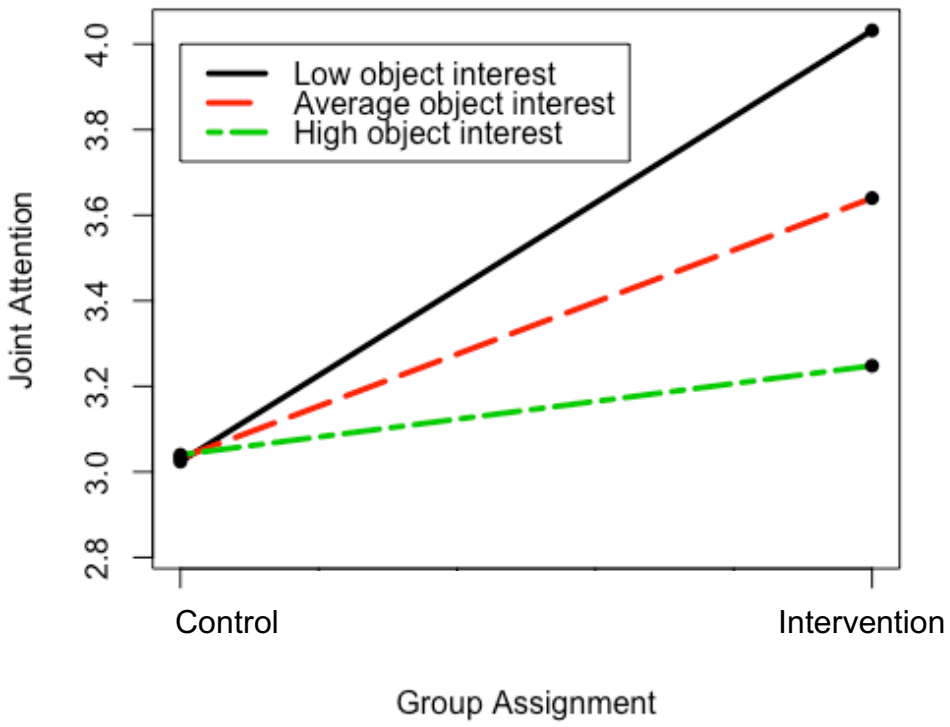


Figure 5. Object interest as a moderator. Interaction of pretest object interest and group assignment on initiations of joint attention at posttest for low (25th percentile=10), medium (50th percentile=18), and high (75th percentile=26) levels of object interest when autism severity and pretest are held constant.

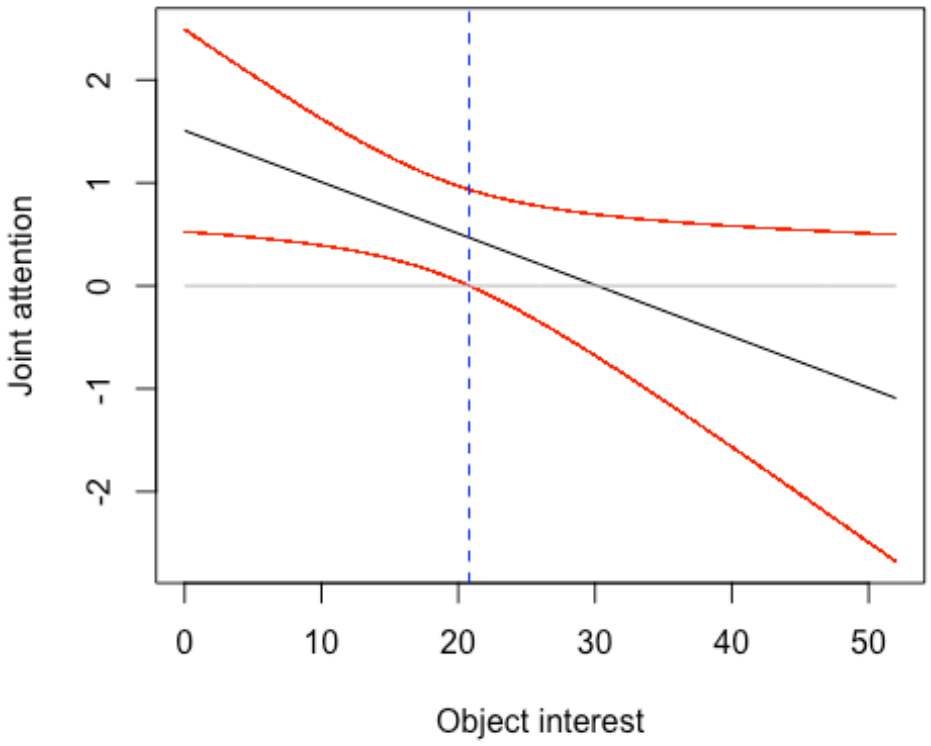


Figure 6. Regions of significance for pretest object interest as a moderating variable of group assignment on initiations of joint attention at posttest. Red lines indicate confidence bands. Values to the left of the blue dotted line indicate regions of significance.

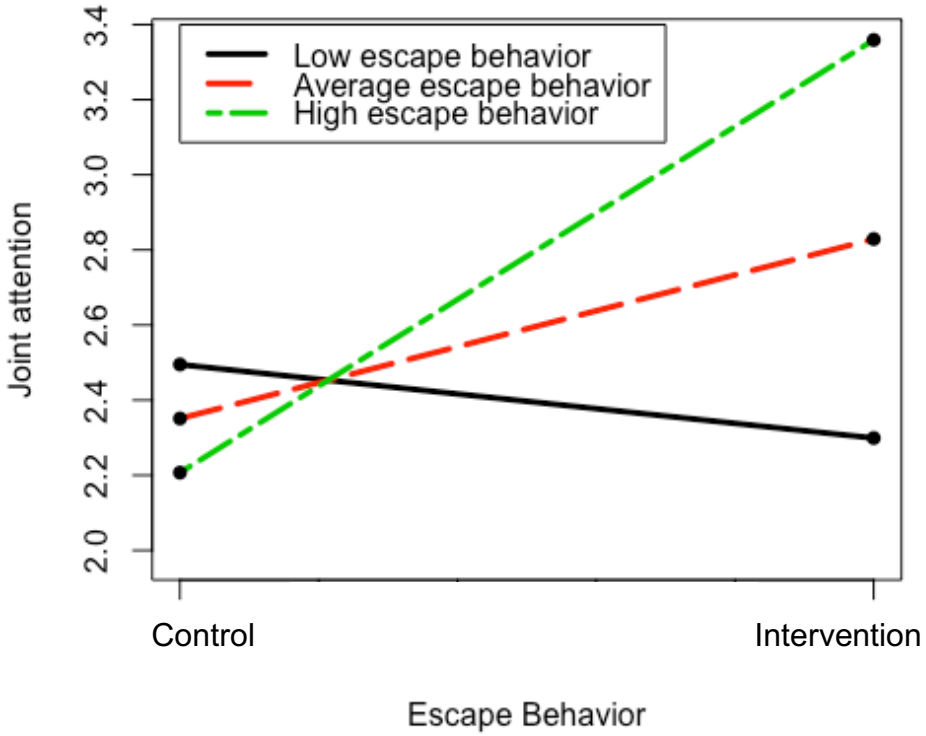


Figure 7. Escape behaviors as a moderator. Interaction of escape behaviors and group assignment on initiations of joint attention at posttest for low (25th percentile =0), medium (50th percentile= 2), and high (75th percentile = 4) levels of escape behaviors when age and pretest are held constant. Escape behaviors are square root transformed for normality.

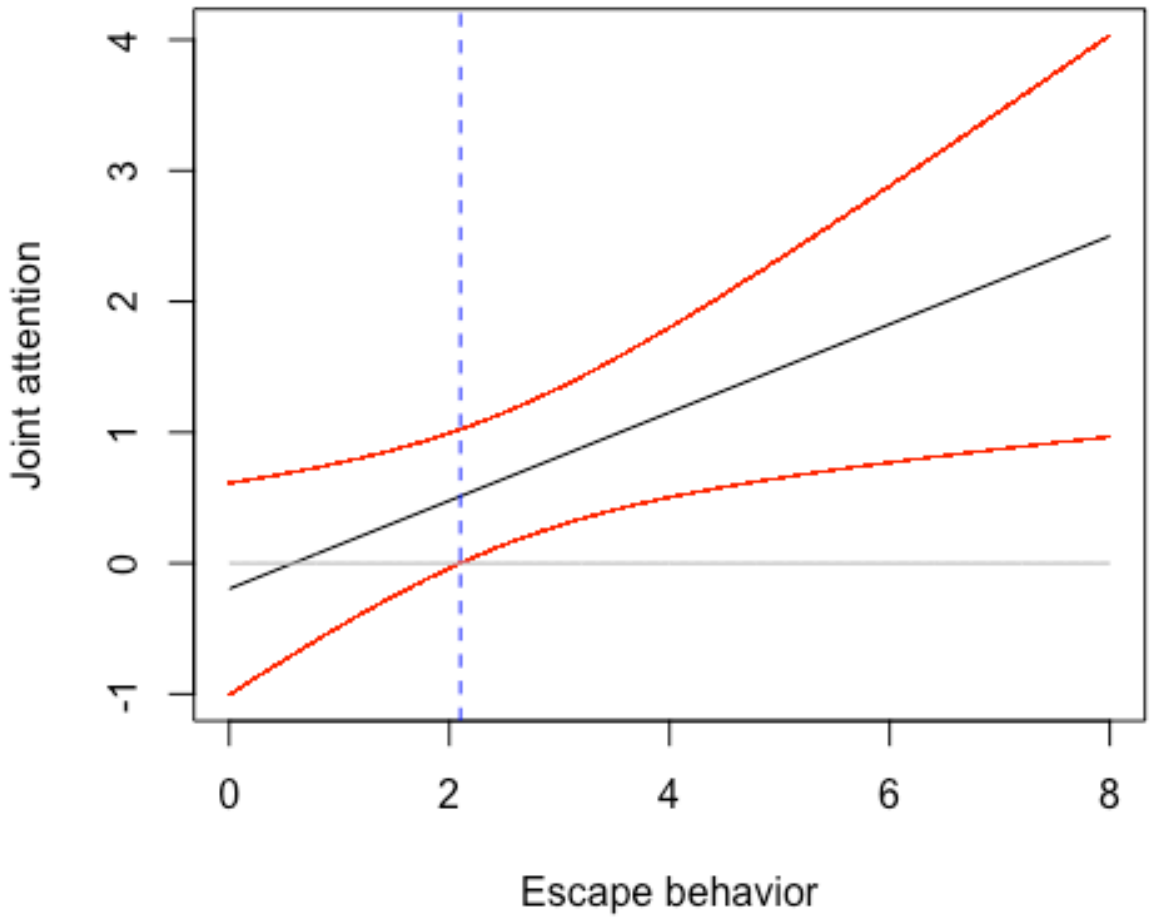


Figure 8. Regions of significance for pretest escape behaviors as a moderating variable of group assignment on posttest initiations of joint attention. Red lines indicate confidence bands. Values to the right of the blue dotted line indicate regions of significance. Measures of escape behaviors were square root transformed for normality.

Appendix A

ESCS Assessment Fidelity

Child ID:

Time Point:

Date of Assessment:

Assessor:

Date of Rating:

Rater:

N/A can be used on any item if it is truly not applicable

1 = yes, 0 = No

Action During the Assessment	**Score**
1) Arranges toys on shelf- to the side and in front of child	
2) Wall posters are hung out of the reach of the child. Posters are hung (left across, left behind, right across, right behind).	
3) Starts each new toy by asking the child "what do you want to play with?" with palm up gesture (discontinues when appropriate)	
4) Does not provide additional prompts related to the toys	
5) Asks "give to me" a total of at least 8 times each up to three times verbally and then up to three times with palm up gesture (1:1 ratio no gesture, gesture, unless confident child can respond without gesture)	
6) Assessor exercises appropriate behavior management strategies as necessary, encouraging the child to sit as much as possible to encourage IBR opportunities (rate as N/A if no challenging behavior present in the assessment)	
7) All correct materials are present	
8) Assessor exercises appropriate time management with session lasting between 15-20 minutes, unless extenuating event occurs	
Wind-Up Toys and Rabbit	
9) Presents each wind-up and rabbit toy three times in corner of table	
10) Pause after activation for child IBR- hands toy to child in response to IBR or if no gesture occurs	
11) Hands toy to child (does not allow child to grab toy) *if necessary set up additional furniture to prevent this	
Balloons	
12) Three presentations of the balloon (blow up and let air out), places balloon in middle of table for child (assessor may abandon balloon if child finds balloon aversive)	
13) Balloon is placed in the middle of the table and assessor waits for child to initiate IBR/IJA before completing beginning the next trial	
Ball and Car	

14) Place ball/car in middle of table to start and cups hands on table to catch ball/car	
15) Passes the ball/car back and forth after the child initiates the pass OR if child does not initiate turn model rolling the ball/whee and car/vroom with sound then pauses for child response a total of 3 times each	
Plastic Jar	
16) Shows jar, pours toys out, puts toys back in, seals and puts on the table in front of the child - PAUSE for IBR	
17) Open the jar, take toy out and activate on corner of table - pauses after the activation for IBR, give toy to child	
18) Repeats procedure for second toy	
Hat, Comb, and Glasses	
19) Place item in reach of child on table and pauses for child to use the item and/or initiate to the assessor. Assessor must lean in. If the child does not activate the object - model use of the object on the child (e.g., brush the child's hair)	
20) If child does not offer the item to adult, ask "(name), can I have a turn?". If the child does not respond, the assessor will ask three times, and then model on him/herself	
Points	
21) Completes 2 sets of points - 4 points in correct order (Left across, left in front, right across, right in front). The assessor ensures the child is facing him/her in between each point	
22) Point fully formed and does not extend past the elbow, holding his/her gaze in the direction of the point (does not look back at child)	
23) Calls child's name twice as s/he points and then waits for the child to respond (3 seconds). If the child does not respond, then the assessor may label what s/he is pointing at	
Walk-Mouse Creep-Mouse	
24) Starts with "lets sing a song"	
25) Total of 6 songs (2 X set of 3) for a total of six clear opportunities for the child to demonstrate anticipation of big tickles	
Book	
26) Starts with "what do you see?"	
27) Six points to pictures in book. The assessor calls the child's name twice as s/he points. The points do not touch the page and are directed the page opposite of where the child is looking	
Total Yes	0
Total No	0
Fidelity Percentage	

Appendix B

Structured Play Assessment (SPA)
Administration Fidelity Checklist

Date of Assessment: Assessor:
Child ID: Timepoint:
Date of Rating: Rater:

Action During the Assessment	**Yes**	**No**
Set 1		
1) Assessor does not model play actions for child or verbally direct the child's play actions (outside of prompt hierarchy)		
2) Assessor provides the child with sufficient time to notice and engage with all of the objects within the set		
3) Cups and puzzle are placed on the table separated (not nested) and shapes are placed on the table outside the container		
Set 2		
4) Assessor does not model play actions for child or verbally direct the child's play actions (outside of prompt hierarchy)		
5) Assessor provides the child with sufficient time to notice and engage with all of the objects within the set		
Set 3		
6) Assessor does not model play actions for child or verbally direct the child's play actions (outside of prompt hierarchy)		
7) Assessor provides the child with sufficient time to notice and engage with all of the objects within the set		
Set 4		
8) Assessor does not model play actions for child or verbally direct the child's play actions (outside of prompt hierarchy)		
9) Assessor provides the child with sufficient time to notice and engage with all of the objects within the set		
Set 5		
10) Assessor does not model play actions for child or verbally direct the child's play actions (outside of prompt hierarchy)		
11) Assessor provides the child with sufficient time to notice and engage with all of the objects within the set		
12) Barn is oriented to face the camera so that the child's actions on the barn are not blocked from camera view by the structure		
General Administration		
13) Each toy set is presented on the table without any prompts for how to play with the toys		
14) All five sets of toys were presented within child's reach and all of the correct materials are were present in each set (no additional materials were present)		

15) Assessor remove distracting items when necessary (temporarily shift position or remove particular toy item or iPad)		
16) Have iPad present within the child's eye sight and reach		
17) Prompt hierarchy is used correctly throughout (Environmental Arrangement, Verbal, Model- also include correct use of "what's happening?") *See Notes*		
18) Assessor is responsive to the child's language and other communication throughout		
19) Assessor exercises appropriate and timely behavior management strategies as necessary (rate as N/A if no challenging behavior present in the assessment)		

Total Yes:

Percentage Fidelity:

Rating Notes

Environmental Arrangement: The assessor should setup the toys in a way that the child has access to everything. If the child is not engaging in play, the assessor should present them with objects to try and engage them.

Verbal Model is used when the child does not respond to environmental arrangement or being given toys. This is something like "how about these?" or "let's play with these toys for a few more minutes."

The assessor should ask "what's happening?" when they see a child possibly using an object as a substitution for something else, when they appear to be making the doll act as an agent but the assessor needs more clarity for scoring, or when the child is doing something that is generally unclear.

Observer Notes:

Appendix C

Naturalistic Langauge Sample Assessment Fidelity

Child ID:			Time Point:				
Tester Name: See each item for scoring instructions			Observer:			Rating Date: Assessment Date:	
1 Material management and transitions	Babies	Farm	Playdoh	Cars	Bubbles	Book	All
1a. All toysets are present and within the child's view but contained to maintain environmental control - 0/100							
1b. Transition between play sets is minimized (less than 1 minute) and distracting materials are removed - 0/100							
1c. Language Samples lasts 20 minutes (after intro & setup) - 0/100							
Material Management Average							
2 Item Presentation							
2a. Tester sets the expectation for iPad use before starting the timer. “Look, I have a talker. I can use this to talk to you and you can use this to talk to me.” “See, I have all these different things for us to do and talk about. I have babies (while opening the ‘baby’ folder), I have cars (while opening the car folder), etc.” - 0/100							
2b. Tester has open an available, the corresponding iPad page for each toy set - 0/100							

2c. Tester attempts to gain child's attention (calling name, bringing toy near child's face, tapping child to get attention, making eye contact) before presenting toy and asking open question - 0/50/100: 0 = child not present or paying attention 50 = child is present but engaged with other toys 100 = child is present and paying attention							
2d. Tester introduces each toy set with an open-ended question (adds iPad model) - 0/100							
Here are my **babies**, what should they do?							
Here are my **animals**, what should they do?							
Here are my **cars**, where should they go?							
Here is my **playdoh**, what should we make?							
Here is my **book**, tell me what you see?							
2e. Tester points to at least, but **no more** than, 4 different pictures in the picture book 1 point = 25, 2 points = 50, 3 points = 75, 4 points = 100							
2f. Tester plays with the child during each of the play sets - 0/100							
2g. Tester models at least 2 novel play actions for each of the play set - 0 = 0 play acts, 50 = 1 play act, 100 = 2 play acts							
2h. Tester completes one TD environmental arrangement strategies per toy set, must have resistance while waiting for communication (assistance, insufficient amounts, waiting during a predictable play routine, choice making) or a total of 5 during the sample. If tli, tester should try again, but tli(s) can count toward the 5 if needed. -							

0/50/100 : 0 = no attempt, 50 = attempted but executed poorly, 100 = correctly administered TD						[redacted]	
2i. Tester asks one Test Question per toy set. - 0/100							
2j. Tester does not use new language unless the child has <u>not</u> initiated vocalizations or verbal language within the 30 second interval. This does not include behavioral, redirection, or transition statements. - 0-100, -10 points each time new content language is used							
2k. The tester makes a comment about the toy or book, if the child has not initiated vocalizations or verbal language within the 30 second interval. - 0-100, -10 points each time 30 seconds goes by with no comment from assessor							
2l. The tester responds to 90% of child communication with a verbal response. 0-100 -10 points each time the adult does not respond							
2m.Tester models iPad using template language for each set while playing with it. - 0/100							
*They like to **eat**!*							
*This **farm** is so fun!*							
*This **slide** is so fun!*							
*I like to **roll** it!*							
*Let's **open** it again!*							
*Let's **blow** them again!*							
Item Presentation Average *(average of 2a to 2l)*							

3 Child Engagement							
3a. Responds to child questions/requests using positive but non-specific language. - 0/100							
3b. Redirects child to the toys when bad behavior occurs necessary. - 0/100							
3c. Reengages child when they stop playing by giving choices, handing toys, encouraging to sit, moving to table, removing distracting toys. - 0/100							
3c. Tester gives child a break, if needed. - 0/100 (if NA, 100)							
3d. Voice tone is warm and positive. - 0/100							
3e. Tester makes eye contact and sits at child's level. - 0/100							
3f. Tester praises for engagement. - 0/100							
Child Engagement *(average of 3a to 3f)*							
Overall Fidelity *(average of Part 1 through 3)*							
High Fidelity (90-100) met							yes/no
Low Fidelity (80-89) met							yes/no

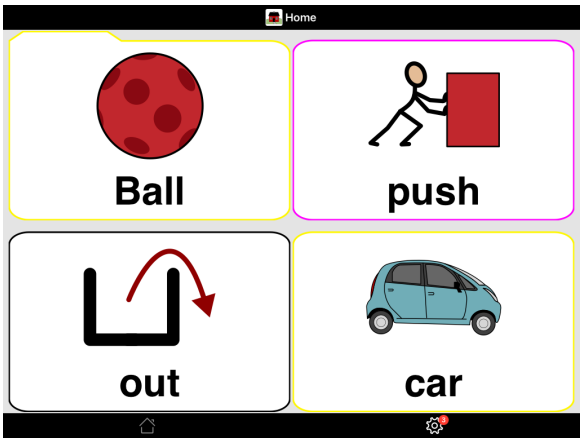
Appendix D

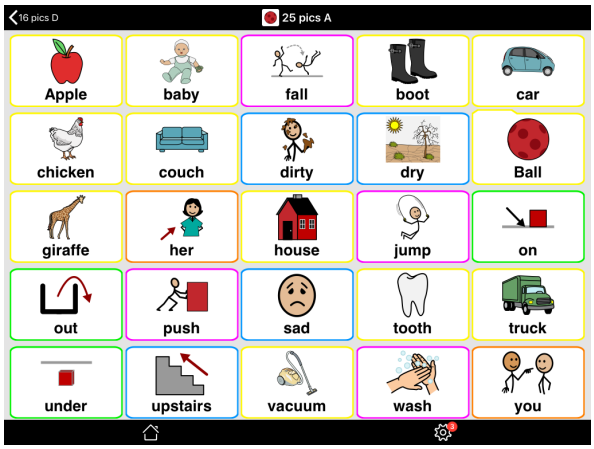
DTT Curriculum Map.

<table>
<tr><th colspan="2">Imitation</th><th colspan="2">Receptive Language</th><th colspan="2">Joint Attention</th><th>SGD Proficiency</th></tr>
<tr><td>One Syllable Words</td><td>Gross Motor Actions</td><td>Objects</td><td>One Step direction</td><td>Give to request</td><td>Point to Request</td><td>Requesting up to 5 highly preferred items on the iPad</td></tr>
<tr><td rowspan="2">One Syllable Words
Two Syllable Words</td><td>Gross Motor Actions
Imitate Action with Objects*</td><td colspan="2">Objects in Pictures</td><td colspan="2">Point/show to comment</td><td>Match Identical Objects</td></tr>
<tr><td></td><td colspan="2">Demonstrate actions</td><td colspan="2">Statement-Statement with JA</td><td>Match Identical iPad Pictures</td></tr>
<tr><td rowspan="2">Two Syllable Words
Fine Motor Actions</td><td>Imitate Action with Objects*</td><td colspan="2">Identify actions in pictures (iPad pictures)</td><td colspan="2"></td><td>Match objects to iPad Pictures</td></tr>
<tr><td></td><td colspan="2"></td><td colspan="2"></td><td>1-word request on iPad up to field of 25</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td>Navigate 1 level of folder</td></tr>
</table>

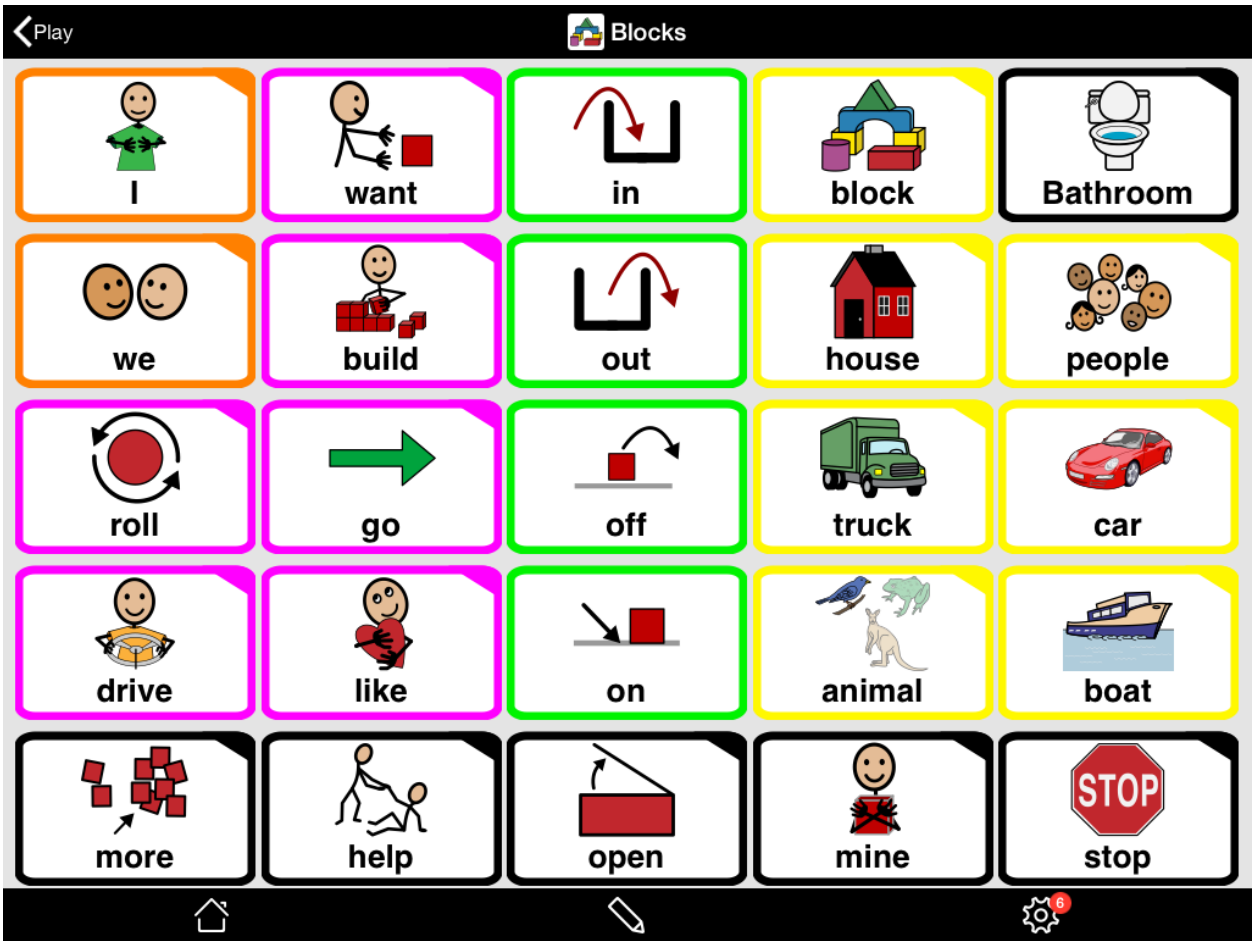
Note. Children were eligible for one program in each of the four foundational areas. Children were pretested during the first three sessions. Following mastery of a program, the child moved to the next program in the sequence of the foundational skill. Following mastery of all skills in a foundational area, the child no longer received DTT programming in that area.

Appendix E
Chase the Ball Example





Appendix F
Example of Vocabulary Page



Appendix G
Clinic-based Session Fidelity

Child ID:	**Rater:**	
Therapist:	**Date:**	
Session number:	**Date rated:**	

****Rate the first 10 minutes of EMT that occur after (or closest to) the time segment that is assigned on Redcap with this session. Use this rating from the data sheet to rate the EMT strategies section**

Session components

Item	Coding	Data	Rating	Comments
1. The session includes 5-minutes of DTT for each component that the child qualifies for. (see child target list)[4=yes, 3= too long, 2=not enough, 0=no]	[3=yes, 2=too long, 1=too short, 0=none]			
2. The session includes 30 minutes of J-EMT, at least half of this time is implemented by the therapist. [4=yes, 3= too long, 2=not enough, 0=no]	[3=yes, 2=too long, 1=too short, 0=none]			
3. The parent practices for the appropriate amount for the phase of interveniton (phase 1: 5 minutes, phase 2: 10 minutes, phase 3: 15 minutes, phase 4-6: 20 minutes) [4=yes, 3= too long, 2=not enough, 0=no]	[3=yes, 2=too long, 1=too short, 0=none]			
Number of Items excluded			0	
Points possible			9	
Score obtained			0	

DTT: Rate first 10 trials after randomized start time

Item	Coding	Data	Rating	Comments
1. All of the child's current targets are addressed in the session.(teaching plans are followed as outlined)	[1=yes, 0=no]			
2. Therapist establishes a reinforcer	[1, 80% or more, 0, less than 20% of trials]			

3. Therapist gains the child's attention before placing a task direction (does not recruit with the child's name, child's body is oriented towards the therapist, child's body is still)	[1, 80% or more, 0, less than 20% of trials]			
4. Therapist delivers a clear task direction 1 time (without elaboration, repetition, cajoling, encouragement, redirection, overt facial expressions, nodding etc.)	[1, 80% or more, 0, less than 20% of trials]			
5. Errors result in minimal attention, a corrective procedure with neutral tone	[1, 80% or more, 0, less than 20% of trials]			
6. Reinforcement is delivered immediately paired with praise (within 5 seconds)	[1, 80% or more, 0, less than 20% of trials]			
7. The instructional materials are reset immediately following the end of a trial	[1, 80% or more, 0, less than 20% of trials]			
8. Adult responds to 80% or more of the child's communicative attempts during reinforcer breaks	[1, 80% or more, 0, less than 20% of trials]			
9. The adult expands the child's communication (2 out of 5 communicative attempts) during reinforcer breaks	[1, 80% or more, 0, less than 20% of trials]			
10. Teaching is done in isolation for new tasks and intermixed for mastered tasks	[1, 80% or more, 0, less than 20% of trials]			
11. The adult uses good teaching procedures to minimize error patterns (varied materials, SDs, and placement of materials)	[1, 80% or more, 0, less than 20% of trials]			
Number of Items excluded			0	
Points possible			11	

Score obtained			0	
Parent coaching (T-M-C-R)				
Item	Coding	Data	Rating	Comments
1. The therapist reviews with the parent the skill to be practiced for the session.	[1=yes, 0=no]			
2. The therapist models the skill before having the parent practice	[1=yes, 0=no]			
3. The therapist points out the specific skill that they are modeling at least twice before the adult practices.	[1=yes, 0=no]			
4. The therapist establishes a play routine with the child before the parent practices	[1=yes, 0=no]			
5. The therapist gives the adult specific positive feedback (behavior specific praise) at least 5 during practice	[1=yes, 0=no]			
6. The therapist gives the adult specific corrective feedback on 1-2 skills for the session. Can mark NA if parent really does not need any feedback	[1=yes, 0=no]			
7. The therapist supports the parent and child's interaction to ensure success (managing behaviors, materials, handing the adult additional materials to sustain engagement)	[1=yes, 0=no]			
8. The therapist reviews with the parent what they did well and what they should practice before the next session.	[1=yes, 0=no]			
9. Examples are linked to specific child and adult behaviors. They are clear and specific (when you did this, your child did that) and skills to practice are clear and specific.	[1=yes, 0=no]			
10. The therapist is warm and positive with the parent. Positive tone and affect are maintained during the entire session.	[1=yes, 0=no]			
11. The therapist answers/addresses every question the parent asks during the session.	[1=yes, 0=no]			
Number of Items excluded			0	
Points possible			11	
Score obtained			0	

J-EMT				
Item	Coding	Data	Rating	Comments
1. The adult sits across from and within arm's reach of the child and stays at the child's level (within the child's line of sight) during play interactions (excluding transitions between toys and behavior management instances) for the majority of the session.	[1=yes, 0=no]			
2. Adult removes distractions and unused materials.	[1=yes, 0=no]			
3. Sets out developmentally appropriate/motivating toys (i.e. at the child's play level)	[1=yes, 0=no]			
4. Offers a selection of toys	[1=yes, 0=no]			
5. Removes distracting/perseverative items	[1=yes, 0=no]			
J-EMT: Play routines				
6. Play routines have consistent, predictable, repeatable steps	[1=yes, 0=no]			
7. Play routines have clear roles for the child and the adult. Each person is participating activity in the play, and turn-taking is encouraged/supported	[1=yes, 0=no]			
8. The majority of steps in the play routines are at the child's play level	[1=yes, 0=no]			
9. Adult physically interacts with the materials the child is playing with and engages in child's activity with the toy for the majority of the session.	[1=yes, 0=no]			
10. All Imitated/mirrored play acts are in the child's attentional focus	[1=yes, 0=no]			
11. The adult paces their play models such that they imitate more often than they model	[1=yes, 0=no]			
12. Additional toys/materials are moved into the child's attentional focus to promote **spontaneous initiations.**	[1=yes, 0=no]			
13. The adult will hand materials if a child hasn't initiated play.	[1=yes, 0=no]			
14. Play expansions are implemented only after mirroring the child's play actions first	[1=yes, 0=no]			
Number of Items excluded			0	

Points possible			14	
Score obtained			0	
J-EMT: Responsive Interactions				
1. The adult pauses (>3s) after the majority of their utterances to give the child time to reply or take a turn.	[1=yes, 0=no]			
2. Adult responds, within 2 seconds, to all child communicative attempts (voc, gesture, sign, approximation, word, aac, joint attention) with a related response.	3=>90%, 2=>80%, 1=>70%, 0=<70%			
3. The adult maintains appropriate pacing of language models throughout play, less than 4 instances of a silence for 20 seconds or more.	[1=yes, 0=no]			
4. The adult only mirrors and maps language onto play acts that are functional and appropriate for the majority of the session.	[1=yes, 0=no]			
5. The adult uses language and inflection in a way that mirrors typical conversation, avoiding speech patterns that are robotic, monotone, or sing-songy for the majority of the session. .	[1=yes, 0=no]			
6. Coping with moments of dysregulation. If the child engages in problem behavior, the adult responds in a developmentally appropriate manner (providing minimal attention, redirecting, using few simple behavior directions as necessary, and providing visual supports as needed [ie. timer, schedule])	[1=yes, 0=no]			
Number of Items excluded			0	
Points possible			8	
Score obtained			0	
J-EMT: Modeling				
1. Adult models language at the child's target level (1 out of 2 adult utterances are at the child's target level).	[1=yes, 0=no]			
2. The adult models diverse language and avoids using same language models repeatedly. (about 20 for 1-word kid, 50 for 2-word kid)	[1=yes, 0=no]			

3. Adult appropriately expands child communication. (2 out of 5 child utterances are expanded by the adult); **must have at least 5 to score, otherwise NA**	[1=yes, 0=no]			
4. Adult models language that is salient and related to the child (paired with ja, play model, or shared eye contact)	3=>90%, 2=>80%, 1=>70%, 0=<70%			
5. The adult models JA skills (point, show, give) frequently (pacing should be approximately 1-2 models per minute)	[1=yes, 0=no]			
Number of Items excluded			0	
Points possible			7	
Score obtained			0	
J-EMT: Milieu Teaching				
If there are no TDs, the formula will indicate "coder scores". If it is before session 6, you may score na. If it is after session 6, score 0				
1. Adult uses 1-3 well-timed TDs in 10 minutes coded time (including Li episodes).	3=1-3, 2=4-5, 1=>5, 0=0			
2. Time delays are high quality. Of the total number executed, what percentage were a score of 2 or greater? If no Time delays occurred, score this as NA. If all time delays were Li, score this as 0	3=>90%, 2=>80%, 1=>70%, 0=<70%			
3. Adult prompts 1-3 well-timed milieu episodes in a 10 minute session (a balance between TD and Milieu, quality of engagement, and behavior issues can impact this score)	3=1-3, 2=4-5, 1=>5, 0=0			
4. Milieu prompting episodes are high quality. Of the total number executed, what percentage were a score of 2 or greater? If no prompting episodes occurred, score this as NA.	3=>90%, 2=>80%, 1=>70%, 0=<70%			
Number of Items excluded			0	
Points possible			12	
Score obtained			0	
AAC				
You may code na for instances in which the child is not ready for the AAC and it is removed in the first 8 sessions. Must have video of reviewing toys prior to play session.				
Item	Coding	Data	Rating	Comments

1. The interventionist models/imitates at least 3 icons on the iPad before starting the session.	[1=yes, 0=no]			
2. The interventionist consistently maintains placement of the AAC device within view and reach of the child.	[1=yes, 0=no]			
if no AAC present for session, mark all following as na				
3. AAC device is used in conjunction with speech and is at target + proximal target level 80% of the adult utterances.	[1=yes, 0=no]			
4. AAC device is used in conjunction with speech during at least 50% of adult utterances	[1=yes, 0=no]			
5. AAC device is used conjunction with speech during at least 50% of adult expansions.	[1=yes, 0=no]			
6. 50% of Milieu episodes must include adult models on the AAC.	[1=yes, 0=no]			
7. If the child does not respond verbally or use the AAC device, the episode ends with a physical prompt. Coder can decide on opportunities (e.g. if child is losing interest, becoming upset, may not be considered opportunity).	[1=yes, 0=no]			
Number of Items excluded			0	
Points possible			7	
Score obtained			0	

Total Score

Section	Points Earned	Possible Points	Total Percentage
Session components	0	9	**0.00%**
DTT: Rate first 10 trials after randomized start time	0	11	**0.00%**
Parent coaching (T-M-C-R)	0	11	**0.00%**
J-EMT: Play routines	0	14	**0.00%**
J-EMT: Responsive Interactions	0	8	**0.00%**
J-EMT: Modeling	0	7	**0.00%**
J-EMT: Milieu Teaching	0	12	**0.00%**
AAC	0	7	**0.00%**
Overall EMT fidelity	0	79	**0.00%**

Total percentage is an average across sessions, equally weighting each component of the intervention

Appendix H
Home-based Session Fidelity

Child ID:		**Rater:**	
Therapist:		**Date:**	
Session number:		**Date rated:**	

****Rate the first 10 minutes of EMT that occur after (or closest to) the time segment that is assigned on redcap with this session. Use this rating from the data sheet (on the clinic tab) to rate the EMT strategies section**

Caregiver Home Training Session				
Item	Coding	Data	Rating	Comments
1. Therapist asks the caregiver how intervention has been going at home.	[1=yes, 0=no]			
3. Therapist selects 2 strategies for current home session *(list below).*	[1=yes, 0=no]			
1.) target talk				
2.) play				
4. Therapist reviews the rationale behind each of the two strategies *(indicate times below).*	[1=yes, 0=no]			
1.)				
2.)				
5. Therapist explains 1 example of each strategy by showing (role playing) or explaining the steps *(indicate times below).*	[1=yes, 0=no]			
1.)				
2.)				
6. Therapist asks if the caregiver has any questions.	[1=yes, 0=no]			
7. Therapist explains and engages the parent in toy selection and/or how to arrange the environment for play.	[1=yes, 0=no]			
Number of Items excluded			0	
Points possible			5	
Score obtained			0	

Therapist Play Practice Session				
Item	Coding	Data	Rating	Comments
1. Therapist highlights modeling targets of the day at least 2 times each	3=yes, modeled at least 2 of each, 2=modeled at least 1 of			
Time & Example:				
Time & Example:				
Time & Example:				
Time & Example:				

	each, 1=at least modeled 1 skill, 0=did not model both strategies			
2. Play session lasts at least 30 minutes total (at least 20 minutes of active play)	[1=yes, 0=no]			
3. Therapist worked with the child for at least 10 minutes at the start of the session.	[1=yes, 0=no]			
4. Parent plays with child for at least specified amount of time (no more than 5 minutes over) Phase 1,2 5-10, Phase 3,4 10-15, Phase 5 15-20, Phase 6 20	[1=yes, 0=no]			
Number of Items excluded			0	
Points possible			6	
Score obtained			0	
Therapist Play Practice Session: EMT strategies				
1. The adult sits across from and within arm's reach of the child and stays at the child's level (within the child's line of sight) during play interactions (excluding transitions between toys and behavior management instances) for the majority of the session.	[1=yes, 0=no]			
2. Adult removes distractions and unused materials.	[1=yes, 0=no]			
3. Offers a selection of toys from the child's home	[1=yes, 0=no]			
4. Play routines have consistent, predictable, repeatable steps	[1=yes, 0=no]			
5. The adult paces their play models such that they imitate more often than they model	[1=yes, 0=no]			
6. The adult pauses (>3s) after the majority of their utterances to give the child time to reply or take a turn.	[1=yes, 0=no]			
7. Adult responds, within 2 seconds, to all child communicative attempts (voc, gesture, sign, approximation, word, aac, joint attention) with a related response.	3=>90%, 2=>80%, 1=>70%, 0=<70%			
8. Adult models language at the child's target level (1 out of 2 adult utterances are at the child's target level).	[1=yes, 0=no]			

9. The adult models diverse language and avoids using same language models repeatedly. (about 20 for 1-word kid, 50 for 2-word kid)	[1=yes, 0=no]			
10. Adult appropriately expands child communication. (2 out of 5 child utterances are expanded by the adult). **must have at least 5 to score, otherwise NA**	[1=yes, 0=no]			
11. Adult uses 1-3 well-timed TDs in 10 minutes coded time (including Li episodes).	3=1-3, 2=4-5, 1=>5, 0=0			
12. Time delays are high quality. Of the total number executed, what percentage were a score of 2 or greater? If no Time delays occurred, score this as NA. If all time delays were Li, score this as 0	3=>90%, 2=>80%, 1=>70%, 0=<70%			
13. Adult prompts 1-3 well-timed milieu episodes in a 10-minute session (a balance between TD and Milieu, quality of engagement, and behavior issues can impact this score)	3=1-3, 2=4-5, 1=>5, 0=0			
14. Milieu prompting episodes are high quality. Of the total number executed, what percentage were a score of 2 or greater? If no prompting episodes occurred, score this as NA.	3=>90%, 2=>80%, 1=>70%, 0=<70%			
15. The interventionist models/imitates at least 3 icons on the iPad before starting the session.	[1=yes, 0=no]			
16. The interventionist consistently maintains placement of the AAC device within view and reach of the child.	[1=yes, 0=no]			
if no AAC present for session, mark all following as N/A				
17. AAC device is used in conjunction with speech and is at target + proximal target level 80% of the adult utterances.	[1=yes, 0=no]			
18. AAC device is used in conjunction with speech during at least 50% of adult utterances	[1=yes, 0=no]			
19. AAC device is used conjunction with speech during at least 50% of adult expansions.	[1=yes, 0=no]			
20. 50% of Milieu episodes must include adult models on the AAC.	[1=yes, 0=no]			

21. If the child does not respond verbally or use the AAC device, the episode ends with a physical prompt. Coder can decide on opportunities (e.g. if child is losing interest, becoming upset, may not be considered opportunity).	[1=yes, 0=no]			
Number of Items excluded			0	
Points possible			31	
Score obtained			0	
Caregiver Play Practice Session				
Item	Coding	Data	Rating	Comments
1. Therapist gives caregiver specific positive feedback or training feedback at least one time for every minute of the caregivers session	3=1+/min, 2=<1/min, 1=at least once, 0=0			
check each instance per minute (1,2,3) in columns H, I, J				
2. Therapist gives feedback about target 1 at least half as many times as there are minutes.	[1=yes, 0=no]			
3. Therapist gives feedback about target 2 at least half as many times as there are minutes.	[1=yes, 0=no]			
Number of Items excluded			0	
Points possible			5	
Score obtained			0	
Routine sessions				
Item	Coding	Data	Rating	Comments
1. Routines that last at least 2-3 minutes each.	[2=both routines, 1=1 routine, 0=neither routine]			
2. Therapist models or role plays or shows example video with parent for 1-3 minutes	[2=both routines, 1=1 routine, 0=neither routine]			
3. Therapist gives caregiver specific positive feedback or training feedback at least one time for every minute of the caregiver's session.	3=1+/min, 2=<1/min, 1=at least once, 0=0			
check each instance per minute (1,2,3) in columns H, I, J				

4. Therapist gives feedback about target 1 at least half as many times as there are minutes. For at least 1 routine	[1=yes, 0=no]			
5. Therapist gives feedback about target 2 at least half as many times as there are minutes. For at least 1 of the routines	[1=yes, 0=no]			
Number of Items excluded			0	
Points possible			9	
Score obtained			0	

Ending Training session

Item	Coding	Data	Rating	Comments
1. Therapist summarizes how the caregiver used the target strategies.	[1=yes, 0=no]			
2. Therapist relates one example of caregiver behavior to child behavior.	[1=yes, 0=no]			
3. Therapist engages the parent in reflective discussion by using at least 1 probing question, OR, or if parent initiates reflective talk, therapist gives reflective feedback in response.	[1=yes, 0=no]			
Number of Items excluded			0	
Points possible			3	
Score obtained			0	

Total Score

Section	Points Earned		Possible Points	Total Percentage
Caregiver Home Training Session	0		5	**0.00%**
Therapist Play Practice Session	0		6	**0.00%**
Therapist Play Practice Session: EMT strategies	0		31	**0.00%**
Caregiver Play Practice Session	0		5	**0.00%**
Routine sessions	0		9	**0.00%**
Ending Training session	0		3	**0.00%**
Overall EMT fidelity	0		59	**0.00%**

Total percentage is an average across sessions, equally weighting each component of the intervention

Appendix I
CCX Protocol

Toy List:
Legos: including blocks, people, animals, and vehicles
Doll House with cat, dog, car, 2 small dolls, 3 small cars and furniture: table, 2 chairs, 1 lounge chair. bathtub, toilet, sink, TV, bookshelf, cabinet (note: no bed)
School bus with inserting people
8-piece inset puzzle
Ball
Nesting cups (10)
Shape sorter with pieces
Two dolls
Tea set: tray, 4 large plates, 4 small plates, teapot, 4 cups
Pretend food: 10 pieces total (5 sets of identical food)
Dump truck
Book
Other: 3 sponges, 2 popsicle sticks, 4 pom poms

Script: You and (child name) will play with a variety of toys for 10 minutes. Take some time before we start to look at the toys in the bin, and pull out ones you may want to play with.
Our goal is to gain a snapshot of how your child is currently communicating. We are interested in gestures, vocalizations, and language. Please use any tools your child needs to communicate (iPad, pictures, signs). Play with him/her as you normally would at home. We will be videotaping so that we can watch all of the communication taking place at a later time. Do you have any questions?

Appendix J
Naturalistic Language Sample Protocol

A language sample is a naturalistic adult-child interaction with a specific set of toys to evaluate a child's spontaneous expressive language ability.

Purpose:

1. A language sample accurately captures a child's initiated, unprompted language using a 20-minute language sample.
2. A language sample avoids language-rich verbs and labels that may not occur in the child's natural environment but provides a fun, responsive and engaging environment.
3. The language sample has a standard format so that all children get the same number of supports (Time Delay, Open-ended questions, and Test questions) and a minimum amount of verbal statements (2 per minute) from the adult.
4. The spontaneous use of the IPad during this assessment is important. The therapist should make a statement to the child before the session to set up the expectation as well as model once per toy set.

Materials:
There are 6 toys sets that comprise the language sample:

1. Babies	
2. Barn, animals, blocks	
3. Cars with ramp	

4. Playdoh	
5. Where's Spot?	
6. Bubbles	

Getting Started Procedures:

1. Have all 6 toy sets available in the room.
    a. Set up toy sets so that they are all in the child's line of sight, but contained to maintain room organization and environmental control
    b. Move through the toy sets playing with each one individually as much as possible, cleaning up a set when you are done with is as much as you can and introducing new sets periodically.
2. Set a timer for **20 minutes**. The timer makes sure we get a 20-minute sample, and can also be referenced to watch your pacing through toy sets.

Communication

3. Be at the child's eye level and in close proximity to the child.
4. Use a warm, positive tone of voice, smile, and engage with the child.
5. Engage with the child and toys.
    a. Imitate the child's play acts.
    b. Introduce at least new play acts
    c. Play with the child naturally, and be as engaging as possible
    d. Encourage the child and praise them for engaging and playing.
6. **Respond to all child communication** (gesture, vocalization, words):
    a. Imitate the child's words
        i. When imitating a word, use a "comment-like" tone rather than a questioning tone (i.e. "train" rather than "train?").

    Note: transcribers use assessor imitations to verify things the child says, so only repeat what you hear.

    b. If the child continues to talk, let the child talk – do not cut the child off mid-statement. Repeat what you remember from the long utterance only. **Do not add in words you think you might have heard**.
    c. Acknowledge nonverbal communication with sounds (e.g., "mhm," "yeah," "uh-huh") but refrain from making too many silly noises (oop! Vroom, numnumnum (eating noise) that the child might begin to over use)
    d. If the child asks a question, respond with a nonverbal gesture (i.e. point or show). If you are not able to answer nonverbally, then use a brief, positive response (i.e., "I don't know"). If a child asks "what is this?" do not label the object.
7. **Do not** introduce any new content-specific language. You can say things like "this is so fun" "oh wow" and "I like that" or "good job" to praise the child, but never label an object or action you are doing, e.g. "I like this car" or "he's sliding".

Play

8. Let the child choose which toy set he/she wants to play with, and move through all toy sets, playing with each for 3-4 minutes.
    a. If the child **does not** choose a toy set:
        i. pick a toy set, introduce it and begin to play with it
        ii. hand the child part of the toy to play with
        iii. hold up two toys for the child to choose from (remember this is a Time Delay – see below)
        iv. encourage the child to sit and interact with a toy
        v. move the child to the table and help them begin to play
        vi. remove a distracting toy from the room

b. If the child **chooses** a toy set:
    i. Introduce the toy set with the open-ended question listed
    ii. Engage in play with the child
    iii. Model new play acts as well as imitating what the child is doing
    iv. Praise the child for playing and engaging, ex: "good idea!"

9. The adult must attempt to have the child interact with <u>all</u> of the toy sets:
    a. High priority / preferred toys may be cleaned up and put back in the Language Sample bag/box to help the child move on to a different toy set.
    b. If removing a toy or moving to different toy set causes behavior issues, you may include the toy moving forward, but continue to try to remove and replace it if you can.
    c. Discontinue playing with a toy set if the child loses interest and present a different toy set, but try to play with each toy set for 3-4 minutes to maintain good pacing across all sets
    d. If the child loses interest in the toy sets quickly, some of the toy sets may need to be re-introduced to make it through the 20 minute session.

<u>Things you must do during each toy set</u>

10. Introduce the toy set with an **OPEN QUESTION**
    a. *Here are my **babies**, what should they do?*
    *b. Here are my **animals**, what should they do?*
    *c. Here are my **cars**, where should they go?*
    *d. Here is my **playdoh**, what should we make?*
    *e. Here is my **dog** book, tell me what you see?*
    *f. Here are my **bubbles**, what should I do?*

11. Use **1 Time Delay** strategy per toy set.
    Time Delays are a <u>non-verbal</u> strategy. If you do one of the following paired with a verbal prompt – such as asking a question – it does not count as a Time Delay. Do not pair with the open question at the beginning of the toy set.
    a. Set up TD and wait expectantly, for up to 5 seconds, for the child to use a communication attempt (gesture, sign, vocal, or verbal) prior to honoring the request.
    b. The adult must maintain possession of the TD items long enough (tug/resistance) for the child to understand another response is required other than just taking the item from the adult.
    c. If the child loses interest, you may try again, but TLIs can also count toward the 5 total opportunities, if need be.
        i. <u>Inadequate Portions</u>: providing small or inadequate portions of preferred materials (e.g., give the child only a few pieces of train track).
        ii. <u>Assistance</u>: creating situations in which the child needs the adult's help (e.g., giving bubble jar to the child with the cap on)
        iii. <u>Waiting Expectantly</u>: setting up a routine in which the child expects certain actions and then waiting before doing the expected action again (e.g., hold the car above the slide, waiting to let it go down).
        iv. <u>Choice Making</u>: holding up two objects and wait for the child to communicate about which item he/she wants (e.g., holding up a doll and a teacup) – use a little resistance to see if they will use a word before giving the object
    d. There must be a Total of **5** Time Delays in the 20 minute LS.
    e. Time Delays are not used during the book. Therapist is to point 4 times instead (without

words) to elicit communication.

12. Ask one **TEST QUESTION** per toy set. Test Questions are questions that <u>have a</u> correct or incorrect answer:
    a. Examples: "What color is the car?" "What is the doll doing?," "Where is the block?," "What is it?"
    b. There must be a Total of **6** Test- Questions in the 20 minute LS.
13. Comment once per toy set using iPad
    a. *Babies: They like to **eat**!*
    b. *Farm: This **farm** is so fun!*
    c. *Cars: This **slide** is so fun!*
    d. *Playdough: I like to **roll** it!*
    e. *Book: Let's **open** it again!*
    f. *Bubbles: Let's **blow** them again!*

14. **Model at least 2 new play acts per toy set.** If the child will not engage with all of the toy sets, model extra play acts with the toys that the child will use. Otherwise, play with the child naturally.
15. **Point to 4 pictures** during book reading. Preferably point to something the child is already interested in to see if he/she will label it.
16. The adult must make at least two statements per minute (one every 30 sec) to maintain engagement. This rate includes the adult's Open-ended, Comments, and Responses to the child's communication. Behavioral or Transition statements do NOT count toward this total. There should never be more than 30 seconds of silence.
    a. Since there are a lot of built in opportunities, this will only occur when you have completed your open questions, comments, and the child is silent for the 30 seconds.
    b. When making these statements:
        i. Use non-specific words you have heard the child use during the Language Sample and limit introducing new vocabulary (e.g. it/that/ those instead of nouns): "wow, look what you did with that!" "That looks like so much fun!" "it went all the way over there"
        ii. Don't finish a statement with a content word that is likely to be imitated/the child has used spontaneously earlier.

Cheat Sheet

	Open Question	*Other iPad model*	*Test Question*	*Time Delay*	*Model 2 play actions*
Babies	*Here are my **babies**, what should they do?*	*They like to **eat**!*			
Barn	*Here are my **animals**, what should they do?*	*This **farm** is so fun!*			
Cars	*Here are my **cars**, where should they go?*	*This **slide** is so fun!*			
Playdoh	*Here is my **playdoh**, what should we make?*	*I like to **roll** it!*			
Bubbles	*Here are my **bubbles**, what should I do?*	*Let's **blow** them again!*			
Book	*Here is my **dog** book, what do you see?*	*Let's **open** it again!*		***Point to 4 pictures***	

** Bolded words are modeled on the iPad simultaneously

Appendix K

Interfering Behaviors

All coding uses a partial interval recording system with 5s intervals using ProCoder. Behaviors are not mutually exclusive.

Code	Definition
Aggression	Aggression towards oneself, another person, or any property in the room 1. Hitting 2. Biting (including objects) 3. Kicking 4. Throwing any object 5. Verbal aggression: crying, screaming
Repetitive motor movements	1. Stereotypic hand movements: any movement of the hands or fingers that is repeated more that 3 times with no more than 1s between occurrences a. Repetitively pressing the iPad in a way that is clearly not communicative 2. Body rocking: any rocking movement of 6 inches or more of the torso that is repeated more that 3 times with no more than 1s between occurrences 3. Repetitively swinging feet/legs should NOT be coded
Escape	1. Escape: Moving out of arms' reach of or turning 90 degrees from the testing materials or examiner (child initiated) a. During child-initiated transition, stop coding escape if and when child settles on a toy set (pauses for at least 3s within arms' length and facing) b. During adult initiated transitions, the child should be facing the old toy set or new toy set or remains in same location as prior toy set 2. Flopping: Resting ones' head or shoulder on the floor, chair, or table. a. This includes slouching in a chair to the point that the head or should touches the chair on the floor or table. b. Any time the child's shoulders or head are under the table. Any attempted escape, in which the adult has to actively stop the child from escaping: putting out an arm or moving the body or furniture to stop the child, picking the child up. Nonexample: the adult has the child in her lap but is not actively stopping him/her from escaping

Appendix L
Community Services Questionnaire

Demographic Information

Child's Name_____ Address _____

Respondent _____ _____

Phone_____ Parent(s) email _____

Child's birth date_____/_____/_____ Gender: (circle one) male female

Diagnostic History

Age of first developmental concern _____months

Developmental concerns:

□Cognitive/learning □Behavior □Hearing □Motor □Language

Autism-related diagnosis:

□Autism □Autism Spectrum Disorder □Asperger syndrome □PDD-NOS

Age at ASD diagnosis: _____months

Diagnosis made by: □Physician □Psychologist □Other

Siblings (#) _____ (ages) _____ (diagnosis, if any)_____

How many people live in your house? _____

Number of adults over 21 years: _____

Number of children younger than 21 years: _____

Race of the child: (circle all that apply)

1. American Indian or Alaska Native
2. Asian
3. Native Hawaiian or Other Pacific Islander
4. Black
5. White
6. Other, specify_____

Ethnicity of the child:

1. Hispanic or Latino 2. Not Hispanic or Latino 3. Other, specify_____

Child lives with: (circle one)

1. Biological mother and father
2. Biological mother and stepfather
3. **Biological mother and same-sex partner**
4. **Biological father and same-sex partner**
5. Biological mother only
6. Biological father only
7. Biological father and stepmother
8. Adoptive parents
9. Foster parents
10. Relatives
11. Other, specify_____

Biological Mother's birth date ____/____/____

Custodial mother's birth date (if different) ____/____/____

Mother's education: (circle one)

1. Less than 7th grade
2. Junior High
3. Some High School
4. High School graduate
5. Some college
6. Special training after high school
7. College graduate
8. Graduate/professional training

Mother's current employment status: (circle one)

1. Not employed
2. Self-employed part-time
3. Self-employed full-time
4. Employed part-time
5. Employed full-time
6. Employed full-time and second job

Mother's occupation prior to birth of study child: _____.

Mother's current occupation: _____.

Biological Father's birth date ____/____/____

Custodial father's birth date (if different) ____/____/____

Father's education: (circle one)

1. Less than 7th grade
2. Junior High
3. Some High School
4. High School graduate
5. Some college
6. Special training after high school
7. College graduate
8. Graduate/professional training

Father's current employment status: (circle one)

1. Not employed
2. Self-employed part-time
3. Self-employed full-time
4. Employed part-time
5. Employed full-time
6. Employed full-time and second job

Father's occupation prior to birth of study child_____.

Father's current occupation_____.

(If applicable) biological parent's same-sex partner's birth date ____/____/____
Or custodial parent's same-sex parent's birth date (if different) ____/____/____

Partner's education: (circle one)

1. **Less than 7th grade**
2. **Junior High**
3. **Some High School**
4. **High School graduate**
5. **Some college**
6. **Special training after high school**
7. **College graduate**
8. **Graduate/professional training**

Partner's current employment status: (circle one)

1. **Not employed**
2. **Self-employed part-time**
3. **Self-employed full-time**
4. **Employed part-time**
5. **Employed full-time**
6. **Employed full-time and second job**

Partner's occupation prior to birth of study child: _____.

Partner's current occupation: _____.

Primary caregiver's first language: _____.

Language(s) currently used when interacting with the child: _____.

Please mark the line next to the range that is closest to your total average yearly household cash/check income before taxes including child support.

____$0 to $4,999 ____ $20,000 to $24,999 ____ $40,000 to $44,999 ____ $60,000 to $64,999

____$5,000 to $9,999 ____ $25,000 to $29,999 ____ $45,000 to $49,999 ____ $65,000 to $69,999

____$10,000 to $14,999 ____ $30,000 to $34,999 ____ $50,000 to $54,999 ____ $70,000 to $74,999

____$15,000 to $19,999 ____ $35,000 to $39,999 ____ $55,000 to $59,999 ____ $75,000 or above

OR

Please list average total yearly (or monthly) cash/check household income before taxes including child support.

Yearly: _____ **OR** Monthly: _____

Does your family receive any of the following assistance? (circle all that apply)

1. Medicaid
2. Food Stamps
3. SSI (Supplemental Security Income)
4. TANF
5. Unemployment
6. WIC
7. Housing Assistance
    1. Commodities / food pantry
    2. Other: _____

Prenatal/Early Postnatal History

Complications during pregnancy? □Yes □No □Don't Know
Used prescription medications during pregnancy? □Yes □No □Don't Know
Birth weight _____lbs._____ oz. □Don't Know
Birth length _____(inches) □Don't Know
Full term? □Yes □No □Don't Know
If No, how many weeks gestation? _____
Number of days in hospital after birth _____

Type of Intervention	Date began	Date ended	Number of hours received/wk	Intervention done as part of group or individually	Where is the intervention delivered?	Who is funding the intervention? SD = School District PP = Private Pay
Early intervention program (e.g. Head Start, Smart Start)				☐ Ind. ☐ Group	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other:_____
				☐ Ind. ☐ Group	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other:_____
				☐ Ind. ☐ Group	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other:_____
Behavioral Therapy (incl. ABA, Lovaas, Discrete Trials, Behavior modification, Adaptive Skill Training)				☐ Ind. ☐ Group	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other:_____
				☐ Ind. ☐ Group	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other:_____
				☐ Ind. ☐ Group	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other:_____
Occupational Therapy (incl. Physical Therapy, Sensory Integration)				☐ Ind. ☐ Group	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other:_____
				☐ Ind. ☐ Group	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other:_____
				☐ Ind. ☐ Group	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other:_____
Speech and Language Therapy				☐ Ind. ☐ Group	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other:_____
				☐ Ind. ☐ Group	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other:_____
				☐ Ind. ☐ Group	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other:_____
Floortime Therapy (incl. Play Therapy)				☐ Ind. ☐ Group	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other:_____
				☐ Ind. ☐ Group	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other:_____
				☐ Ind. ☐ Group	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other:_____

Type of Intervention	Date began	Date ended	Number of hours received/wk	Intervention done as part of group or individually	Is the intervention delivered at school?	Who is funding the intervention? SD = School District PP = Private Pay
Social Skill Training				☐ Ind. ☐ Group	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other: _____
				☐ Ind. ☐ Group	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other: _____
				☐ Ind. ☐ Group	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other: _____
Play Groups (incl. Mommy and Me, Gymboree, swimming, gymnastics)				Number of peers:____	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other: _____
				Number of peers:____	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other: _____
				Number of peers:____	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other: _____
Other (specify): 1) _____ 2) _____ 3) _____				☐ Ind. ☐ Group	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other: _____
				☐ Ind. ☐ Group	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other: _____
				☐ Ind. ☐ Group	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other: _____
Parent Training (specify): 1) _____ 2) _____ 3) _____				☐ Ind. ☐ Group	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other: _____
				☐ Ind. ☐ Group	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other: _____
				☐ Ind. ☐ Group	☐ Home ☐ School ☐ Clinic	☐ SD ☐ PP ☐ Other: _____

COMMENTS:

School/ pre-school programs attended during this period?
(Please indicate if the schedule changed during summer.)

Name of School	Date began	Date ended	Number of hours per week
			Mainstreamed Classroom: ____ hours **Special Ed Classroom: ____ hours**
			Mainstreamed Classroom: ____ hours **Special Ed Classroom: ____ hours**
			Mainstreamed Classroom: ____ hours **Special Ed Classroom: ____ hours**

Has your child taken any medication during this period?

Name of Medication	Date began	Date ended	Dosage per day

Has your child taken any vitamin supplements, special/restricted diets or alternative (i.e. homeopathic) treatments?

Name of Medication	Date began	Date ended	Dosage per day

Did anyone ever say that your child had a medical problem or give you a medical diagnosis for him/ her? What about hearing? During the period mentioned above, did your child's diagnosis change?

Medical diagnosis	Approximate date	Who made the diagnosis? (e.g. physician)