ABSTRACT

Title of Thesis: LANGUAGE OUTCOMES OF THE PLAY AND LANGUAGE FOR AUTISTIC YOUNGSTERS (PLAY) PROJECT HOME CONSULTATION MODEL—AN EXTENDED ANALYSIS

Allison Catalano, Master of Arts, 2016

Thesis Directed By: Dr. Nan Bernstein-Ratner, Department of Hearing and Speech Sciences

The current study is a post-hoc analysis of data from the original randomized control trial of the Play and Language for Autistic Youngsters (PLAY) Home Consultation program, a parent-mediated, DIR/Floortime based early intervention program for children with ASD (Solomon, Van Egeren, Mahoney, Huber, & Zimmerman, 2014). We examined 22 children from the original RCT who received the PLAY program. Children were split into two groups (high and lower functioning) based on the ADOS module administered prior to intervention. Fifteen-minute parent-child video sessions were coded through the use of CHILDES transcription software. Child and maternal language, communicative behaviors, and communicative functions were assessed in the natural language samples both pre- and post-intervention. Results demonstrated significant improvements in both child and maternal behaviors following intervention. There was a significant increase in child verbal and non-verbal initiations and verbal responses in whole group analysis. Total number of utterances, word production, and

grammatical complexity all significantly improved when viewed across the whole group of participants; however, lexical growth did not reach significance. Changes in child communicative function were especially noteworthy, and demonstrated a significant increase in social interaction and a significant decrease in non-interactive behaviors. Further, mothers demonstrated an increase in responsiveness to the child's conversational bids, increased ability to follow the child's lead, and a decrease in directiveness. When separated for analyses within groups, trends emerged for child and maternal variables, suggesting greater gains in use of communicative function in both high and low groups over changes in linguistic structure. Additional analysis also revealed a significant inverse relationship between maternal responsiveness and child non-interactive behaviors; as mothers became more responsive, children's non-engagement was decreased. Such changes further suggest that changes in learned skills following PLAY parent training may result in improvements in child social interaction and language abilities.

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by

Allison Catalano

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Advisory Committee:
Nan Bernstein-Ratner, Chair
Yi Ting Huang
Rochelle Newman

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Introduction

Over the past two decades, there has been a dramatic increase in the incidence of autism spectrum disorder (ASD), with the latest report indicating a prevalence of 1 in every 68 children (U.S. Centers for Disease Control and Prevention, 2014). Although the increase in prevalence may be attributed to a heightened awareness of the disorder, differences in diagnostic criteria, and changes in availability of services (Blumberg et al., 2013; Schieve et al., 2011), the need for early, effective, and most importantly evidence-based, intervention services is undeniably more essential than ever (Camarata, 2014; Warren, et al., 2011). A number of treatment approaches have been developed to address the persistent deficits in social communication and the restricted, repetitive behaviors and interests that are among the core deficits of ASD. However, identifying the most effective treatments remains controversial. Despite the large number of available treatment approaches, the evidence behind many approaches is still relatively weak. Especially in the realm of developmental social-pragmatic approaches and parent-mediated models, additional high-quality randomized controlled trials are still necessary in order to establish the effectiveness of treatment (Camarata, 2014; Dudzinska, Szymona, Pacian, & Kulik, 2015; Oono, Honey, & McConachie, 2013; Warren, et al., 2011; Weitlauf et al., 2014).

The Play and Language for Autistic Youngsters (PLAY) Project Home Consultation model is a Developmental, Individual-differences, Relationship-based (DIR/Floortime) early intervention model that trains parents to utilize communication techniques to enhance social interactions during parent-child play in order to decrease child use of ASD behaviors and promote child development and social communication. A recent randomized control trial (RCT) conducted by Solomon & colleagues (2014) demonstrated the effectiveness of the PLAY protocol as an early intervention program for young children with ASD. It documented

improved outcomes in parent-child interactions, child socio-emotional functioning, child ASD symptomology, and parent stress and depression following intervention. Mahoney & Solomon (2016) further analyzed the effectiveness of the PLAY project techniques, demonstrating that an increase in parent use of learned PLAY skills positively correlated with increases in child social engagement. Although both analyses demonstrated positive changes from pre- to post-intervention, the measures utilized were primarily broad measures such as parent reports and behavior rating scales that could not describe actual linguistic and functional changes in child or parental language use from pre- to post-intervention. Thus, further analysis may reveal specific changes in behavior that were not fully captured by the measures utilized in previous studies.

The remainder of this introduction will discuss the principles and intervention methods of DIR/Floortime and the PLAY project early intervention program. We will then provide a brief overview of the findings from the original RCT and will discuss limitations of the measures utilized to assess child and maternal language analysis. We will discuss the potential for additional investigation of language outcomes through the use of natural language sample analysis (LSA), in order to further inform child and maternal language outcomes as a result of the PLAY project.

DIR/Floortime and the Principles of the PLAY Program

The PLAY project is a developmental social pragmatic approach to ASD treatment that is based on principles of DIR/Floortime. DIR/Floortime treatment follows the child's progression through Greenspan's (1992) six developmental milestones, emphasizing parental involvement, reciprocal communicative exchanges, and learning through real-life contexts. Clinicians train the parents to follow the child's lead by first identifying the child's interests and behaviors, then

approaching the child in his or her natural playing environment, joining in, and utilizing various techniques in order to enhance social communication. The parents imitate and elaborate on the child's actions as well as set up communicative temptations, with the ultimate goal of creating and closing "circles of communication". According to Greenspan's (2001) "affect diathesis hypothesis", as a result of these enjoyable, child-led interactions, the child will inherently move sequentially through the levels of social development as well as reduce in symptoms of ASD.

The PLAY program follows the principles of DIR/Floortime described above. In the PLAY program, parents are trained to optimize interactions with their children by joining the child in his/her natural playing environment, identifying the child's interests, and following the child's lead. The parent is taught various techniques that work to enhance social communication during play through a structured format of coaching, modeling, and video feedback sessions. Techniques focus on being more responsive, more affective, and less directive during parent-child communication in order to create more circles of communication. The child's developmental profile is continually assessed throughout intervention and techniques are modified in order for optimal developmental growth.

Although DIR/Floortime-based interventions are widely used for treatment in ASD, the current evidence base is controversial. A number of studies have demonstrated benefits of DIR/Floortime, with improvements noted in maternal responsiveness, the number of communication circles, child social communication skills, and child social-emotional development (Dionne & Martini, 2011; Greenspan & Wieder, 1997, 2005; Mahoney et al., 2003; Solomon et al., 2014; Wieder & Greenspan, 2003). However, the majority of these studies are considered weak study designs, using single or few subjects and designs that lack randomized assignment as well as control group comparisons.

A recent systematic review conducted by Mercer (2015) found four randomized control trials that provide strong support for DIR/Floortime-based treatments (Casenhiser et al., 2013; Lal & Chhabria, 2013; Pajareya & Nopmaneejumruslers, 2011; Solomon et al., 2014). Children who participated in these approaches demonstrated significant improvements in the general quality of their social interactions (Casenhiser et al., 2013), in their turn-taking, their two-way communication, and their understanding of cause and effect relationships (Lal & Chhabria, 2013). In addition, positive outcomes were also demonstrated in a study examining the use of DIR/Floortime for children with ASD in Thailand, suggesting that intervention can be replicated cross-culturally (Pajareya & Nopmaneejumruslers, 2011). The results of Solomon and colleagues (2014) are especially noteworthy as they provide the first RCT of a DIR/Floortime-based, parent and child centered, intervention approach, in which significant improvements were not only noted in interactional skills and functional development, but also in ASD symptomology.

Review of Solomon et al. (2014) RCT of PLAY

Solomon and colleagues (2014) compared the effectiveness of the PLAY approach to usual community services for children with ASD. One hundred twenty-eight children diagnosed with ASD or PDD-NOS between the ages of two years, eight months and five years, eleven months were randomly assigned to two one-year interventions, in which half of the children received the experimental treatment, the PLAY program, and the other half received typical community services. Measures of child socio-emotional development, parent-child interactions, and ASD symptomology were collected before intervention as well as twelve months later upon completion of the one-year intervention program.

Child and parental outcomes were assessed by a number of different measures. Parent-child play interactions were video-recorded during play sessions before and after the twelve months of intervention and interactional behaviors were measured through the use of rating scales. The *Maternal Behavior Rating Scale* (*MBRS*; Mahoney, Powell, & Finger, 1986) assessed the mother's responsiveness to her child, her use of affect and animation, her ability to achieve orientation, and her directiveness, while the *Child Behavior Rating Scale* (*CBRS*; Mahoney, Powell, & Finger, 1986) assessed the child's attention and initiation. Autism severity was measured through the administration of the *Autism Diagnostic Observation Schedule—Generic* (*ADOS-G*; Lord et al., 2000) and *Social Communication Questionnaire* (*SCQ*; Rutter, Bailey, & Lord, 2003), a parent report measure. *The Mullen Scales of Early Learning* (Mullen, 1995) as well as the *MacArthur-Bates Communicative Development Inventories Word and Gestures Form* (*MCDI-WG*) and *Words and Sentences Form* (*MCDI-WS*; Fenson et al., 1993), a standardized parent-report measure, were used to measure language. Child social-emotional functioning was measured through the use of the *Functional Emotional Assessment Scale* (*FEAS*; Greenspan, DeGangi, & Wieder, 2001) and parental measures of stress and depression were measured through the use of the *Parenting Stress Index* (*PSI*; Abidin, 1990) and the *Center for Epidemiologic Studies Depression Scale* (*CES-D*; Radloff, 1977).

Solomon and colleagues (2014) demonstrated positive outcomes in parent-child interactions, ASD symptomology, and child socio-emotional functioning, as well as in measures of parent stress and depression. Quality of parent-child interactions improved in the PLAY families, with significant improvements in parental responsiveness and engagement and in child social communication skills such as shared attention and initiation. Children who received the PLAY program were significantly more likely to improve in ASD diagnostic classification as

compared to peers who received usual community services. There was also a significant improvement in child social-emotional functioning, with the children receiving usual community services remaining relatively stable. Parental stress and depression scores also decreased over time, although this change was not statistically different from that seen in the parents of the control group.

Although there were improvements in various child developmental outcomes, verbal and non-verbal language outcomes as a result of the PLAY program were not as definitive. On *The Mullen Scales of Early Learning*, there was a trend in which the PLAY children's scores improved more than those of the control children; however, this trend was not significant. The children did demonstrate improvements on the *MCDI-WG* and *MCDI-WS*; however, these improvements were not significantly greater than those seen in the children receiving usual community services. Thus, PLAY did not appear comparatively advantageous in improving children's language outcomes.

Use of Natural Language Sample Analysis to Determine Maternal and Child Language Outcomes

It is possible that the lack of language outcomes found in Solomon and colleagues (2014) is not an accurate depiction of the actual language improvements the children experienced as a result of the PLAY program. *The Mullen Scales of Early Learning* only includes a few items that can be used to measure language. In addition, not all children were able to complete the *Mullen Scales*, with 20% of children at baseline and 17% of children post-intervention unable to complete the assessment because of low developmental functioning. The *MCDI-WG* and *MCDI-WS* also determined language outcomes. The *MCDI*, which demonstrated the only significant

language outcome, was only completed for 30% of children at baseline and 51% of children post-intervention, missing a large portion of the children who participated in the study. In addition, the *MCDI* is a parent-report language measure and is subject to parental bias as a result of any intervention, regardless of intervention type.

A report conducted by a panel of experts chosen by the National Institute on Deafness and Other Communication Disorders (NIDCD) indicates that a parent-report alone is not sufficient evidence for determining treatment outcomes of early intervention programs for ASD. Measurement approaches should instead encapsulate both specific language measures, including direct assessments and parent reports, as well as more extensive measures, specifically measurements derived from natural language sample analysis (Tager-Flusberg et al., 2009). Standardized parent reports are highly valid and reliable measures of language (Luyster, Qui, Lopez, & Lord, 2007); however, with the lack of scores for more than half of the participants as well as the lack of extensive measures such as language sample analysis, it is likely that language outcomes were not completely represented in the Solomon and colleagues (2014) study.

In addition to child language measures, maternal language and communicative behaviors can also be further analyzed. Maternal behaviors were scored through the use of behavior rating scales. Although changes in overall responsiveness, affect, directiveness, and orientation from pre- to post-intervention were documented through MBRS score, changes in the specific types of behaviors as well as their frequencies was not documented. Mahoney and Solomon (2016) demonstrated that increased MBRS scores of maternal responsiveness and affect predicted improvements in child social engagement; however, the behaviors utilized to achieve positive affect and responsiveness were not documented. Identifying the specific changes in maternal behaviors that follow the PLAY program enrollment and ability to relate changes in these

behaviors to child social and developmental outcomes will not only improve the quality of the PLAY treatment, but could provide valuable insight into general ways in which we can improve the overall treatment of ASD.

Natural language sample analysis is an ecologically valid approach to analyzing child language use and can highlight important communicative features that may have been missed through the use of the *MCDI*, *The Mullen Scales of Early Learning*, and the MBRS. Computerized programs have been developed to aid in the transcription and analysis of natural language samples, including those developed by the Child Language Data Exchange System (CHILDES; MacWhinney, 2000). Language sample analysis allows for the coding of verbal and non-verbal language utilized by the child within his or her natural environment. Language is transcribed and can be assessed for linguistic quantity and structure. Further analysis may reveal specific lexical and syntactic gains that were not captured by the standardized assessments used in the current study.

In addition to verbal language measures, language sample analysis can also capture non-verbal communication profiles. Early communication serves functional purposes long before the production of words (Wetherby, Cain, Yonclas, & Walker, 1988). Infants first learn that language serves a variety of communicative functions. They begin to communicate these functions through the use of gestures and vocalizations and, it is then from this basis that the production of words can emerge. It is therefore important to assess the use of communicative functions as well as the use of non-verbal communicative behaviors in children with language impairments. Natural language sample analysis is useful for analyzing these social communication behaviors, which are most affected in children with ASD and are difficult to measure through standardized assessments. Children with ASD utilize both verbal and non-

verbal communicative acts less often than typically developing peers and communicate with the primary function of regulating the behavior of others, with very few attempts for joint attention and social interaction (Shumway & Wetherby, 2009). The use of natural language sample analysis can allow for the coding of these specific communicative behaviors to determine changes over intervention.

Parental verbal and non-verbal communicative behaviors can also be quantitatively measured and assessed within the same natural environment. Since the PLAY project is a parent-mediated treatment program, it relies on parental use of learned techniques. Through the use of language samples, we can measure maternal communicative behaviors pre- and post-intervention to determine changes in specific behaviors that are emphasized by the PLAY program. As with other parent-training programs, there is a presumption that changes in the mother's behavior should result in changes in the child's behavior. Therefore, by quantifying behaviors through language sample analysis, we should be able to determine relationships between changes in maternal behaviors and changes in child behaviors.

Research Questions

In the current study, we used natural language sample analysis through the use of CHILDES transcription and CLAN analysis software to further examine the language and communicative outcomes of the PLAY project early intervention program RCT. As this was a preliminary analysis, we focused solely on the children who received the PLAY intervention. In addition, as ASD is a spectrum disorder and the needs/abilities of low functioning children are likely to be quite different from those of high functioning children, we separated the children into two groups based on pre-treatment ASD severity for further analysis.

As the first goal of this project, we hoped to extend the current evidence base for the PLAY project (Solomon et al., 2014; Mahoney & Solomon, 2016) in a number of ways. First, we examined if child verbal and non-verbal communicative behaviors improved significantly post-administration of the PLAY intervention beyond the results reported on the *MCDI* and *The Mullen Scales of Early Learning*. We analyzed child verbal and non-verbal language for improvements in quantity of verbal output, increases in vocabulary and linguistic structure and changes in linguistic function of behaviors. We hypothesized that all children would demonstrate significant improvements in the quantity of utterances produced as well as in the production of words from pre- to post-intervention. We also hypothesized that both groups of children would demonstrate improved verbal language outcomes as seen through an increase in lexical diversity and grammatical complexity of speech post-intervention. In addition, we also predicted that children receiving PLAY services would improve social interaction abilities as seen through an increase in the proportions of initiations, responses, and social interactive behaviors, as well as a decrease in non-interactive behaviors symptomatic of ASD.

Since the higher functioning children have greater language and communicative abilities prior to intervention, we predicted that these children would show greater improvements in the *function* of communicative behaviors, while we predicted that the children in the lower functioning group, who displayed lower language and communicative abilities prior to intervention, would likely show global improvements in the quantity, linguistic structure as well as function of communicative behaviors.

Second, since the PLAY project is a parent-mediated treatment program, we hypothesized that maternal verbal and non-verbal communicative behaviors targeted by the PLAY program would also change significantly post-intervention. We predicted that, following

intervention, mothers of both the high and lower functioning groups would increase use of verbal and non-verbal responsive behaviors, increased ability to follow the child's lead, and decreased use of directive behaviors. In summary, the two major research questions of the current study were:

1. Does the PLAY intervention program significantly improve children's verbal and non-verbal communicative behaviors?
2. Does the PLAY intervention program significantly change the program's targeted maternal verbal and non-verbal communicative behaviors?

Additionally, we examined the degree of benefit from the PLAY program as a function of the pre-intervention communicative profiles of the mother and the child. Since the PLAY project is a parent-trained intervention approach, the communicative skills of the mother may greatly impact the child's progress and outcomes. We therefore examined if the degree of change observed in the mother's communicative behaviors was related systematically to changes in the child's communicative behaviors. The PLAY program specifically emphasizes that mothers need to increase their frequency of following the child's lead and responding to the child's intents. Therefore, we predicted that increases in maternal use of responsive behaviors from pre- to post-intervention would correlate with improvements in their children's functional communication. Verbal responsiveness should also directly impact the child's language. Responsive behaviors such as expansions are known to promote child language development by providing additional semantic and/or syntactic information (Cleave et al., 2015). Therefore, we predicted that if the mother increased her use of expansions from pre- to post-intervention, then the child would demonstrate improvements in vocabulary and/or grammar. Thus, our third question was:

3. Do changes in the mother's communicative behaviors following the PLAY intervention program relate to specific changes in the child's communicative behaviors?

Methods

Intervention Methods

In the current study, we examined data from the original Solomon and colleagues (2014) study (a full review of the methods used in the study can be found in Solomon et al., 2014). In the original study, measures regarding child development, parent-child interactions, and ASD symptomology were collected from 128 children with a diagnosis of ASD and PDD-NOS. The children were referred to Easter Seals, a national, nonprofit, disability service agency, by local physician offices in 5 U.S. cities. The recruited children were split into two one-year cohorts and within the cohorts, were split into an experimental group, who received the PLAY program intervention services, and a control group, who received usual community services. For the current study, we will solely focus on intervention methods for the experimental group.

In the experimental group, 1 of the 6 certified PLAY consultants was assigned to each family to train the primary caregiver in the PLAY principles, methods, and techniques. Training sessions occurred during 3-hour home visits once a month over the span of 12 months and consisted of consultant coaching, modeling, and video feedback sessions. PLAY consultants coached the primary caregivers to follow the child's lead, detect the child's cues and intents, and respond to the child's behaviors in a way that would facilitate an effective and reciprocal communicative exchange. Parents were also coached on how to provide developmentally appropriate challenges in correspondence with Greenspan and Wieder's Functional Developmental Levels (Greenspan & Wieder, 1997). Consultants modeled target behaviors during 15-30 minute clinician-child play session and parents were then able to implement these techniques in their own play with their child. Written feedback was provided including a review of the interactions, a summary of the child's developmental profile, and any recommendations

based on the child's evolving development. Between sessions, parents were encouraged to engage in 15-20 minute play sessions with their child for a total of 2 hours a day.

Various measures were collected before and after treatment in order to assess treatment outcomes. ASD symptomology was measured through the use of the ADOS-G and SCQ, child socio-emotional functioning was measured through the FEAS, parent-child interactions were measured through the MBRS and CBRS, parent stress was measured through the PSI, parenting depression was measured through the CES-D, and child language outcomes were measured through the use of *The Mullen Scales of Early Learning* and the MCDI. Video files of mother-child play sessions were obtained before and after the 12 months of treatment.

Participants

Twenty-two participants from the experimental group were chosen for the current study. These participants were chosen based on ADOS module administered upon first visit. The five modules of the ADOS assess varying levels of communicative ability. When administering the ADOS, one module is selected based on the age and expressive language profile of the child. ADOS module 1 was administered to children who produced minimal to no verbal language at onset of the study. Such children may speak in single words or may only utilize pre-verbal communication skills such as gestures or pointing. ADOS module 2 was administered to those children who produced "phrasal speech" or spontaneous and meaningful word combinations; however, these children did not have age-appropriate language skills. For the current study, children in the lower functioning group were defined as those who were administered ADOS module 1 and children in the higher group were defined as those who were administered ADOS module 2. Only 12 participants who received the PLAY treatment from the original study were

administered ADOS module 2. Therefore, these 12 participants were selected to be included in the higher functioning group. We then determined the age range of these 12 children and assigned 12 children who received ADOS module 1 to the lower group, matching for age as closely as possible.

Following initial selection, only 11 pairs of participants were chosen for the two groups in the current study, due to complications with video documentation for one dyad, leading to exclusion of its matching comparison child as well. The higher functioning group consisted of one female and ten males between the age of 42 and 71 months (M = 57.36), while the lower functioning group consisted of three females and eight males between the age of 48 and 67 months (M = 57.18). All of the participants and caregivers were native-English speakers. All of the caregivers trained to administer treatment were mothers.

Procedures

Child and maternal language outcomes were determined through the use of natural language sample analysis. CITI credentialed undergraduate and graduate students from the University of Maryland were recruited to transcribe the 15-minute pre- and post-treatment video files of mother-child interactions. Out of the 44 files collected, four files for participants in the higher functioning group were shorter than 15 minutes in length. Due to limited participants in this group, video files were cut to equal length for the matched pair in the other group and remained in the analyses.

Coders were blind to condition, group, and time. Verbal and non-verbal language was transcribed for both the child and mother through the use of CHILDES CHAT protocols

(MacWhinney, 2001). A total of 9,911 maternal utterances and 33,706 maternal words were transcribed. A total of 7,044 child utterances containing 11,336 words were transcribed.

Transcripts were then coded for communicative intent and manner. Communicative act codes were adapted from the Inventory of Communicative Acts, or INCA codes (Ninio & Wheeler, 1986) Types of acts were divided into three categories: initiating behaviors, responding behaviors, and non-interactive behaviors. Initiating behaviors included any vocalizations, gestures, or facial expressions that opened a circle of communication, while responding behaviors included any vocalizations, gestures, or facial expressions that closed a circle of communication. All initiations and responses were further coded as verbal behaviors or non-verbal behaviors. If a communicative partner utilized both a verbal and non-verbal behavior within one initiation or response, the verbal behavior was coded, as this is a more sophisticated form of communication. Non-interactive behaviors are those that appear to serve no communicative purpose and are typically self-regulatory, such as fixating on objects, flapping, singing to oneself, or ignoring communicative attempts by persisting in ongoing activities or states.

Communicative Types	
Type of Behavior	**Explanation**
Initiating (I)	Behaviors that initiate an interaction and open a circle of communication. These behaviors may include, but are not limited to, calling the hearer's name, initiating eye contact, requesting an action, directing the hearer's attention to an object, person, or event, and asking a question. Initiations are further marked as verbal (IV) or non-verbal (INV).
Responding (R)	Behaviors that are in response to a communicative bid and therefore close the circle of communication. These behaviors may include, but are not limited to, answering the speaker's call for attention, making eye contact with speaker upon request, performing an action in response to the speaker's request, and answering a question. Responses are further marked as verbal (RV) or non-verbal (RNV).

Non-interactive (N)	Behaviors that serve no communicative purpose. These behaviors may include, but are not limited to, ignoring questions, comments, or requests, fixating on objects, refusing to answer or act, and walking away from communication partner.

The total number of these behaviors was proportioned over the Mean Length of Turn (MLT), or the average length of conversational turn. Any verbal or non-verbal behavior, or set of behaviors, that began a communicative interaction was coded as one initiation for the duration of that behavior until there was a response from or failure to communicate by the other communication partner. Any verbal or non-verbal behavior, or set of behaviors, that responded to a communicative bid was coded as one response. Alternating responding behaviors between the two communicative partners were continually coded as responses until a new topic was initiated. Responses were only coded in response to the other communicative partner's bid, not in response to self.

In addition to coding the different types of behaviors, we also coded the communicative function or the reason for the behavior. The three major functions of communication include behavior regulation, social interaction, and joint attention (Bruner, 1981; Wetherby & Prizant, 2002). We divided communicative function into two broad categories, behaviors for behavioral regulation and behaviors for social interaction. Acts for behavior regulation included those meant to regulate another person's behavior in order to obtain a specific result. Communicative acts used for social interaction were those meant to attract or maintain the other communication partner's attention.

Communicative Functions	
Communicative Function	**Explanation**
Social interaction (SI)	Behaviors used to initiate or respond to social interaction. Goal is to attract or maintain another's attention. These behaviors may include, but are not limited to, asking

	questions about an activity, initiating/responding to a social smile, initiating/responding to physical comfort such as kissing or hugging, and initiating/completing a turn in a social game.
Behavior regulation (BR)	Behaviors used to regulate the behavior of another person. Goal is to get the other person to do something or to stop doing something. These behaviors may include, but are not limited to, crying for the mom to give back a toy, requesting the child to do something physical with a toy, and requesting the communicative partner to move or come.

It was possible for a communicative interaction to be both for behavior regulation and for social interaction; however, non-interactive behaviors were considered mutually exclusive. Therefore, it was possible obtain averages greater than 100% for behaviors coded over turns for social interaction and behavior regulation.

Measures

Child Communicative Behaviors and Language

Verbal and non-verbal communicative behaviors were measured for quantity and function. Since the PLAY program emphasizes child-led interactions, we measured changes in child initiations from pre- to post-intervention. Initiations were computed as the total number of initiations produced over the MLT. As the children in the lower functioning group had minimal language, we separated analysis into changes in verbal and non-verbal initiations. Since these child-led interactions should promote social interaction, we also measured increases in child responses from pre- to post-intervention. Responses were also measured as the total number of responses over child MLT and were separated into verbal and non-verbal responses for analysis.

Improvements in child verbal language were also measured for quantity. Multiple measures were utilized to determine changes in production of utterances, production of words,

lexical diversity, and grammatical complexity. Production of utterances was computed as the total number of utterances produced from pre- to post-intervention, given the standard time frame for the interaction. Word production was determined as the total number of words (tokens) produced from pre- to post-intervention, as well as the number of different types of words produced from pre- to post-intervention.

Two measures were utilized to analyze grammatical complexity, based on the child's pre-intervention profile (high vs. lower functioning). Mean length of utterance (MLU; Brown, 1973) is a well-regarded and widely used early child language measure appropriate to fairly immature language users. MLU is no longer considered an appropriate assessment tool after an individual has an MLU of 4 or 5. The Index of Productive Syntax (IPSyn; Scarborough, 1989), which computes a score based on the presence of 60 specific grammatical elements, is a more appropriate assessment measure for more mature language. Therefore, we measured changes in grammatical complexity as both changes in MLU in morphemes from pre- to post-intervention, as well as changes in IPSyn score (Scarborough, Rescorla, Tager-Flusberg, Fowler, & Sudhalter, 1991) from pre- to post-intervention.

Two measures were also utilized to analyze vocabulary in order to account for the varying language profiles of the two groups. Vocabulary diversity (*Vocd*; Malvern, & Richards, 2002) accounts for longer samples that contain a greater number of tokens by randomly sampling a number of words from the speech, calculating the TTR, and then repeating this process multiple times on randomly selected samples of tokens from the child's speech. *Vocd* is therefore likely to be a more accurate picture of the lexical diversity in the more advanced speech of the higher functioning children (Durán, Malvern, Richards, & Chipere, 2004). *Vocd*, however, cannot be used with short samples characteristic of the low functioning sample. Therefore,

number of different words in 100 words (NDW) was used to assess language for the lower functioning group. Improvements in lexical diversity were defined as changes in *vocd* and changes in NDW from pre- to post-intervention.

The core deficits in ASD are deficits in social interaction and restrictive, repetitive patterns of interest. Children with ASD typically utilize communicative behaviors to regulate another person's behavior rather than for social interaction. Therefore, we assessed child communicative behaviors for changes in the use of behavior regulation, an increase in the use of social interaction, and a decrease in non-interactive behaviors characteristic of ASD. Behavior regulation was defined as the total number of behaviors for behavior regulation from pre- to post-intervention over the child's MLT. The same was computed for behaviors for social interaction and non-interactive behaviors.

Maternal Communicative Behaviors and Language

We were not interested in the same developmental language measures in the mothers as we were for the children. We were instead interested in the mother's ability to learn the principles of the PLAY program and to implement the various techniques emphasized by the program into her own interactions with her child. The PLAY project emphasizes maternal communicative skills that work to detect the child's intents, follow the child's lead, and respond to the child's behaviors creating effective, rewarding, and reciprocal communicative exchanges that ultimately promote child development. Maternal language measures were therefore focused on behaviors that promote responsiveness, following the child's lead, and positive social interactions.

Overall maternal responsiveness was defined as the total number of maternal responses over the mother's MLT. We also separated changes in the proportion of non-verbal responses and verbal responses from pre- to post-intervention. Since the parent-child interactions in PLAY should be child-led, we also assessed maternal initiations from pre- to post-intervention. Initiations were determined as the total number of initiations from pre- to post-intervention over the MLT and were further separated into non-verbal and verbal improvements.

We also measured the function of maternal behaviors. The PLAY program emphasizes a decrease in parental directiveness and an increase in positive social interactions. We operationally defined directiveness as use of behavior regulation language, and measured it as the total number of behaviors for behavior regulation over the mother's MLT. Social interaction was defined as the total number of behaviors used for social interaction over the mother's MLT.

For maternal verbal language outcomes, we examined the mother's language for responsiveness. We assessed maternal ability to verbally respond to child utterances through the use of maternal expansions and imitations. These were computed as the proportion of maternal expansions over total maternal utterances from pre- to post-intervention, as well as the proportion of imitations over total maternal utterances from pre- to post-intervention.

Relationship Between Maternal and Child Communicative Behaviors

As the PLAY project is a parent-mediated model we also conducted post-hoc analyses to determine relationships between changes in maternal behavior and changes in child behavior. Since the PLAY project emphasizes maternal responsiveness in order to increase child social interaction. Specifically, we asked if an increase in maternal responsivity (proportioned over MLT) correlated with a decrease in child non-interactive behaviors. Therefore, we also asked if

an increase in maternal expansions from pre- to post-intervention (as a proportion of maternal MLT) was related to in an increase in child MLU.

Reliability

In order to establish reliability of coding, transcripts were given to a second coder and reliability between the second coder and the author was computed. The middle five minutes of eight total video files were coded for reliability. These eight files consisted of pre- and post-intervention video files from two participants in the higher functioning group and from two participants in the lower functioning group. Reliability was determined for each broad category of communicative act types (e.g., the sum of identical codes for initiations, responses, and non-interactive behaviors) and category of communicative act functions (e.g., the total number of function judgments: behavioral regulation and social interaction). Pairwise correlations were conducted to determine reliability of each. Spearman's rank correlations range from .812 to .976. The lowest agreement was non-verbal initiations ($p = .014$) and the highest agreement was non-verbal responses ($p = .00001$). All correlations were significant, and suggested adequate reliability of coding. The first rater's codes were used for computations.

Results

Child Verbal and Non-Verbal Language Outcomes

1.1. Child Communicative Behaviors

As the two groups of children showed very unequal variances for most of the measures of interest, Wilcoxon signed-rank tests were conducted to assess the significance of all language outcomes from pre- to post-intervention. We first examined the quantity of child communicative behaviors. We controlled for the number of analyses by adjusting the .05 alpha level on a per-hypothesis basis, with verbal and non-verbal behaviors considered separate hypotheses for both child initiations and responses, resulting in a criterial level of .025. Child initiating behaviors increased significantly from pre- to post-intervention (See Table 1). Results demonstrated a significant increase in the proportion of verbal initiations from pre- to post-intervention (M = .13, M = .22; Z = 3.052, p = .002). The proportion of non-verbal initiations also increased significantly from pre- to post-intervention (M = .014, M = .039; Z = 2.41, p = .016). Thus, we found that post intervention, children were interacting more and utilizing a greater quantity of verbal and non-verbal communicative behaviors during parent-child interactions than they had done at baseline.

In addition to an increase in initiating behaviors, children also demonstrated an increase in responding behaviors. The increase in the proportion of child verbal responses during parent-child interactions was significant (M = .36, M = .46; Z = 2.69, p = .007), indicating greater child verbal responsiveness post intervention. Although verbal responses increased significantly, analysis revealed that the proportion of non-verbal responses decreased (M = .16, M = .14); however, this decrease was not significant (Z = 1.006, p = .314).

Table 1. Child Communicative Behaviors

Measure	Mean Pre	Mean Post	p value
Initiations			
Non Verbal	0.014	0.039	0.016*
Verbal	0.131	0.220	0.002*
Responses			
Non-Verbal	0.161	0.137	0.314
Verbal	0.361	0.463	0.007*

1.2. Child Language

We also analyzed the quantity of the language the children produced from pre- to post-intervention. We found that the children produced more language following the PLAY program (See Table 2). The total number of child utterances increased by over a third following intervention (M = 77.2, M = 108.2), which is a significant increase (Z = 2.08, p = .038). Not only did the children produce more utterances, but they also produced more words within these utterances. We controlled for the number of analyses by adjusting the .05 alpha level on a per-hypothesis basis, with word totals and word types considered separate hypotheses, resulting in a criterial level of .025. The total number of words the children produced increased by two thirds from pre- to post-intervention (M = 194.1, M = 321.2), demonstrating a significant increase in word production following intervention (Z = 2.59, p = .009). In addition to producing more total words, the types of words the children produced increased by half of the baseline total (M = 73.9, M = 107.9) demonstrating a significant increase (Z = 2.94, p = .003).

After examining the number of children's verbal and non-verbal communicative behaviors, we analyzed the grammatical and lexical complexity of their language. We controlled for the number of grammatical analyses by adjusting the .05 alpha level on a per-hypothesis basis, with changes in IPSyn score and changes in MLU considered separate hypotheses,

resulting in a criterial level of .025. We found that after intervention, children demonstrated an increase in grammatical complexity as seen through improvements in both IPSyn score and MLU in morphemes. The increase in IPSyn score was significant (M = 39.6, M = 51.9; Z = 3.3124, p = .0009), indicating the presence of a greater number of syntactic forms in child speech following intervention. The increase in MLU in morphemes was also significant (M = 2.49, M = 2.90; Z = 2.66, p = .0078), further suggesting improvements in grammatical complexity of child speech after participation in the PLAY program.

Improvements in vocabulary were not as consistent. We controlled for the number of vocabulary analyses by adjusting the .05 alpha level on a per-hypothesis basis, with changes in *vocd* and NDW considered separate hypotheses, resulting in a criterion level of .025. As reported above, the children demonstrated a significant increase in the different types of words used; however, neither measure utilized in the current study to assess vocabulary improvements demonstrated significant increases in vocabulary from pre- to post-intervention. Child *vocd* scores improved (M = 41.5, M = 55.5): however, this increase was not statistically significant (Z = 1.89, p = .058). NDW decreased slightly from pre- to post-intervention (M = 48, M = 47.2; Z = 0.525, p = .599), indicating little change in child vocabulary during parent-child interactions. Possible reasons for this will be addressed in discussion.

Table 2. Child Language

Measure	**Mean Pre**	**Mean Post**	**p value**
Total Utterances	77.2	108.2	0.038*
Words			
Types	73.9	107.9	0.003*
Total	194.1	321.2	0.009*
Syntactic Complexity			
IPSyn	39.6	51.9	0.0009*
MLU Morphemes	2.49	2.90	0.0078*

Vocabulary			
Vocd	41.5	55.5	0.058
NDW	48	47.2	0.599

1.3. Child Communicative Function

The proportion of behaviors used for behavior regulation slightly increased from pre- to post-intervention (M = .467, M = .473); however, this increase did not reach significance (Z = .617, p = .537). We found a significant increase in the proportion of behaviors used for social interaction following intervention (M = .539, M = .796; Z = 4.09, p = .00004), further confirming a core principle of the PLAY program (See Table 3). We also found a significant decrease in the proportion of non-interactive behaviors displayed by the children with ASD following PLAY program enrollment (M = .339, M = .176; Z = 3.93, p = .00009). These results further suggest a significant difference in social interactive behaviors following PLAY intervention.

Table 3. Child Communicative Function

Child Communicative Behavior Function			
Measure	**Mean Pre**	**Mean Post**	**p value**
Behavior Regulation	0.467	0.473	0.537
Social Interaction	0.539	0.796	0.00004*
Non-Interactive	0.339	0.176	0.00009*

1.4. High vs. Low Child Communicative Behaviors

After assessing child language outcomes as a whole, we separated analyses by high and low groups to assess more specific patterns of change. First, we determined patterns of change in the quantity of communicative behaviors. We found that the number of initiating behaviors in both groups of children increased; however, improvements were only significant for the lower

functioning group (See Table 4). The proportion of verbal initiations in the higher functioning group increased non-significantly following intervention (M = .189, M = .268; Z = 1.823, p = .068). In addition, the proportion of non-verbal initiations in the higher functioning group increased slightly from pre- to post-intervention (M = .018, M = .025), although this increase was not significant (Z = .712, p = .477).

The children in the lower functioning group produced significantly more behaviors to initiate communicative interaction following intervention. The proportion of verbal initiations increased from pre- to post-intervention (M = .072, M = .172), demonstrating a significant increase in the use of verbal initiations by the lower functioning group of children (Z = 2.45, p = .015). In addition, the proportion of non-verbal initiations increased (M = .0099, M = .055), demonstrating a significant increase in the use of non-verbal initiations following treatment (Z = 2.50, p = .01). These results suggest that the children in the lower functioning group initiated more communicative interactions both verbally and non-verbally after enrollment in the PLAY program.

We next analyzed the responding behaviors. Both the high functioning and low functioning group demonstrated an increase in the use of verbal responses after treatment; however, neither group reached significance. The proportion of responses in the higher functioning group increased non-significantly post-intervention (M = .462, M = 0.566; Z = 1.91, p = 0.056). Conversely, the proportion of non-verbal responses in the higher functioning group decreased (M = .133, M = .069), although this decrease was not significant (Z =1.56, p = .119).

The use of verbal responses in the lower functioning group increased following intervention. The proportion of verbal responses increased from a mean of .259 to a mean of .361; however, this increase did not reach statistical significance (Z = 1.91, p = .056). Unlike

what was observed in the higher functioning group, the proportion of non-verbal responses also increased (M = .189, M = .205), but once again this change in behavior was not significant (Z= .045, p = .965).

Table 4. High vs. Low Functioning Child Communicative Behaviors

Low Group			
Measure	**Mean Pre**	**Mean Post**	**p value**
Initiations			
Non Verbal	0.009	0.055	0.012*
Verbal	0.072	0.172	0.015*
Responses			
Non-Verbal	0.189	0.205	0.965
Verbal	0.259	0.361	0.056
High Group			
Measure	**Mean Pre**	**Mean Post**	**p value**
Initiations			
Non Verbal	0.018	0.025	0.477
Verbal	0.189	0.268	0.068
Responses			
Non-Verbal	0.133	0.069	0.119
Verbal	0.462	0.566	0.056

1.5. High vs. Low Child Language

Next, we analyzed the quantity of language within the two groups (See Table 5). Although the total number of utterances per play session in both groups increased, these changes were not significant when divided by group. The children in the higher functioning group demonstrated an increase in total utterances from a mean of 103.6 pre-intervention to a mean of 138.3 post-intervention; however, this increase was not significant (Z = 1.25, p = 0.21). The lower functioning group also produced more total utterances after treatment (M = 50.73, M =

78.09); however, this increase once again did not reach statistical significance (Z = 1.92, p = .055).

Within group analysis also revealed non-significant gains in word production after enrollment in the PLAY program. The lower functioning group nearly doubled the number of words produced at baseline (M = 82.8, M = 170); however, these gains did not reach significance after Bonferroni adjustment (Z = 2.00, p = .05). The higher functioning group also demonstrated an increase in the total number of words produced (M = 305.4, M = 472.4), but this trend also did not reach significance (Z = 1.73, p = .08). The lower functioning group almost doubled the total number of word types produced from pre- to post-intervention (M = 39.6, M = 68.3); however, this difference failed to reach significance (Z =2.0005, p = .0454). The higher functioning group also demonstrated non-significant improvements in the different types of words produced (M = 108.4, M = 147.5; Z = 2.002, p = .045) after controlling for multiple comparisons.

We next analyzed grammatical and lexical complexity in each group. Improvements in grammatical complexity varied across groups. The children in the higher functioning group used more syntactically complex forms, as indicated by an increase in IPSyn scores from pre- to post-intervention (M= 58.4, M = 70.5); however, this did not reach significance after alpha was adjusted for multiple comparisons (Z = 2.22, p = .03). The MLU in the higher functioning group also increased from pre- to post-intervention (M = 3.25, M = 3.80), indicating a non-significant increase in the length and complexity of utterances following intervention (Z = 2.09, p = .04). In contrast, the IPSyn scores in the lower functioning group increased significantly (M = 20.9, M = 33.4; Z = 2.40, p = .02), suggesting the use of significantly more complex syntactic forms by the lower functioning children following enrollment in the PLAY program. Although IPSyn scores

increased, MLU of the lower functioning group did not significantly increase from pre- to post-intervention (M = 1.75, M = 2.003; Z = 1.56, p = .119).

Vocabulary improvements were not observed after splitting groups by ADOS status for analysis. This is likely due to a reduction in statistical power. *Vocd* calculates the Type Token Ratio (TTR) from a number of randomly selected samples of tokens from the child's speech and therefore requires a sufficient number of words. Although NDW can be utilized for shorter samples, analysis requires a minimum of 100 words. As a result, a number of children, especially in the lower functioning group, were excluded from analyses of both measures. *Vocd* scores in the higher functioning group increased from pre- to post-intervention (M = 45.9, M = 58.4), although this change was non-significant (Z = 1.38, p = .168). Only 10 participants could be analyzed for NDW in the higher functioning group. NDW decreased non-significantly after treatment (M = 49.4, M = 48; Z = .767, p = .443).

Vocabulary in the lower functioning children also did not change significantly as a result of intervention. Only 6 participants in the lower functioning group could be analyzed for *vocd*. Although *vocd* scores improved from a mean of 33.41667 to a mean of 50.12833, this increase was not significant (Z = 1.2579, p = .208). Only 3 participants from the lower functioning group were included in analysis for NDW. NDW increased non-significantly following intervention (M = 43.3, M = 44.3; Z = .267, p = .789). The lack of participants for the lower functioning group resulted in a severe loss of power for this statistical analysis.

Table 5. High vs. Low Functioning Child Language

Low Group			
Measure	**Mean Pre**	**Mean Post**	**p value**
Total Utterances	50.7	78.09091	0.055
Words			
Types	39.6	68.27273	0.045

Total	82.8	170	0.045
Syntactical Complexity			
IPSyn	20.9	33.4	0. 02*
MLU Morphemes	1.75	2.003	0.119
Vocabulary			
Vocd	33.4	50.1	0.208
NDW	43.3	44.3	0.789
High Group			
Measure	**Mean Pre**	**Mean Post**	**p value**
Total Utterances	103.6	138.3	0.213
Words			
Types	108.4	147.5	0.045
Total	305.4	472.4	0.083
Syntactical Complexity			
IPSyn	58.4	70.5	0.026
MLU Morphemes	3.25	3.80	0.037
Vocabulary			
Vocd	45.9	58.4	0.168
NDW	49.4	48	0.443

1.6. High vs. Low Child Communicative Function

In the lower functioning group, there was a non-significant increase in the proportion of behaviors for behavior regulation after treatment (M = .366, M = .401; Z = .934, p = .351). In contrast, the proportion of behaviors used for behavior regulation in the higher functioning group decreased from pre- to post-intervention (M = .567, M = .544) although this decrease was also non-significant (Z = .045, p = .965).

The remaining trends in use of behavior function following enrollment in the PLAY program were similar across groups (See Table 6). The proportion of behaviors for social interaction in the higher functioning group increased significantly from a mean of .67 to a mean of .85 (Z = 2.89, p = .004). The proportion of behaviors for social interaction in the lower functioning group also increased significantly from a mean of .407 pre-intervention to a mean of

.738 post-intervention (Z = 2.89, p = 0.004). These results suggest that children utilize significantly more behaviors for social interaction following the PLAY program treatment despite baseline communication profiles.

In addition to a significant increase in behaviors for social interaction, both the high functioning and low functioning groups demonstrated a significant decrease in the use of non-interactive behaviors. The proportions of non-interactive behaviors used by the higher functioning group decreased from a mean of .219 to a mean of .109, demonstrating a significant reduction in the use of non-interactive behaviors following intervention (Z = 2.80, p = .005). The proportion of non-interactive behaviors also decreased significantly in the lower functioning children from a mean of .459 pre-intervention to a mean of .243 post-intervention (Z = 2.71, p = .007). These results further suggest that the use of non-interactive behaviors characteristic of children with ASD significantly decrease after enrollment in the PLAY early intervention program.

Table 6. High vs. Low Functioning Child Communicative Function

Low Group			
Measure	**Mean Pre**	**Mean Post**	**p value**
Behavior Regulation	0.366	0.401	0.351
Social Interaction	0.407	0.738	0.004*
Non-Interactive	0.459	0.243	0.007*
High Group			
Measure	**Mean Pre**	**Mean Post**	**p value**
Behavior Regulation	0.567	0.544	0.965
Social Interaction	0.670	0.853	0.004*
Non-Interactive	0.219	0.109	0.005*

Maternal Verbal and Non-Verbal Communicative Outcomes

2.1. Maternal Communicative Behaviors

Next we analyzed changes in quantity and function of maternal behavior following intervention. Changes in maternal behaviors were also analyzed using Wilcoxon signed-rank tests. We first examined the quantity of initiations and responses (See Table 7). We controlled for the number of analyses by adjusting the .05 alpha level on a per-hypothesis basis, with verbal and non-verbal behaviors considered separate hypotheses, resulting in a criterion level of .025. The proportion of maternal verbal initiations decreased from pre- to post-intervention (M = .594, M = .405), demonstrating a significant decrease in maternal initiations during parent-child interactions after intervention ($Z = 3.73$, $p = .0002$). This might be expected if the parent has learned to follow the child more, and guide the child less. In contrast, the proportion of non-verbal initiations increased slightly from pre- to post-intervention (M = .014, M = .034); however, this increase did not reach statistical significance ($Z = 1.73$, $p = .08$).

As the PLAY project trains parents to follow the child's lead, we also analyzed maternal responding behaviors after training. Not surprisingly, we found that the quantity of responsive behaviors increased from pre- to post-intervention, indicating a greater ability to follow the child's lead. The proportion of non-verbal responses in parent-child interactions increased from a mean of .015 to a mean of .029; however, this value did not reach significance ($Z = 1.89$, $p = .058$). The proportion of verbal responses increased from a mean of .509 to a mean of .664, demonstrating a significant increase in verbal responsiveness of the mothers after PLAY training ($Z = 3.99$, $p = .00007$).

Table 7. Maternal Communicative Behaviors

Measure	Mean Pre	Mean Post	p value
Initiations			
Non Verbal	0.014	0.034	0.08
Verbal	0.594	0.405	0.0002*
Responses			
Non-Verbal	0.015	0.029	0.058
Verbal	0.509	0.664	0.000065*

2.2. Maternal Communicative Function

Next, we analyzed changes in maternal communicative function. According to PLAY and DIR/Floortime theory, parent-child interactions must be more enjoyable and less directive in order for the child to make gains. Therefore, mothers must use more behaviors for social interaction and fewer behaviors for behavior regulation. We found that maternal communicative behavior function changed following PLAY program training, with significant changes in the use of behaviors for behavior regulation and social interaction (See Table 8). The proportion of maternal behaviors for behavior regulation decreased from a mean of .764 to a mean of .606, demonstrating a significant reduction in maternal behaviors used to regulate the child's behavior after the PLAY program early intervention ($Z = 3.41$, $p = .0007$).

In addition to a decrease in the use of behaviors for behavior regulation, the mothers also demonstrated an increase in the use of behaviors for social interaction. The proportion of behaviors for social interaction increased from a mean of .852 pre-intervention to a mean of 1.004 post-intervention, demonstrating a significant increase in the use of social interacting behaviors following intervention ($Z = 3.18$, $p = .002$). The proportion of non-interactive behaviors also decreased from pre- to post-intervention ($M = .0403$ $M = .028$); however, this decrease did not reach statistical significance ($Z = .244$, $p = .808$).

Table 8. Maternal Communicative Function

Measure	Mean Pre	Mean Post	p value
Behavior Regulation	0.763	0.606	0.00065*
Social Interaction	0.852	1.004	0.002*
Non-Interactive	0.040	0.028	0.808

2.3. Maternal Language

Maternal language was analyzed for responsiveness through the use of imitations and expansions. CHIP analysis, a CLAN analysis tool, was utilized to quantify the percent of maternal imitations and expansions during parent-child interactions. Results revealed that although the proportion of these behaviors increased from pre- to post-intervention, the number of expansions and imitations following intervention was not significantly different (See Table 9). The proportion of maternal imitations increased from a mean of .082 pre-intervention to a mean of .1004 post-intervention; however, this value did not reach significance ($Z = 1.35$, $p = .178$). The proportion of maternal expansions also increased from pre- to post-intervention (M = .035 M = .041); however, this value was also non-significant ($Z = .699$, $p = .485$)

Table 9. Maternal Language

Measure	Mean Pre	Mean Post	p value
Imitations	0.082	0.1004	0.178
Expansions	0.035	0.041	0.485

2.4. High vs. Low Maternal Communicative Behaviors

We then analyzed the quantity and function of communicative behaviors in the mothers of the lower functioning children and the mothers of the higher functioning children. Verbal

initiations decreased across both groups; however, the use of non-verbal initiations slightly increased (See Table 10). In the high functioning group, the proportion of verbal initiations decreased from a mean of .554 to a mean of .343, demonstrating a significant decrease in the use of maternal verbal initiations during parent-child interactions following PLAY intervention ($Z = 2.62$, $p = .009$). Non-verbal initiations in this group slightly increased from pre- to post-intervention with the proportion of non-verbal initiations increasing from a mean of .004 to a mean of .011; however, this decrease in behavior did not reach significance ($Z = 1.67$, $p = .095$).

The proportion of verbal initiations in the lower functioning group also decreased from a mean of .634 to a mean of .467, demonstrating a significant decrease in maternal initiations in the low functioning group following PLAY intervention ($Z = 2.62$, $p = .009$). Although verbal initiations decreased, the proportion of non-verbal initiations in the low functioning group increased from a mean of .025 to a mean of .056; however, this change in behavior was non-significant ($Z = .890$, $p = .373$).

The results also demonstrated that maternal responses increased after intervention, with within-group trends emerging for non-verbal responses. In the high functioning group, the proportion of maternal verbal responses during parent-child interactions increased from a mean of .572 to a mean of .748, demonstrating a significant increase in the use of maternal verbal responses after PLAY training ($Z = 2.80$, $p = .005$). The proportion of non-verbal responses also increased from pre- to post-intervention ($M = .021$, $M = .024$); however, this change was not significant ($Z = .311$, $p = .756$).

In the lower functioning group, the use of verbal and non-verbal responses improved significantly after training. The proportion of verbal responses increased from a mean of .445 to a mean of .579, demonstrating a significant increase in the use of verbal responses following

PLAY intervention (Z = 2.80, p = .005). In addition to verbal responses, the proportion of non-verbal responses also increased following the PLAY intervention (M = .0097, M = .034), demonstrating a significant increase in the use of non-verbal responses in the mothers of the lower functioning children following treatment (Z = 2.40, p = .02).

Table 10. High vs. Low Functioning Maternal Communicative Behaviors

High Group			
Measure	**Mean Pre**	**Mean Post**	**p value**
Initiations			
Non Verbal	0.004	0.011	0.095
Verbal	0.554	0.343	0.009*
Responses			
Non-Verbal	0.021	0.024	0.756
Verbal	0.572	0.748	0.005*
Low Group			
Measure	**Mean Pre**	**Mean Post**	**p value**
Initiations			
Non Verbal	0.025	0.056	0.373
Verbal	0.634	0.467	0.009*
Responses			
Non-Verbal	0.445	0.579	0.005*
Verbal	0.0097	0.034	0.02*

2.5. High vs. Low Maternal Communicative Function

Next we analyzed the communicative behavior functions in the mothers of each group. We found that trends in behavior function were similar across both groups (see Table 11). Both groups demonstrated a decrease in the use of behaviors for behavior regulation from pre- to post-intervention. In the higher functioning group, the proportion of behaviors used for behavior regulation decreased from a mean of .777 to a mean of .638, demonstrating a significant reduction in the use of maternal behaviors for behavior regulation in the higher functioning group following intervention (Z = 2.18, p = .03). The mothers in the lower functioning group

also demonstrated a reduction in the use of behaviors for behavior regulation, with the proportion of behavior regulation decreasing from a mean of .750 to a mean of .574 from pre- to post-intervention, once again demonstrating a significant reduction in the use of maternal behavior regulation following intervention ($Z = 2.62$, $p = .009$).

In addition to a reduction in behavior regulation, mothers in both groups demonstrated an increase in the use of behaviors for social interaction. The proportion of behaviors for social interaction used by the mothers in the higher functioning group significantly increased from pre- to post-intervention from a mean of .913 to a mean of 1.003 after PLAY program training ($Z = 2.27$, $p = .023$). The proportion of social interaction behaviors used by the mothers in the lower functioning group also significantly increased following intervention, from a mean of .792 to a mean of 1.004 ($Z = 2.18$, $p = .03$). These results further suggest a significant increase in the use of maternal behaviors for social interaction during parent-child play following the PLAY program training

The number of non-interactive behaviors utilized by the mothers decreased following intervention; however, this change in behavior was not significant for either group. The proportion of non-interactive behaviors used by the mothers in the higher functioning group decreased non-significantly ($M = .04$, $M = .026$; $Z = 0.578$, $p = .563$). The proportion of non-interactive behaviors used by the mothers in the lower functioning group also decreased non-significantly ($M = .036$, $M = .031$; $Z = .089$, $p = .929$).

Table 11. High vs. Low Maternal Communicative Function

High Group			
Measure	**Mean Pre**	**Mean Post**	**p value**
Behavior Regulation	0.777	0.638	0.03*
Social Interaction	0.913	1.003	0.02*
Non-Interactive	0.044	0.026	0.563

Low Group			
Measure	**Mean Pre**	**Mean Post**	**p value**
Behavior Regulation	0.750	0.574	0.009*
Social Interaction	0.792	1.004	0.03*
Non-Interactive	0.036	0.031	0.929

2.6. High vs. Low Maternal Language

Maternal language was also analyzed to determine between group differences. The use of expansions and imitations varied across groups, with the trends of expansions and imitations increasing in the mothers of the low functioning children and the trends decreasing in the mothers of the high functioning children, although neither were significant (See Table 12). In the high functioning group, the proportion of imitations decreased non-significantly (M = .081, M = .075; Z = .133, p = .894). The proportion of expansions also demonstrated a non-significant decrease (M = .0304 to M = .0301; Z = .445, p = .656).

In the mothers of the lower functioning group, the proportion of imitations increased (M = .083, M = .126); however, this increase did not reach statistical significance (Z = 1.82, p = .068). The proportion of expansions also increased (M = .039, M = .051); however, once again this value did not reach significance (Z = 1.29, p = .197).

Table 12. High vs. Low Maternal Language

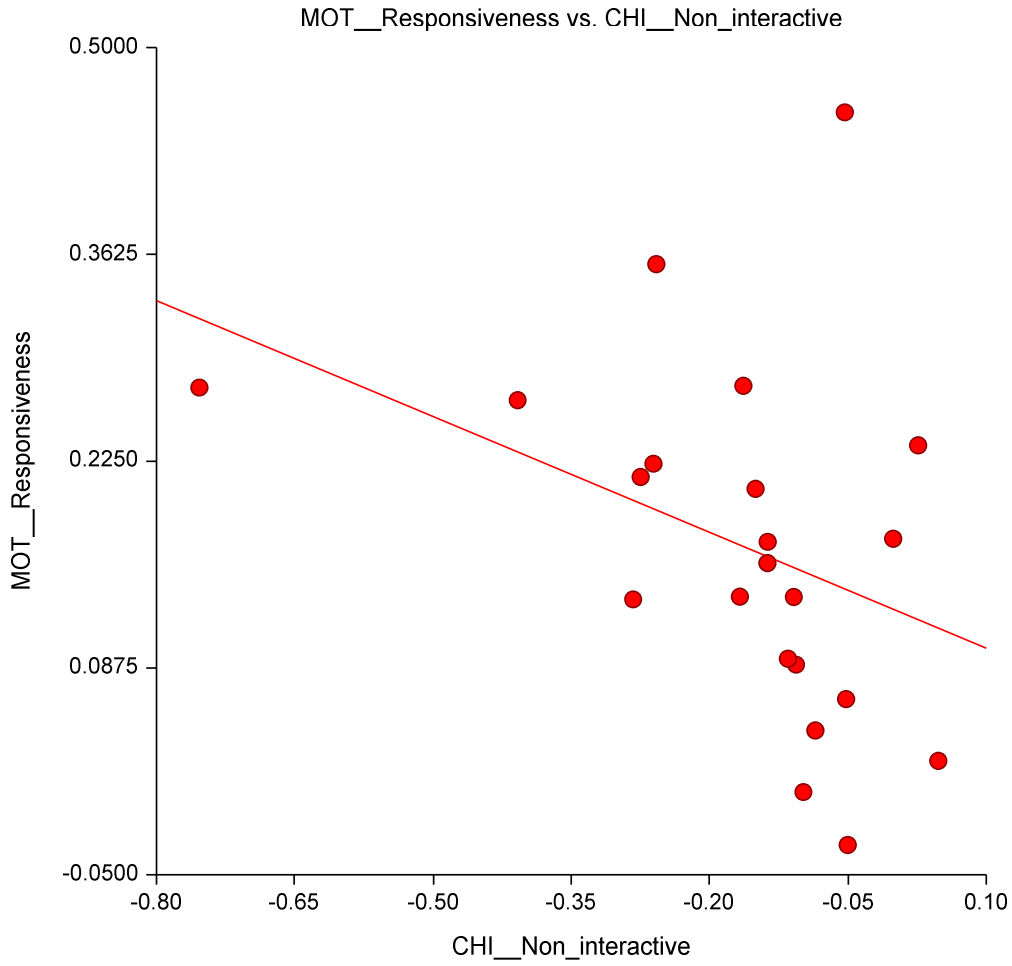
High Group			
Measure	**Mean Pre**	**Mean Post**	**p value**
Imitations	0.083	0.126	0.068
Expansions	0.039	0.051	0.197
Low Group			
Measure	**Mean Pre**	**Mean Post**	**p value**
Imitations	0.081	0.075	0.894
Expansions	0.0304	0.0301	0.656

Relationships between Change in Maternal Outcomes and Child Outcomes

3.1. Maternal Responsiveness to Child Interaction

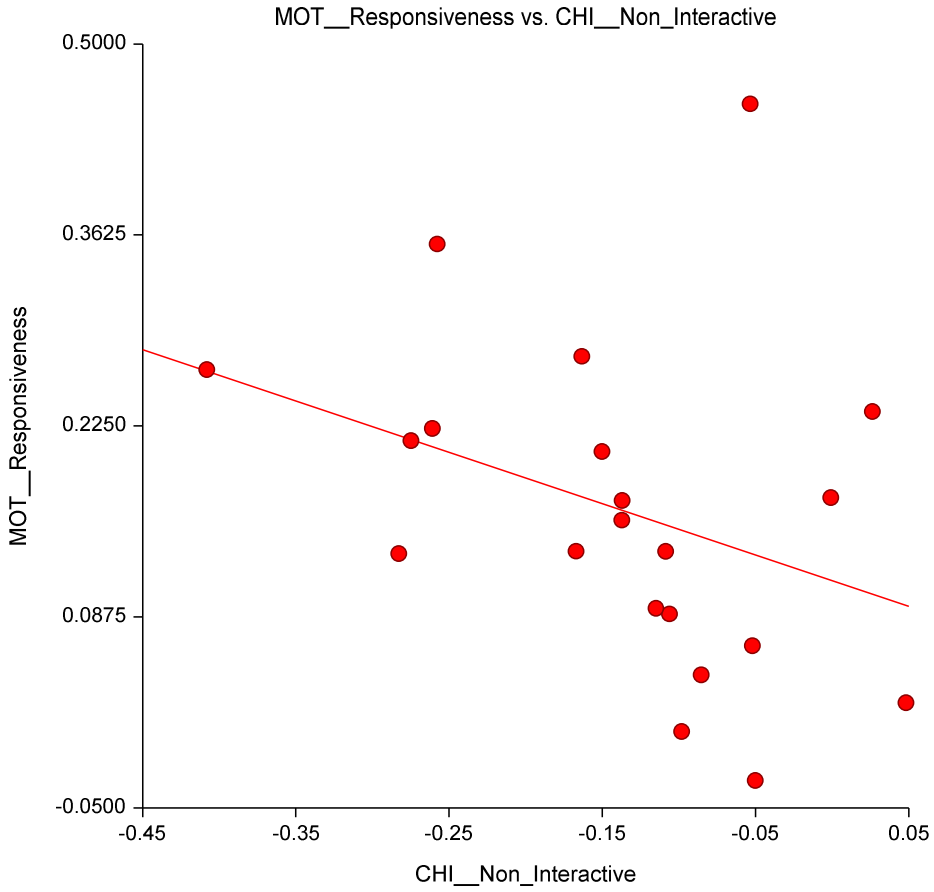
We also completed additional analyses to determine the degree of change in child communicative behaviors as a result of the degree of change in maternal communicative behaviors. First, we compared the degree of change in maternal responsiveness to the degree of change in child non-interactive behaviors. Spearman rank-order correlations were conducted in order to determine if there is a relationship between the use of maternal responsive behaviors and child non-interactive behaviors. A two-tailed test of significance indicated that there was a significant negative relationship between the use of maternal responding behaviors and child non-interactive behaviors ($r_s = -0.476$, $p = .025$). The greater the rise in responding behaviors by the mother, the fewer non-interactive behaviors from the child, confirming a theoretical goal of the PLAY parent counseling strategy. Results are further displayed below in Figure 1.

Figure 1.



Statistically analysis revealed an outlier in which the difference in proportion of maternal responses from pre- to post-intervention was .274 and the difference in the proportion of child non-interactive behaviors was -.754. As there is potential for this single outlier to be driving the relationship, this outlier was removed and the relationship was once again analyzed to determine significance. A two-tailed test of significance revealed that once again there was a significant negative relationship between the use of maternal responding behaviors and child non-interactive behaviors ($r_s = -0.434$, $p = .049$). Results are displayed in figure 2 below.

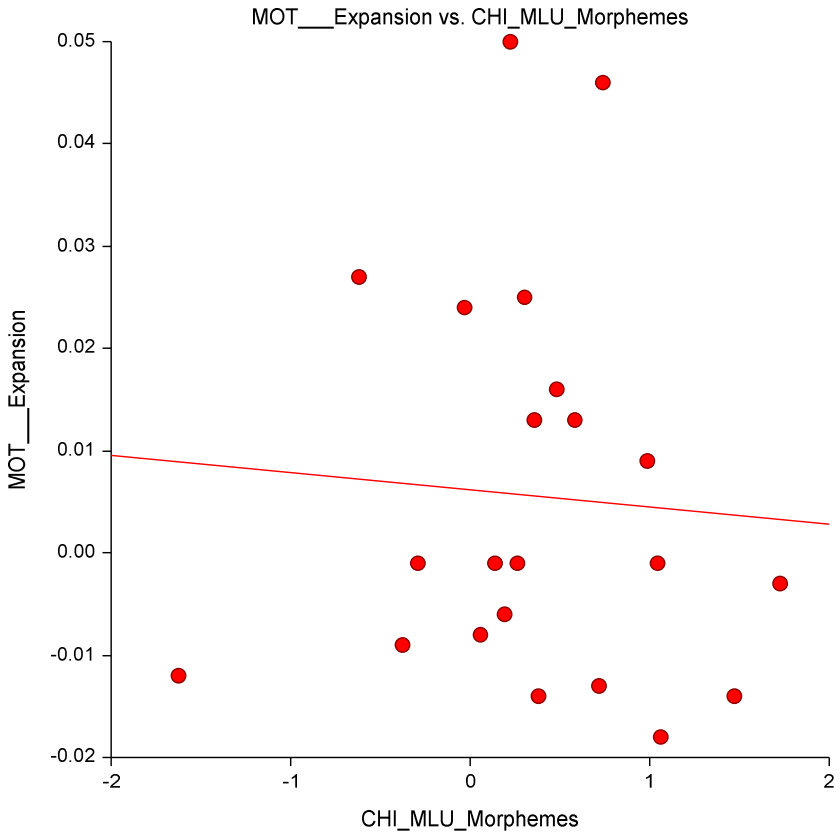
Figure 2.



3.2. Maternal Expansions to Child MLU

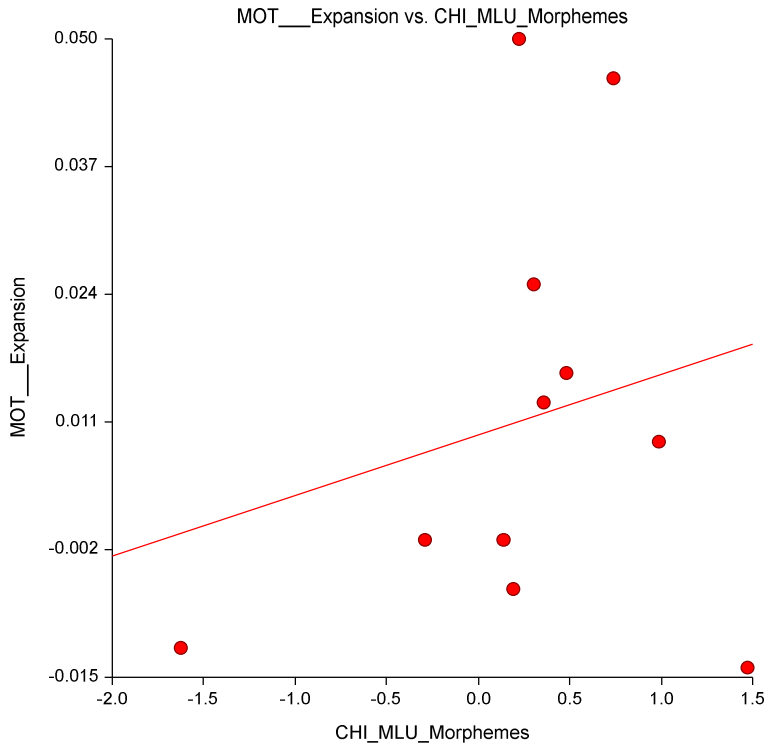
We also completed a Spearman rank-order correlation to determine if there was a relationship between the use of maternal expansions and child MLU. A two-tailed test of significance revealed no relationship between maternal use of expansions and child MLU (r_s = -.171, p = .446). Results are displayed in Figure 3 below.

Figure 3.



Since the mothers in the higher functioning group and the mothers in the lower functioning group demonstrated differences in use of expansions from pre- to post-intervention, analysis was repeated with only the mothers of the low functioning group. The results indicated a trend towards a positive relationship between maternal use of expansions and child MLU: however, this relationship was not significant ($r_s = 0.2141$, $p = 0.5272$). With the reduction in group size, power also decreased; however, the actual correlation between behaviors was not large. Results are displayed in Figure 4 below.

Figure 4


MOT___Expansion vs. CHI_MLU_Morphemes
MOT___Expansion
0.050
0.037
0.024
0.011
-0.002
-0.015
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
CHI_MLU_Morphemes

Discussion

Child Outcomes

The current study extends the results of the original RCT by providing ecologically valid assessment of child and maternal language improvements that may result after one year of the PLAY DIR/Floortime-based, early intervention program. The first goal of the current study was to determine if children improved in verbal and non-verbal communicative outcomes after intervention. We analyzed child language outcomes through the use of natural language sample analysis to determine if language improved beyond the measures utilized in the original study. Specifically, we analyzed child language for changes in communicative act quantity, linguistic quantity and structure, and communicative function.

Language sample analysis revealed specific changes in child communication during parent-child interactions as opposed to the global impressions of child communication post-intervention documented in the original study. First, the results of the current study suggest that after undergoing a year of the PLAY intervention program, children with ASD utilized more initiating behaviors during parent-child interactions than prior to intervention. The children initiated communicative interactions, both verbally and non-verbally, significantly more post-intervention. Further analysis of group trends revealed that the children in the lower functioning group significantly increased the use of verbal and non-verbal initiations; however, the children in the higher functioning group did not significantly produce more verbal and non-verbal initiations post-intervention. It is possible that the lack of significance in the higher functioning group resulted from a loss of power when splitting the groups for analysis. It may also be possible that since the children in the lower functioning group displayed very few

communicative behaviors to begin with, any improvement in the use of initiating behaviors more easily achieved significance.

In addition to initiating more communicative bids, the children also responded to more communicative bids during parent-child interactions post-intervention. The proportion of verbal responses by the whole combined group of children significantly increased post-intervention, suggesting that children may respond more to adult bids for communication after participation in the PLAY program. Child non-verbal responses demonstrated a non-significant decrease post-intervention.

Differences emerged between groups in the use of non-verbal responses within parent-child interactions; the proportion of non-verbal responses in the higher functioning group decreased and the proportion in the lower functioning group increased. The decrease in non-verbal responses in the higher functioning group can possibly be attributed to an increase in verbal language production, while the increase in non-verbal responses in the lower functioning children may represent an increase in interaction given minimal language ability. Lower functioning children may have been interacting more through non-verbal communicative behaviors, while higher functioning children may have been utilizing more sophisticated means by responding less non-verbally and more verbally.

The amount of language produced also increased by the whole group of children during parent-child interactions from pre- to post-intervention. The total number of utterances produced, the total number of words produced, and the types of words produced all significantly increased, suggesting possible language improvements after participation in the PLAY project early intervention program. The total utterances produced increased by over a third of the total utterances at baseline. In addition, the total number of words produced increased by two-thirds

of the number of words at baseline and the types of words produced increased by half of the number of word types produced at baseline. Further analysis, however, revealed that these changes in utterance and word production were not significant within each group when analyzed separately. Although both groups demonstrated improvements from pre- to post-intervention, these differences were not significant. Once again, it is likely that a decrease of power impacted significance.

Child language was also assessed for grammatical and lexical diversity. Significant increases in both IPSyn score and MLU in morphemes in whole group analysis suggest potential benefits in syntactic development after participation in the PLAY program. However, once again, trends were not as strong when groups were split for analysis. In the higher functioning group, IPSyn score and MLU in morphemes increased, but did not reach significance. The lower functioning group showed a somewhat surprising significant increase in IPSyn score from pre- to post-intervention, but not in MLU. It is once again possible that inability to achieve significance of the changes was a result of reduced power after splitting the groups for analysis.

Vocabulary improvements were not as noteworthy as other child language analyses. Whole group analysis of vocabulary revealed an increase in *vocd* from pre- to post-intervention; however, this change did not reach significance. Further within-group analysis revealed increases in *vocd* from pre- to post-intervention in both the higher functioning group and lower functioning group; once again, however, these did not reach significance. Due to minimal word production in some of the children, all of the children were not included in NDW and *vocd* analyses. Therefore, statistical power was greatly weakened, especially for the lower functioning group.

There may also be a pragmatic explanation for a failure to observe significant changes in conversational vocabulary diversity following PLAY therapy. As part of the PLAY program, parents were trained to follow their child's lead and expand upon the child's language during interactions. As a result, it is likely that post-therapy interactions were restricted to the ongoing interests of the child and therefore the vocabulary produced was limited to these topics, in contrast to pre-intervention samples, where mothers took the lead and initiated more frequently. Formal assessment of vocabulary following administration of the PLAY program would inform vocabulary changes outside of the restricted environment of these parent-child play sessions.

The improvements in the use of communicative function from pre- to post-intervention were most noteworthy, providing new data regarding quantitative changes in child communication not represented in the original study. The use of behaviors for behavior regulation varied across groups, with the low functioning children demonstrating increases in behavior regulation (the use of language to achieve their desired ends) and the high functioning children demonstrating a slight decrease in behavior regulation. Both of these changes; however, were non-significant. There was a significant change in the use of behavior for social interaction post-intervention. As a whole group, the children used behaviors for social interaction significantly more and non-interactive behaviors significantly less often post-intervention. These results may provide further support that the PLAY program reduces behaviors characteristic of ASD and increases social interaction (Solomon et al., 2014). Within-group analysis revealed that these trends in behavior were significant for both the low functioning and high functioning children, suggesting that the use of social interaction behaviors may increase after PLAY enrollment regardless of baseline communicative profile.

The results of the current study provide a possible explanation for the lack of language outcomes observed in the original RCT. As previously stated, the understanding and use of communicative functions emerges before the production of words. Children learn to utilize gestures and vocalizations to convey these means of communication before they are able to attach verbal language to these intentions. In the current study, it can be argued that the greatest improvements were noted in the use of function, specifically in the increase of social interaction behaviors and the decrease of non-interactive behaviors, as these behaviors significantly changed for whole group analysis as well as within group analysis. Gains in quantity and structure of verbal language, however, were not as strong during within-group analysis, revealing non-significant improvements for most measures.

Without a control group comparison (either the children who received community-based services, or a wait list control) it is not possible to claim that these significant improvements were a direct result of the techniques of the program alone. It is possible that children receiving the usual community services also demonstrated similar changes. Since the PLAY program occurred over the course of a year, it is also possible that the language outcomes could be attributed to language development as a function of time. As deficits in social interaction are the core deficits of ASD, it is not completely clear that functional behaviors would change over the course of a year without intervention and may be more likely to reflect PLAY-induced change.

Maternal Outcomes

The use of language sample analysis also revealed specific changes in maternal behavior post-intervention that were not captured by the MBRS in the original study. Whole group analysis revealed that the number of maternal verbal initiations decreased significantly from pre-

to post-intervention, suggesting maternal ability to allow the child take the lead during interactions. Maternal non-verbal initiations, however, increased slightly from pre- to post-intervention, which may have been a result of PLAY implemented principles. PLAY, as well as many other DIR/Floortime based treatments, emphasizes setting up communicative failures or temptations, such as putting a toy out of the child's reach or giving the child a toy they need assistance with in order to operate. In making such non-verbal initiations, these maternal acts require the child to communicate through gestures, signs, or verbal language in order to get the toy or make the toy work. It is possible that after intervention, the mothers created more communicative temptations in order to get the child to communicate and therefore produced more non-verbal initiations. Further analysis should code for specific instances of this technique to quantify these behaviors pre- and post-intervention and correlate them with changes in the child's behavior.

The current study also provides possible ecological support for maternal ability to respond to the child's behaviors after intervention. Notably, the use of verbal maternal responses during parent-child interactions from pre- to post-intervention significantly increased. These results suggest that the mothers may be able to increase their responsiveness to their child after parent training in the PLAY program. These results also may suggest that mothers understood principles of the PLAY program and were able to implement these principles within their own interactions with their child. Within-group analysis revealed that the mothers in the lower functioning group not only increased the number of verbal responses, but also significantly increased the number of non-verbal responses following intervention. This is especially noteworthy, and unique to this study, as it suggests greater maternal ability to respond to child behaviors despite baseline communicative profile.

Maternal function of communication also changed post-intervention. There was a significant decrease in the regulation of the child's behavior and a significant increase in social interaction behaviors by the mother post-intervention. These results suggest that mothers may be able to apply principles of the PLAY program over the course of a year by decreasing directive behaviors, or behaviors for regulatory purposes, and increasing positive social interactions by increasing social interaction behaviors. Maternal communicative function changes were also significant for within group analysis, suggesting that mothers of high functioning and mothers of lower functioning children may be able to implement these PLAY techniques.

Maternal verbal language outcomes following PLAY program training were not as clear. Although the mothers demonstrated an increase in the proportion of imitations and expansions from pre- to post-intervention, this change was not significant. Further within-group analysis revealed that the mothers of the lower functioning children demonstrated an increase in the use of imitations and expansions, while the mothers of the higher functioning children demonstrated a decrease. It is possible that the lower functioning children produced shorter and less complete phrases that could be easily expanded on, while the higher functioning children produced longer and more complex utterances that did not require or motivate expansions for correctness. Instead, the mothers of higher functioning children may have been more likely to respond to the intent of the child's utterance rather than providing additional information to increase the syntactic and morphological accuracy of the child's utterance.

Relationships Among Behaviors

Natural language sample analysis also provided the opportunity to analyze relationships between the degree of change in maternal behaviors and the degree of change in a small set of

child behaviors. Post-hoc analysis demonstrated no relationship between maternal expansions and child MLU, although when analysis was conducted for the low group only, a stronger trend emerged. However, this trend was still not significant.

The results did suggest a negative relationship between maternal responsiveness and child non-interactive behaviors, possibly indicating that an increase in the use of responding behaviors by the mother led to a decrease in the use of non-interactive behaviors by the child. This finding suggests that the mothers may have been able to utilize principles of the PLAY program after training, specifically responding more to children during interactions, which led to a decrease in child non-interactive behaviors and increase in child social interaction. This relationship may further support a primary theory of the PLAY program intervention program as well as inform a parental approach to increasing social interaction in children with ASD regardless of treatment approach used.

The reverse interpretation of this correlation is also possible, in which a decrease in non-interactive behaviors by the child post-intervention led to an increase in the use of responding behaviors by the mother. The PLAY program emphasizes changing the parent's types and uses of behaviors during parent-child interaction while not directly targeting child behaviors. A reduction in children's use of non-interactive behaviors over time may not be likely without some form of intervention. Therefore, it may be more likely that the mother's change in behavior drove the child's change in behavior. This cannot be confirmed without a control or contrast group comparison. If children in both intervention groups decrease in the use of non-interactive behaviors post-intervention, then it may be possible that the reverse relationship is true.

Conclusions

The current study provides preliminary support for ecological changes in child and maternal communication during parent-child interactions that may result after participation in the PLAY DIR/floor-time based early intervention program. First, natural language sample analysis revealed significant gains in the use of children's verbal and non-verbal initiations, as well as in the use of verbal responses during parent-child interactions from pre- to post-intervention. Significant improvements were also noted in the total number of utterances, production of words, and grammatical complexity for the group as a whole, but within-group comparisons were not significant. Surprisingly, gains in vocabulary were also non-significant. Notably, whole group and within-group analysis revealed significant improvements in the function of communicative behaviors, suggesting that children's functional communicative gains were greater than purely linguistic gains. The high functioning and the low functioning children produced significantly more behaviors for social interaction and significantly fewer non-interactive behaviors, further demonstrating a reduction in the core deficits of ASD.

The current study also suggests improvements in maternal use of principles emphasized by the PLAY program. The mothers followed the child's lead more, as seen through a decrease in maternal initiations, and were more responsive to their children following the PLAY training. The mothers were also able to create positive interactions and utilize fewer direct behaviors as demonstrated through an increase in the use of social interaction behaviors and a decrease in the use of behaviors for behavior regulation. The current study also demonstrated a significant relationship between maternal responsiveness and children's non-interactive behaviors, suggesting that possible increases in maternal responsiveness may correlate with a decrease in non-interactive behaviors.

The current study has a number of limitations in its ability to provide more generalized guidance about treatments for ASD, as the sole focus was on the children who underwent the PLAY project intervention program. It is not clear that the child verbal and non-verbal communicative improvements demonstrated in this study were primarily the result of the PLAY program or in any way superior to conventional intervention. Although it is possible that natural development over time may have attributed to language gains, it is less probable that gains in child communication quantity and function are a result of developmental change over the year's time. As social interaction is one of the core deficits in ASD, it is less probable that these behaviors would change significantly over time without some form of intervention. The changes in maternal communicative function and behavior observed in this study are also less likely to significantly change over time without parent training. Further research is warranted to examine if maternal and child communication profiles changed significantly over time in families who received usual community services or if some changes are unique to the families who received the PLAY project training and early intervention. Comparison of the current group to children who received usual community services may further strengthen the support for the PLAY program and other parent-administered DIR/Floortime approaches. Additional analysis should also work to identify relationships between maternal and child changes in behavior in order to inform effective treatment of children with ASD.

References

Abidin, R. R. (1990). *Parenting Stress Index (PSI)*. Charlottesville, VA: Pediatric Psychology Press.

Bruner, J. (1981). The social context of language acquisition. *Language and Communication, 1*, 155–178.

Blumberg, S. J., Bramlett, M. D., Kogan, M. D., Schieve, L. A., Jones, J. R., & Lu, M. C. (2013). Changes in prevalence of parent-reported autism spectrum disorder in school-aged US children: 2007 to 2011–2012. *National Health Statistics Reports*, *65*, 1-7.

Brown, R. (1973). *A first language*. Cambridge, MA: Harvard University Press.

Camarata, S. (2014). Early identification and early intervention in autism spectrum disorders: Accurate and effective? *International Journal of Speech-Language Pathology, 16,* 1-10.

Casenhiser, D. M., Shanker, S. G., & Stieben, J. (2013). Learning through interaction in children with autism: Preliminary data from a social-communication-based intervention. *Autism, 17*, 220–241.

Cleave, P. L., Becker, S. D., Curran, M. K., Van Horne, A. J. O., & Fey, M. E. (2015). The efficacy of recasts in language intervention: A systematic review and meta-analysis. *American Journal of Speech-Language Pathology*, *24*, 237-255.

Dionne, M., & Martini, R. (2011). Floor Time Play with a child with autism: A single-subject study. *Canadian Journal of Occupational Therapy*, *78*, 196-203.

Dudzinska, E., Szymona, K., Pacian, A., & Kulik, T. (2015). Selected forms of therapy for individuals with autism spectrum disorder. *Current Issues in Pharmacy and Medical Sciences*, *28*, 21-23.

Durán, P., Malvern, D., Richards, B., & Chipere, N. (2004). Developmental trends in lexical diversity. *Applied Linguistics, 25*, 220-242.

Eigsti, I. M., de Marchena, A. B., Schuh, J. M., & Kelley, E. (2011). Language acquisition in autism spectrum disorders: A developmental review. *Research in Autism Spectrum Disorders*, *5*, 681-691.

Fenson, L., Dale, P. S., Reznick, J. S., Thal, D., Bates, E., Hartung, J. P., Pethick, S. T., & Reilly, J. S. (1993). *The MacArthur Communicative Development Inventories* (MCDI). San Diego, CA: Singular Publishing Group, Inc.

Greenspan, S. I. (1992). *Infancy and early childhood: The practice of clinical assessment and intervention with emotional and developmental challenges*. Madison, CT: International Universities Press.

Greenspan, S. I. (2001). The affect diathesis hypothesis: The role of emotions in the core deficit in autism and in the development of intelligence and social skills. *Journal of Developmental and Learning Disorders*, *5*, 1-45.

Greenspan, S. I., DeGangi, G. A., & Wieder, S. (2001). *The functional emotional assessment scale (FEAS) for infancy and early childhood: Clinical and research applications*. Bethesda, MD: Interdisciplinary Council on Developmental and Learning Disorders.

Greenspan, S. I., & Wieder, S. (1997). An integrated developmental approach to interventions for young children with severe difficulties in relating and communicating. *Zero to Three*, *17*, 5-18.

Greenspan, S. I., & Wieder, S. (2005). Can children with autism master the core deficits and become empathetic, creative and reflective? A ten to fifteen year follow-up of a subgroup of children with autism spectrum disorders (ASD) who received a comprehensive

developmental, individual-difference, relationship-based (DIR) approach. *The Journal of Developmental and Learning Disorders*, *9*, 39-61.

Koegel, L. K., Koegel, R. L., Shoshan, Y., & McNerney, E. (1999). Pivotal response intervention II: Preliminary long-term outcome data. *Research and Practice for Persons with Severe Disabilities, 24,* 186–198.

Lal, R., & Chhabria, R. (2013). Early Intervention of Autism: A Case for Floor Time Approach. In M. Fitzgerald (Ed.), *Recent Advances in Autism Spectrum Disorders.* InTech Open Access Publisher.

Lovaas, O. I. (1987). Behavioral treatment and normal educational and intellectual functioning in young autistic children. *Journal of Consulting and Clinical Psychology, 55*, 3–9.

Lord, C., Risi, S., Lambrecht, L., Cook Jr, E. H., Leventhal, B. L., DiLavore, P. C., Pickles, A. & Rutter, M. (2000). The Autism Diagnostic Observation Schedule—Generic: A standard measure of social and communication deficits associated with the spectrum of autism. *Journal of autism and developmental disorders*,*30*, 205-223.

Luyster, R., Qui, S., Lopez, K., & Lord, C. (2007). Predicting outcomes of children referred for autism using the MacArthur–Bates Communicative Development Inventory. *Journal of Speech, Language, and Hearing Research, 50*, 667–681.

MacWhinney, B. (2000). The CHILDES Project: Tools for analyzing talk (3rd ed.). Mahwah, New Jersey: Erlbaum.

Mahoney, G., Kim, J. M., & Lin, C. (2007). Pivotal behavior model of developmental learning. *Infants & Young Children*, *20*, 311-325.

Mahoney, G., & Perales, F. (2003). Using relationship-focused intervention to enhance the social—emotional functioning of young children with autism spectrum disorders. *Topics in Early Childhood Special Education*, *23*, 74-86.

Mahoney, G., & Perales, F. (2005). Relationship-focused early intervention with children with pervasive developmental disorders and other disabilities: A comparative study. *Journal of Developmental & Behavioral Pediatrics*, *26*, 77-85.

Mahoney, G., Powell, A., & Finger, I. (1986). The maternal behavior rating scale. *Topics in Early Childhood Special Education*, *6*, 44-56.

Mahoney, G., & Solomon, R. (2016). Mechanism of Developmental Change in the PLAY Project Home Consultation Program: Evidence from a Randomized Control Trial. *Journal of Autism and Developmental Disorders, 46,* 1860-1871.

Malvern, D., & Richards, B. (2002). Investigating accommodation in language proficiency interviews using a new measure of lexical diversity. *Language testing*, *19*, 85-104.

Mercer, J. (2015). Examining DIR/Floortime™ as a Treatment for Children With Autism Spectrum Disorders A Review of Research and Theory. *Research on Social Work Practice*, 1049731515583062.

Mullen, E. M. (1995). *Mullen scales of early learning*. Circle Pines, Minnesota: AGS.

Myers, S. M., & Johnson, C. P. (2007). Management of children with autism spectrum disorders. *American Academy of Pediatrics*, *120*, 1162-1182.

Ninio, A., & Wheeler, P. (1986). A manual for classifying verbal communicative acts in mother-infant interaction. *Transcript Analysis*, 3, 1-83.

Oono, I. P., Honey, E. J., & McConachie, H. (2013). Parent-mediated early intervention for young children with autism spectrum disorders (ASD). *Evidence-Based Child Health: A Cochrane Review Journal*, *8*, 2380-2479.

Pajareya, K., & Nopmaneejumruslers, K. (2011). A pilot randomized controlled trial of DIR/Floortime™ parent training intervention for pre-school children with autistic spectrum disorders. *Autism*, *15*, 563-577.

Prizant, B. M., Wetherby, A. M., & Rydell, P. J. (2000). Communication intervention issues for children with autism spectrum disorders. In A. M. Wetherby, B. M. Prizant, A. M. Wetherby, B. M. Prizant (Eds.), *Autism spectrum disorders: A transactional developmental perspective* (pp. 193-224). Baltimore, MD, US: Paul H. Brookes Publishing.

Radloff, L. S. (1977). The CES-D scale a self-report depression scale for research in the general population. *Applied psychological measurement*, *1*, 385-401.

Rogers, S. J., & Dawson, G. (2009). Play and Engagement in Early Autism: The Early Start Denver Model. Volume I: The Treatment. New York: Guilford Press.

Rutter, M., Bailey, A., & Lord, C. (2003). *The social communication questionnaire: Manual*. Western Psychological Services.

Scarborough, H. (1989). Index of productive syntax. *Applied Psycholinguistics*, 11, 1–22.

Scarborough, H. S., Rescorla, L., Tager-Flusberg, H., Fowler, A. E., & Sudhalter, V. (1991). The relation of utterance length to grammatical complexity in normal and language-disordered groups. *Applied Psycholinguistics*, *12*, 23-46.

Schieve, L. A., Rice, C., Devine, O., Maenner, M. J., Lee, L., Fitzgerald, R., Wingate, M. S., Schendel, D., Pettygrove, S., van Naarden Braun, K., & Durkin, M. (2011). Have secular

changes in perinatal risk factors contributed to the recent autism prevalence increase? Development and application of a mathematical assessment model. *Annals of Epidemiology*, *21*, 930-945.

Shumway, S., & Wetherby, A. M. (2009). Communicative acts of children with autism spectrum disorders in the second year of life. *Journal of Speech, Language, and Hearing Research*, *52*, 1139-1156.

Solomon, R., Van Egeren, L. A., Mahoney, G., Huber, M. Q., & Zimmerman, P. (2014). PLAY Project Home Consultation intervention program for young children with autism spectrum disorders: A randomized controlled trial. *Journal of Developmental and Behavioral Pediatrics*, *35*, 475-485.

U.S. Department of Health and Human Services Centers for Disease Control and Prevention. (2014) Prevalence of Autism Spectrum Disorder Among Children Aged 8 Years — Autism and Developmental Disabilities Monitoring Network, 11 Sites, United States, 2010. Morbidity and Mortality Weekly Report. Surveillance Summaries Volume 63. No 2.

Warren, Z., McPheeters, M. L., Sathe, N., Foss-Feig, J. H., Glasser, A., & Veenstra-VanderWeele, J. (2011). A systematic review of early intensive intervention for autism spectrum disorders. *Pediatrics*, *127*, e1303-e1311.

Weitlauf, A. S., McPheeters, M. L., Peters, B., Sathe, N., Travis, R., Aiello, R., Williamson, E., Veenstra VanderWeele, J., Krishnaswami, S., Jerome, R., & Warren, Z. (2014). Therapies for children with autism spectrum disorder. Rockville, Maryland: Agency for Healthcare Research and Quality (US).

Wetherby, A., & Prizant,B. (2002). *Communication and Symbolic Behavior Scales Developmental Profile*. Baltimore, Maryland: Paul H Brookes Publishing.

Wetherby, A., Cain, D., Yonclas, D., & Walker, V. (1988). Analysis of intentional communication of normal children from the prelinguistic to the multi-word stage. *Journal of Speech and Hearing Research, 31*, 240–252.

Wieder, S., & Greenspan, S. I. (2003). Climbing the symbolic ladder in the DIR model through floor time/interactive play. *Autism*, *7*, 425-435.