# Examining Special Educators Verbal Responsiveness in Groups of Students with Autism Spectrum Disorder

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## Dedication

For Jason, Emma, and Eddie.

## Abstract

This study examined whether verbal responsiveness to students' attentional focus and verbal/vocal acts in special educators varied among subgroups of preschool students with Autism Spectrum Disorder (ASD) ($n$ = 112). Participants were divided into clusters using cluster analysis based on their standardized scores from the Preschool Language Scale-4 and the Mullen Scales of Early Learning. For each student, a 15-minute video of free play in school setting was collected. Three types of responsive utterances were coded: follow-in directives for behavior, follow-in directives for language, and follow-in comments. Results showed that the clusters did not differ in the rate of overall responsive utterances. Additionally, the groups did not differ in follow-in directives for behavior after controlling for classroom types. However, compared with a cluster of students with ASD who scored within normal range on standardized cognitive and language tests, the cluster of students with more severe cognitive and language impairments received a significantly higher rate of follow-in directives for language from special educators. Moreover, student engagement was positively associated with the amount of responsive utterances from the teacher. Students with more cognitive and language impairments produced significantly fewer vocal/verbal acts, which may have resulted in receiving fewer verbal responses from their teachers.

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## Chapter 1 Introduction

Autism spectrum disorder (ASD) represents one of the most rapidly growing developmental disabilities in the United States (Dawson & Bernier, 2013). The Centers for Disease Control and Prevention (2014) reported that the prevalence rate of ASD in the U.S. in 2014 was 1 in 68, an estimated 30% increase between 2008 and 2010. Approximately 25% to 60% of students with ASD fail to develop spoken speech by the age of 5 years (Tager-Flusberg, Paul, & Lord, 2005). One important language support for children with ASD involves verbal responsiveness on the part of communicative partners. Caregiver verbal responsiveness has been shown to be positively related to communicative gains among both typically developing children and children with ASD (Haebig, McDuffie, & Ellis Weismer, 2013a; Hart & Risley, 1995; McDuffie & Yoder, 2010; Siller & Sigman, 2002, 2008). "Verbal responsiveness" refers to utterances that follow the child's focus of attention, actions, and communication (McDuffie & Yoder; Siller & Sigman, 2002). To date, most studies addressing verbal responsiveness have focused on maternal responsiveness. Few investigators have examined teachers' verbal responsiveness (Engevik, Hollan, & Hagtvet, 2015; Kim & Hupp, 2005). Given that teachers spend a significant amount of time interacting with students who have ASD, it is important to understand the extent to which special educators engage in verbal responsiveness with children experiencing ASD. Without a better understanding of this issue, efforts to develop effective teacher-mediated intervention strategies for students

with ASD are likely to be compromised (Warren & Brady, 2007; Warren, Brady, Sterling, Fleming, & Marquis, 2012).

Despite the potential effects of teacher verbal responsiveness on social-communicative outcomes of students with ASD, few studies to date have examined teachers' verbal responsiveness during interactions with these children. Recently, others have explored this topic with students having Down syndrome (Engevik et al., 2015). Given that children with Down syndrome and ASD often experience language delays, it is possible that these findings have relevance for preschool students with ASD. Engevik et al. compared interactions between special education teachers of elementary school students with Down syndrome to those of preschool teachers of TD students. They reported that teachers of students with Down syndrome used a greater proportion of directives compared to preschool teachers, and the differences in teachers' behavior may due to the child's ability to initiate during interactions.

Studies have also shown that mothers of children with intellectual disabilities are more responsive to children who produce more vocal and verbal sounds compared to mothers of children with limited speech (Hudry et al., 2013; Roach, Barratt, Miller, & Leavitt, 1995). Based on the available information describing the relationship between parent spoken responses and the language of typically developing children, it is reasonable to hypothesize that the frequency of vocal/verbal communicative acts by children with ASD may correspond to a greater frequency of teachers' spoken responses. Driven by this hypothesis, the following section provides a review of studies that have

examined the relation between verbal responsiveness and language in children with ASD, as well as the influence of the child's characteristics on caregiver responsiveness.

**Effects of Verbal Responsiveness on Language in Children with ASD**

**Definitions of responsiveness used in studies.** Researchers have examined maternal verbal responsiveness to children with ASD, who vary greatly in cognitive, expressive and receptive language skills, as shown in Table 1 (McDuffie & Yoder, 2010; Haebig et al., 2013a; Siller & Sigman, 2002, 2008). Among the various ways to characterize responsiveness, this study explored three types of responsive utterances that include follow-in directives for behavior/language and follow-in comments.

[Insert Table 1 Here]

Before reviewing findings of each study, it is important to clarify aspects of responsiveness that are of interest in the current investigation. McDuffie & Yoder ( 2010) and Haebig et al. (2013a, b) defined "follow-in directives for behavior" as spoken utterances produced by a caregiver that follow the child's focus of attention and convey a direction for the child to change their action. "Follow-in directives for language" were defined as caregiver-produced spoken utterances that require a spoken response from the child. "Follow-in comments" were defined as comments produced by a caregiver describing the child's action without placing a demand on the child. Siller and Sigman (2002; 2008) used the term "synchronized demanding utterances" to describe follow-in directives for behavior, and the term "synchronized undemanding" to refer to follow-in comments. Siller and Sigman made a distinction between utterances synchronized with

the child's attentional focus and those synchronized with both the child's attention and action. Based on this definition, follow-in comments were considered to be synchronized with both the child's attention and play action, whereas follow-in directives were synchronized only with the child's attention.

**Verbal responsiveness of child's attentional focus during interactions with children with ASD.** Four studies examined maternal responsiveness in children with ASD. In each study, language production or comprehension served as the main outcome in relation to maternal verbal responsiveness. Table 1 shows different aspects of language and the assessments that were used in each study. In a 16-year longitudinal study that began with 25 preschoolers with ASD, Siller and Sigman (2002) found that follow-in comments were positively related to language gains 10 ($r$ = .67) and 16 years later ($r$ = .79). Maternal follow-in comments were measured when children were at 50 months ($SD$ = 11), and language measures were collected at baseline, and 1, 10, and 16 years after baseline using the Clinical Evaluation of Language Fundamental-Revised (CELF-R) (Semel, Wiig, & Secord, 1987).

Siller and Sigman (2008) studied 28 preschoolers with ASD and measured follow-in comments and a composite score that included follow-in comments and follow-in directives for behavior coded during parent-child interaction. These measures were administered at initial intake and at three different time points later. The initial intake was conducted when the children were 45 months (SD = 8 months). The average interval between the four waves of data was 12.3, 12.7, and 20.2 months. Both the follow-in

comments and a composite of follow-in directives for behavior and comments positively predicted the child's language growth. Taken together, the Siller studies (2002, 2008) concluded that follow-in comments are significantly positively correlated with standardized language scores based on the Clinical Evaluation of Language Fundamentals (CELF-Preschool) (Wiig, Secord, & Semel, 1992). However, the role of follow-in directives for behavior remains unclear because these utterances were included as part of the composite score and were not predictive when analyzed separately.

McDuffie and Yoder (2010) found that both follow-in directives for behavior and follow-in comments were positively correlated with spoken vocabulary at baseline and 6 months later in 32 preschoolers with ASD (average CA = 40.65 months, *SD* = 8.62), with follow-in directives for behavior and follow-in comments accounting for 11% and 14% of the variance in spoken language, respectively. The authors found that parental utterances that follow the child's focus of attention, even those demanding in nature, predict spoken vocabulary in preschoolers with ASD. They suggested that this is because these utterances provide mapping between labels and objects or events (McCathren, Yoder, & Warren, 1995). This study assessed only follow-in directives for behavior and did not evaluate follow-in directives for language, which may be positively associated with language production by requiring responses from the child (Yoder, Davies, Bishop, & Munson, 1994).

Haebig and colleagues (2013a) examined the role of follow-in directives for language on comprehension and production of children with ASD. They studied 40

preschoolers with a mean chronological age of 31 months (see Table 1 for child characteristics). This study found that follow-in directives for language were positively correlated with the child's language comprehension ($r$ = .66, $p$ <.01) and production ($r$ = .67, $p$ <.01) measured by the Preschool Language Scales-4 (PLS-4; Zimmerman, Steiner, & Pond, 2002). In addition, this study showed an interaction effect between the child's language ability and parent follow-in comments. That is, children with limited language ability, defined as those who spoke less than five words during the Autism Diagnostic Observation Schedule (ADOS) administration, benefited from parent follow-in comments, whereas children who spoke five or more words during the ADOS administration did not.

Available evidence suggests that follow-in directives for behavior or language and follow-in comments are positively associated with language comprehension and production in at least some preschoolers with ASD. Additionally, children who have more limited expressive language appear to benefit more from follow-in comments (Haebig et al., 2013a). The present study extended previous studies by examining whether special education teachers' spoken responsiveness to the student's attentional focus differs in groups of students (preschoolers) with ASD who have different language and cognitive abilities and whether the verbal or vocal output of the students differs across groups.

A transactional framework for caregiver-child interaction emphasizes the importance of a bidirectional process, in that not only the caregiver's behavior has an

impact on the child's development, but also that the child affects the caregiver's behavior (Sameroff & Chandler, 1975). Although few studies have examined the impact of child factors on caregiver behavior in students with ASD, some evidence from typically developing (TD) children and children with intellectual disabilities suggests that caregivers interact differently with students who differ in age, cognitive ability, and language ability (Doussard-Roosevelt, Bazhenova, & Porges, 2003; Roach et al., 1995; Yoder & Warren, 2001; Yoder et al., 2001)

**The Influence of Child's Characteristics on Caregiver Responsiveness**

Studies that compared interactive behavior of caregivers of TD children and children with disabilities showed that caregivers of the latter have a propensity to use more directive utterances compared with caregivers of TD children (Cielinkski, Vaughn, Seifer, & Contreras, 1995; Cunningham, Reuler, Blackwell, & Deck, 1981; Green, Caplan, & Baker, 2013; Wheeler et al., 2007). These findings have been reported in children with ASD (Doussard-Roosevelt et al., 2003; EI-Ghoroury & Romanczyk, 1999) and children with Down syndrome (Cielinski et al., 1995; Slonims & McConachie, 2006).

Some investigators have suggested that mothers of children with developmental disabilities adjust their interactive behaviors in response to the child's limitations in social, linguistic, and cognitive domains by being more directive (Bell, 1981; Doussard-Roosevelt et al., 2003; Marfo, 1991; Roach et al., 1998). Although the bulk of these studies examined interactions between mothers and their children with intellectual delay,

a similar interpretation may also apply to students with ASD who have limited social communication skills when interacting with teachers in classrooms (Hudry et al., 2013; Warren & Brady, 2007).

A number of investigators have focused on examining the extent to which different aspects of a child's communication ability may impact a caregiver's behavior (Doussard-Roosevelt et al., 2003; Hudry et al., 2013; Roach et al., 1995; Yoder & Warren, 2001; Yoder, Hooshyar, Klee, & Schaffer, 1996). Doussard-Roosevelt et al. (2003) compared how two groups of mothers responded to their children with ASD. One group consisted of children with ASD who were nonverbal, and the other group consisted of children with ASD who were verbal. These investigators reported that mothers of nonverbal children with ASD used significantly more directives than mothers of verbal children with ASD. Given these data, it seems plausible that special education teachers may be more responsive to children with ASD who produce more spoken communication than to children with ASD who are do not use spoken language. This difference in spoken input produced by teachers has been proposed as a variable that may be correlated with language development in children with ASD (Haebig et al., 2013; Siller & Sigman, 2002). That is, children with ASD having greater language ability might receive a greater amount of responsive input from their teachers when compared with teacher responsivity to children who produce substantially less or no spoken language (as a result of fewer contingent language models to assist in their acquisition of communicative behavior).

**Present Study**

The current investigation was designed to determine whether special educators (referred to hereafter as teachers) respond differentially to preschool students with ASD who have severe language and cognitive impairments as compared to students with ASD who have fewer impairments. Originally three individual clusters of participants were specified that differed with respect to cognitive and language competence. These groups followed a logic articulated by Tager-Flusberg and Joseph (2003) suggesting that three distinct subgroups of children with ASD could be defined using children's cognitive and language status. Based on cluster analysis results, cluster 1 consisted of students with the most severe impairments in both language and cognitive abilities. Students in cluster 2 had less severe cognitive and language ability compared with students in cluster 1. Cluster 3 consisted of students with mild or no impairments in language and cognitive abilities. Table 2 shows the mean and standard deviations of standard cognitive and language scores of students in each cluster. Even though these three groups demonstrated statistically significant differences, some students in cluster 2 displayed overlap with students in cluster 3 in standard language (derived from PLS-4) or cognitive scores (derived from MSEL). Consequently, the decision was made to establish greater separation by performing group comparisons that focused on teachers' responsive utterances for clusters 1 and 3. By doing this, type 1 error rate, a common concern in multiple comparison tests, was reduced (Benjamini, 2010).

[Insert Table 2 Here]

The present study addressed the following research questions:

1. Is the rate of overall responsiveness produced by students with ASD less for those having severe impairments (cluster 1), compared with those having less severe impairments (cluster 3)? It is hypothesized that the overall rate of responsiveness will be lower for students in cluster 1 compared with students in cluster 3.

2. Do teachers use a higher rate of follow-in directives with students who have severe impairments (cluster 1), compared with students with less severe impairments (cluster 3)? It is hypothesized that the rate of teachers' follow-in directives will be higher for students with more severe language and cognitive impairments compared with students with less severe impairments.

3. Do teachers use a lower rate of follow-in comments with students who have severe impairments (cluster 1), compared with students with less severe impairments (cluster 3)? It is hypothesized that the rate of teachers' follow-in comments will be lower for students in cluster 1 compared with students in cluster 3.

4. Is the percentage of teachers' responses that follow students' vocal or verbal acts within 3 seconds lower for students who have severe impairments (cluster 1), compared with students with less severe impairments (cluster 3)? It is hypothesized that the percentage of teachers' responses to students' vocal/verbal acts will be lower for students in cluster 1 compared with students in cluster 3.

## Chapter 2 Literature Review

In this chapter, I will first define verbal responsiveness and then review studies that examined verbal responsiveness and language comprehension and production in children with ASD. Next, I will review evidence on how the child's overall developmental level and communication ability may impact caregiver behavior. The majority of the studies reviewed here focused on maternal responsiveness, given that few studies have examined responsiveness in teachers.

Responsiveness has been studied extensively in mother-child dyads. It refers to adult utterances produced contingently to play and communication acts produced by the child (Landry, Smith, & Swank, 2006; Tamis-Lemonda, Bornstein, & Baumwell, 2001). A number of studies have shown that responsiveness is positively related to language outcomes in TD children and children with disabilities (Girolametto & Weitzman, 2002; Mahoney & Wheeden, 1999). Furthermore, studies have shown that verbal responsiveness is positively associated with language comprehension and production in students with ASD (Haebig et al., 2013a; Hudry et al., 2013; McDuffie & Yoder, 2010; Siller & Sigman, 2002, 2008). For the most part, these studies examined mother-child interaction (Haebig et al., McDuffie & Yoder, Siller & Sigman); thus, very little is known about how specific child factors are associated with maternal verbal responsiveness. Even less is known about how child factors, such as the child's spoken language, affect verbal responsiveness in teachers (Kim & Hupp, 1995; Engevik, Hølland, & Hagtvet, 2015). Despite limited empirical evidence on this topic, Warren and Brady (2007) suggested that

children with ASD were likely to experience deficits in environmental input from caregivers because of their limited and atypical behavior repertoire, such as low rates of initiations, atypical eye gaze, hypersensitivity to sensory input, stereotypical behavior, unintelligible speech, and problems with conversational discourse. This bidirectional transaction between the caregiver and the child can be described using a transactional framework (Sameroff & Chandler, 1975).

**Caregiver Responsiveness: A Transactional Framework**

A transactional framework suggests that the caregiver's and child's behavior have a bidirectional impact (Sameroff & Chandler, 1975). Cicchetti and Lynch (1993) observed that "environmental forces, caregiver characteristics, and child characteristics all influence each other and make reciprocal contributions to the events and outcomes of child development" (*p.* 97).

During an interaction between a teacher and a child with ASD, this transactional framework suggests that, on one hand, the teacher has the opportunity to influence multiple aspects of the student's development. On the other hand, student characteristics, such as social and communication deficits associated with ASD, may exert a great influence on the teacher's interactive behavior. Some evidence supports this latter position by showing that mothers of children with ASD use more directives compared with parents with TD children (Doussard-Roosevelt et al., 2003). This evidence led some researchers to suggest that parents may adjust their behavior to compensate for the limited behavioral repertoire in children with ASD (Warren & Brady, 2007).

**Caregiver Responsiveness: Definition**

Responsiveness is a multifaceted construct. At a molar level, it is characterized by positive affect, such as warmth (Warren & Brady, 2007; Landry et al., 2001). At a molecular level, it refers to a specific type of caregiver response to a child's signal that may be viewed as a three-chain event: (a) child's signal; (b) caregiver's response; and (c) child's experience that his or her needs are important and will be responded to in a sensitive way (Landry, Smith, & Swank, 2006). The child's signal can be an affect display, play, or vocal/verbal acts. To be viewed as responsive, the caregiver's reaction to the child's signal must be emitted promptly. Promptness addresses the temporal relationship between the child's signal and the caregiver's response. For example, McDuffie and Yoder (2010) defined prompt responses as those that occurred within 3 seconds following the child's spoken acts. Moreover, the adult responses needed to align with the object or the event that was the child's focus of attention or be topically related to the child's spoken acts (Bornstein, Tamis-LeMonda, & Haynes, 1999; Yoder, McCathren, Warren, & Watson, 2001). For example, if a child is making the dump truck drive on a floor, a responsive utterance would be an adult saying "the truck is driving fast!" (Siller & Sigman, 2002). In this case, there is a mapping between the child's focus of attention and the caregiver's verbal input (that is, the truck).

Verbal responsiveness refers to caregivers' spoken input that is semantically and/or pragmatically relevant to the child's attentional focus or communicative acts (McDuffie & Yoder, 2010; Cress, Grabast, & Jerke, 2013). Responsive utterances may

serve a variety of functions that include commenting (describing the child's action), directing (asking the child to do something with a toy), requesting information ("what color is it?"), or requesting an action ("sit down!") (Brady et al., 2014; Girolametto, Weitzman, van Lieshout, & Duff, 2000; Marfo, 1992; Mahoney & Wheeden, 1999; McCathren, Yoder, & Warren, 1995).

One type of verbal responsiveness involves "follow-in" utterances. For example, McDuffie and Yoder (2010) described follow-in directives for behavior and follow-in comments. Follow-in directives were defined as spoken language "that followed the child's current focus of attention and conveyed a request for the child to change some aspect of his/her play with the toys" (McDuffie & Yoder, *p.* 1032). For example, when a child is holding a ball, the caregiver might say, "roll the ball to me." Follow-in comments were defined as spoken utterances "that followed the child's focus of attention and described what the child was looking at or playing with, without conveying the expectation that the child do something different or respond verbally to the parents" (McDuffie & Yoder, p. 1032). For example, in the case of the child holding a ball, a mother might say, "You have a yellow ball." Haebig et al. (2013a) included the category "follow-in directive" for language as one type of responsive utterances, defined as utterances that request a verbal response from the child (for example, "what color is this?"). Each of these utterance categories has been examined in children with ASD in relation to their effects on the child's language ability.

## Effects of Verbal Responsiveness on Language in Children with ASD

A review of the literature addressing verbal responsiveness with preschoolers with ASD yielded four studies (Siller & Sigman, 2002, 2008; McDuffie & Yoder, 2010; Haebig et al., 2013a). Each investigation used existing data and focused on mother-child interactions. The following section will provide a description of terms that have been used in these investigations, followed by a description of each study in detail.

**Terms used in studies examining verbal responsiveness among children with ASD.** Siller and Sigman (2002, 2008) used the term "undemanding/demanding synchronized utterances." Undemanding synchronized utterances are maternal verbal inputs that describe the child's action without requesting any change from the child, whereas in the McDuffie and Haebig studies, this type of verbal input was termed "follow-in" comments (McDuffie & Yoder, 2010; Haebig et al., 2013a). In contrast, demanding synchronized utterances required an action from the child ("put the ball over there") as demanding utterances synchronized with only attention, not the child's play actions. For example, as a child is rolling a truck toy, the caregiver might say, "dump the truck." Siller and Sigman would code this utterance as a demanding utterance that synchronized with the child's attention but not action (dumping versus rolling). This same event would be referred to as a follow-in directive for behavior in other studies (McDuffie &Yoder, Haebig et al.).

**Studies on the effects of verbal responsiveness involving children with ASD**. Siller and Sigman (2002) examined the association between maternal verbal

responsiveness and children' language by observing three groups of participants: 25 children with ASD, 18 TD children, and 18 children with Developmental Delay (DD). The groups were matched on IQ, mental age, and language age. Children in the ASD group on average were 50.3 months ($SD$ = 11.7), with an average IQ score of 46 ($SD$ = 9.4) (initial language was not reported). Each participant was observed during a 4-minute parent-child interaction in a playroom of a university laboratory and was coded for synchronized and unsynchronized utterances, using 30-second interval coding. To control for the child's toy-directed attention, a percentage score of follow-in comments (referred to as undemanding synchronized utterances in the Siller study) was calculated by dividing the percentage of follow-in comments by the percentage of child toy-directed attention. The results showed that this percentage score was strongly associated with communication ability of students with ASD, as measured by the Clinical Evaluation of Language Fundamentals-Revised (CELF-R) (Semel, Wiig, & Secord, 1987) at a 10-year ($r$ = .67, $p$ < .005) and a 16-year follow-up ($r$ = .79, $p$ < .001). The effects of follow-in directives for behavior were not clear because follow-in directives for behavior were coded as a part of composite score of both demanding and undemanding utterances.

In an extension of the study just described, Siller and Sigman (2008) conducted a longitudinal study with 28 students with ASD using multilevel modeling. At baseline, students ranged in chronological age from 31 to 64 months ($M$ = 45.2 months, $SD$ = 8.4). The participants' nonverbal IQ ranged from 25 to 122 ($M$ = 57.5, $SD$ = 19.8) as assessed by the Mullen Scales of Early Learning (MSEL) (Mullen, 1995). Four waves of data were

obtained; the mean elapsed months between the four waves were 12.3, 12.7, and 20.3 months, respectively. Average chronological age of the participants at the four waves was 45.2 months (*SD* = 8.4), 57.5 months (*SD* = 8.9), 69.5 months (*SD* = 9.1), and 89.0 months (*SD* = 9.1), respectively. Standardized language scores were derived from one of the following three measures, depending on the child's developmental level: MSEL (Mullen, 1995), Reynell Developmental Language Scale (RDLS) (Reynell, 1977), or the CELF-Revised (Semel et al., 1987). Definitions for verbal responsive utterance were the same as those described in Siller and Sigman (2002). Consistent with findings from previous studies (Siller & Sigman), mothers who used more follow-in comments at Wave 1 had children who showed greater language gains later. A composite score of follow-in comments and follow-in directives for behavior were shown to be significant predictors of language growth longitudinally.

McDuffie and Yoder (2010) studied the relation between follow-in directives for behavior, follow-in comments, and spoken vocabulary of 32 students with ASD (*CA* = 40.7 months, *SD* = 8.6, ranging from 26-70 months) who had an average cognitive standard score of 51.4 (*SD* = 5.5, ranging from 48-67) assessed by MSEL (Mullen, 1995). The child's spoken vocabulary was measured by the MacArthur Communicative Development Inventory (MCDI) (Fenson et al., 1993). All children produced fewer than 10 words at pretreatment during the administration of the Early Social Communication Scales (Mundy, Hogan, & Doehring, 1996). In the original study, these children were assigned to one of the two intervention conditions (Picture Exchange Communication

System and Responsive Education and Prelinguistic Milieu Teaching). Data were obtained at both pretest and posttest (6 months after the pretest). The analysis was based on pooled data from both groups. This study showed that both follow-in directives for behavior and follow-in comments were positively correlated with spoken vocabulary at baseline and 6 months later, measured by a parent report (that is, MCDI). Further, both types of utterances significantly predicted spoken language 6 months after baseline, accounting for about 11% and 14% of the variance in spoken language, respectively. These findings support the notion that parental utterance that follows into the child's focus of attention, even when demanding in nature, predicts spoken language in preschoolers with ASD (McCathren et al., 1995).

Haebig and colleagues (2013a) extended the McDuffie study by examining the relation between follow-in directives for language and the child's receptive and expressive language, as measured by the Preschool Language Scale-4 (Zimmerman, Steiner, & Pond, 2002). A total of 40 students with ASD participated in this study (*CA* = 31.4 months, *SD* = 4.5, ranging from 24 to 39 months), with the nonverbal mental age ranging from 16 to 34 months (*M* = 24.3 months, *SD* = 4.9, as assessed by the MSEL (Mullen, 1995). These children were divided into two groups: minimal expressive language (speaking less than five spoken words during the administration of the Autism Diagnostic Observation Schedule (ADOS) and verbal fluent group (speaking at least five spoken words or phrases during ADOS) (Lord et al., 2000). Follow-in directives for language were significantly associated with both language comprehension and

production, after controlling for parent education. Although results using the total sample size showed that follow-in comments were significantly associated with comprehension and production, the effects of follow-in comments on language were present with students who had minimal expressive language (Haebig et al., 2013b). That is, students who were minimally verbal showed significantly greater gains in both receptive and expressive language when their parents used more follow-in comments. These findings were not the case among students who spoke at least five words or phrases during ADOS. The authors suggested that the parent commenting on the child's behavior may not support language comprehension and production for students who are in the verbal fluent group.

In summary, each of the four studies reported positive findings on the effects of follow-in comments on the child's language ability measured by standardized language tests in students with ASD. More specifically, this positive relationship between follow-in comments and language gains is likely to be present for students with ASD who have very limited speech (McDuffie & Yoder, 2010; Haebig et al., 2013b). Additionally, some evidence, although limited, supports a positive predictive relation between parents' follow-in directives for behavior (McDuffie & Yoder), follow-in directives for language, and the child's language (Haebig et al.).

Although it would be helpful to directly compare outcomes across studies, it is difficult, given the differences in sample characteristics (see Table 1). For example, the average chronological age was 31 months (Haebig et al., 2013a), but 50 months in the

study by Siller and Sigman (2002). Such a difference in chronological age may contribute to different findings, given that caregivers may interact differently with students of different chronological ages (Cunningham et al., 1981; Girolametto & Weitzman, 2002; Girolametto, Weitzman, Wiigs, & Pearce, 2000; Pellegrino & Scopesi, 1990). Also, there was a substantial range in vocabulary comprehension and production in students recruited across the three studies. The average number of words understood by the students in one study ranged from 13 to 371 ($M$ = 155.5, $SD$ = 103.7) (McDuffie & Yoder, 2002) and from 1 to 396 ($M$ = 151.8, $SD$ = 112.9) in another study (Haebig et al., 2013a). Differences in the child's comprehension ability may influence the number of directives reported in studies, given that caregivers tend to use more comments and fewer directives with students who have higher receptive language (Wheeler et al., 2007).

Differences in measuring responsiveness also make it difficult to compare results across studies. In the Siller and Sigman study (2002), maternal responsiveness was measured by dividing the percentage of verbal responsive utterances by the percentage of child toy-directed attention. However, in the Haebig study (2013a), caregiver responsiveness was measured by dividing the frequency of follow-in directives and follow-in comments by the duration of the child's engagement. Unlike these two studies, McDuffie and Yoder (2010) used the frequency of follow-in directives/comments and included the duration of engagement as a covariate in the regression analysis. These differences in metrics may yield different analysis results, given that data obtained using these metrics may yield data with different distributions.

Although the influence of a caregiver on the child's behavior is important, equally important is how child factors influence the caregiver's behavior. Because few studies have examined how caregivers interact with children with ASD who have different cognitive and communication abilities (Doussard-Roosevelt et al., 2003), the following section includes evidence drawn from three bodies of literature involving both TD children and children with disabilities. Studies reviewed included those that (a) compared the interactive behavior of mothers of TD children and mothers of children with disabilities (Engevik et al., 2015; Green, Caplan, & Baker, 2013; Roach, Barratt, Miller, & Leavitt, 1998; Slonims, Cox, & McConachie, 2006; Wheeler et al., 2007); (b) examined how different aspects of a child's communicative ability are associated with caregiver behavior (Baird, Peterson, & Reilly; 1995; Dawson, Hill, Spender, Galpert, & Watson, 1990; Yoder & Warren, 1999, 2001); and (c) examined how caregivers interact with children of different ages (Cunningham et al., 1981; Girolametto & Weitzman, 2002; Girolamett, Weitzman, Wiigs, & Pearce, 2000).

**Effects of Child Speech and Developmental Level on Caregiver Verbal Responsiveness**

Studies on TD students have shown that caregivers reduce the length and syntactic complexity of their speech during interaction with toddlers compared with preschoolers (Cunningham et al., 1981; Girolametto & Weitzman, 2002; Girolametto, Weitzman, Wiigs, & Pearce, 2000; Pellegrino & Scopesi, 1990). For example, Girolametto, Weitzman, Lieshout, and Duff (2000) examined different types of

directiveness used by daycare teachers when interacting with a group of toddlers versus preschoolers. The toddlers in this study ranged in chronological age from 17 to 33 months ($M$ = 24.9, $SD$ = 3.9, $n$ = 40). The preschoolers ranged in age 32 to 53 months ($M$ = 41.1, $SD$ = 4.5, $n$ = 40). The teacher-child ratio for toddler classrooms was 1:5, and for preschool classrooms, 1:8. All participating teachers were females with at least 2 years of experience teaching in a daycare setting. Each teacher was asked to select four students in her classroom who were typically developing and had average language skills. Each group, consisting of a teacher and four students, was videotaped for 15 minutes in a book-reading activity followed by another 15 minutes in a play-dough activity but only the last 10 minutes of videotaped sessions were analysed to allow a brief warm-up period. Each utterance was coded as one of three types of directives: behavior control (that is, attention calls and group management), response control (commands, directive yes/no questions, choice questions), and conversational control (that is, *wh*-questions, conversational yes/no questions, and clarification questions). The child's language production was measured as the number of different words, number of utterances, and average length of the three longest utterances. Results revealed that teachers used significantly more attention calling with younger students and more *wh*-questions with older students. Additionally, teachers used a significantly greater amount of behavior control with students who spoke fewer words and had less complex language. One interpretation offered by the authors was that the lower level of language ability in

toddlers resulted in the teacher using more directives to encourage participation from these students.

Using the same procedures as in a previous study (Girolametto et al., 2000), Girolametto and Weitzman (2002) reported that teachers modeled significantly more single words to label objects with toddlers, whereas they used significantly more extensions of the students' topics with preschoolers. Participants in this study included 52 toddlers ($M$ = 24 months, ranging from 17 to 33 months) and 52 preschoolers ($M$ = 39 months, ranging from 30 to 53 months). The child's language productivity was measured by number of utterances, different words, and multiword utterances used during 10-minute play-dough and book-reading activities. The authors posited that these findings reflected the teachers' awareness of the differences between the toddlers and preschoolers in spoken language and stated that learning single words is more important for preschoolers whose language skills are emerging, compared to preschoolers.

The two studies described above suggested that daycare teachers tend to use more complex language with preschoolers (older than 30 months) compared with toddlers (18-30 months). The age difference may reflect the students' difference in their spoken language, with preschoolers producing more complex sentences. The following section first provides a review addressing the influence of a child's language ability on an adult's interactive behavior, followed by a review of studies that compared caregivers' (mothers and teachers) interactive behavior with TD children and children with ASD, to determine whether a child's overall developmental level impacts the adult's behavior. Once again,

the studies to be reviewed focus primarily on mother-child dyads (Green et al., 2013; Roach et al., 1998; Yoder et al., 1996; Yoder & Warren, 2001), with one study comparing interaction between teachers and students with DS dyads with teachers and typically developing preschoolers dyads (Engevik et al., 2015). No studies examined how teachers interact with preschoolers with ASD who differ in cognitive and language abilities.

**Impact of child communication skills on caregiver behavior among children with developmental disabilities.** investigators have reported on how different aspects of child communication behavior, such as coordination of eye gaze, gesture and vocalization, speech intelligibility, and sentence complexity influence the caregiver's interactive behavior ((Baird, Peterson, & Reilly; 1995; Dawson, Hill, Spender, Galpert, & Watson, 1990; Yoder & Warren, 1999, 2001; Yoder, Hooshyar, & Schaffer, 1996)). With respect to children with ASD, Doussard-Roosevelt and colleagues (2003) examined the differences in mothers' interactive behavior with each of two groups of students with ASD who varied in language ability (verbal and nonverbal) based on the parent report of absence or presence of spoken words. This study showed that mothers in the nonverbal group used more physical contacts and more verbal cues than mothers in the verbal group.

Several groups of investigators have examined types of children's spoken acts that are responded to most frequently by caregivers (Cress, Grabast, & Jerke, 2013; Yoder Hooshyar, Klee, & Schaffer, 1996; Yoder & Warren, 2001; Yoder, McCathren,

Warren, & Watson, 2001). Caregivers tend to respond significantly more often to infants' intentional communication acts than to preintentional acts (Yoder, Warren, Kim, & Gazdag, 1994; Yoder & Warren, 2001). In these studies, intentional communication acts were those that showed coordinated attention between an object and a communication partner (Wetherby & Prizant, 1993).

Yoder and Warren (2001) examined maternal responsiveness to communicative acts initiated by 58 children with developmental disabilities with varied etiologies. Participants had a mean chronological age of 23 months (*SD* = 4, range = 17 to 32). All children scored below the 10th percentile on expressive vocabulary measured by the MacArthur-Bates Communication Development Inventory (Fenson et al., 1993). Each child was assigned to one of the two treatment conditions: prelinguistic milieu teaching and responsive small group instruction; a 15-minute free play sample was collected in a laboratory setting. The authors coded two types of child gestures or vocalizations: (a) intentional acts consisting of coordinated attention to adult and an object (for example, pointing at a toy while looking at the caregiver) and (b) non-intentional acts (for example, reaching for a toy without looking at the caregiver). Maternal responsiveness was defined as the proportion of child's gestures or vocalizations to which the mother responded. An analysis of performance for both groups showed that the child's intentional communication was highly correlated with the frequency of responsive input from the mother ($r = .71$, $p < .01$). Mothers of children with developmental disabilities were more likely to respond to child communicative acts with a clear communicative function (for

example, requesting) that was explicitly directed toward an adult than to those that were not.

Speech intelligibility is another factor that has been associated with frequency of caregiver responsivity. Yoder et al. (1996) studied how the intelligibility of the child's speech is related to mothers' responses. Eight children with Down syndrome and eight with language delay matched on the Mean Length of Utterance (MLU) participated. The MLUs for the Down syndrome (DS) and Language Delay (LD) group were 1.89 (*SD* = .50) and 1.91 (*SD* = .42), respectively. The mean chronological age for students with Down syndrome was 83 months (*SD* = 26) and 44 months (*SD* = 9) for students with language delay. A speech sample was collected during 20-minute free play sessions between the child and the mother. Mothers were asked to play with their child as they typically did. Each child utterance was coded into one of three categories: unintelligible (that is, the transcriber did not recognize any vocalizations as a particular English word), partially intelligible (that is, the transcriber recognized at least one vocalization as a particular English word), and fully intelligible (the transcriber was able to recognize all vocalizations). The authors found that mothers of children with Down syndrome responded significantly more often to partially intelligible utterances compared to mothers of children with a learning disability (without Down syndrome).

The number of different vocalizations or spoken words produced by a child has also been shown to be related to verbal responsiveness. Roach, Barrat, and Miller (1998) examined mothers' verbal behavior during interaction with their children with Down

syndrome. Three groups of 28 children and their mothers participated in this study: a DS group, a TD group matched on chronological age (CA) with the DS group, and another TD group matched on mental age (MA) with the DS group based on performance on the Bayley Scales of Infant Development (Bayley, 1969). The CA matched groups had a chronological age ranging from 15 to 26 months ($M$ = 21.11, $SD$ = 3). The MA matched groups had a mental age ranging from 10 to 17 months ($M$ = 12.86, $SD$ = 1.4). A language sample was collected during a 15-minute mother-child play session videotaped in a laboratory setting. The authors coded several types of mother's behavior that included spoken directives (that is, the mother requested an action or a toy from the child), spoken restrictions (that is, utterances that conveyed rejection of the child's behavior), and vocal maintains (that is, commenting on the child's action or asking questions to maintain the conversations). Child vocalizations consisted of any sound that expressed pragmatic intent. They found that mothers in all three groups were significantly more likely to produce speech following the child's vocalizations. The authors concluded the child's vocalizations appeared to elicit spoken language from parents. Consequently, it seems reasonable to hypothesize that among children with ASD, more frequent vocal/verbal acts during interactions may be associated with more frequent spoken language from their mothers or teachers.

In sum, existing evidence suggests that coordination of gestures/vocalizations and the gaze, intelligibility of the speech, and the amount of vocalizations or spoken words possessed by the child play an important role in caregiver's interactive behavior. Also, a

majority of studies have focused on interaction between mothers and TD students or students with developmental disabilities (with various etiologies). No studies have examined the interaction between teachers and students with ASD.

**Interactive behavior of mothers of TD children and mothers of children with disabilities.** Studies that compared interactive behaviors of caregivers (mainly mothers) of students with disabilities and those of TD children showed that caregivers of children with disabilities are more likely to use directives compared with caregivers of TD children (Doussard-Roosevelt et al., 2003; Kim & Hupp; 2005; Lemanek, Stone, Fishel, 1993; Marfo, 1992; Roach, Barratt, Miller, & Leavitt, 1998; Slonims, Cox, & McConachie, 2006; Wheeler et al., 2007). These studies have compared the caregivers of TD children to caregivers of children with different types of disabilities that have included ASD (Doussard-Roosevelt et al.) and Down syndrome (DS) (Roach, Barratt, Miller, & Leavitt; Wheeler et al.).

***Differences in verbal responsiveness between students with ASD and TD students.*** Doussard-Roosevelt et al. (2003) compared the interactive behavior of mothers of 24 preschoolers with ASD (ages 36 to 69 months, $M = 51.0$ months) and mothers of 24 TD children matched on chronological age (ages 36 to 66 months, $M = 51.0$ months). Among the group of children with ASD, two subgroups (12 verbal and 12 nonverbal) were formed based on maternal report of the presence or absence of words. During a laboratory setting session, mothers and their children were asked to play with a set of toys for 10 minutes. Three approach types were used by mothers during interactions with their

child. These included a social approach (that is, using gestures or vocal cues to engage the child), a physical approach (that is, physical movement toward the child), and an object approach (that is, using an object to engage the child). Social and object approaches were categorized into verbal and nonverbal. The intensity of each approach was coded as low-level intensity (an approach that did not intend to direct the child's behavior), midlevel (an approach aiming to involve the child to elicit any response), or high-level approach (an approach aiming to elicit a specific response). Two types of child's responses were coded: approach (that is, responses that served to continue the interaction) and withdrawal (that is, responses that did not maintain the interaction). The findings showed that (a) mothers of children with ASD used more physical approaches compared with mothers of the TD children; (b) the two groups differed in the number of high-level intensity approaches used during interaction, with 21 out of 24 mothers of children with ASD using at least one high-intensity approach, whereas only 8 out of 24 mothers of TD children used at least one high-intensity approach, and (c) there were differences in maternal approach behavior toward verbal and nonverbal children with ASD. Mothers of the nonverbal group used a significantly greater number of approaches ($M = 89$) than the mothers of the verbal group ($M = 73$) and the mothers of TD group ($M = 76$). Moreover, in this study, children with ASD responded to a low intensity level approach 24% of the time, midlevel approach 48% of the time, and 69% of the time to the high-level approach. Based on these results, the authors suggested that the difference in the number of maternal approach behaviors is primarily due to the child's language

ability. Mothers of children with ASD use a greater number of high-intensity approaches because such an approach is more likely to elicit responses from children with ASD.

In sum, limited evidence suggests that mothers of children with ASD adjust their approaches by initiating more interactions or by being more directive compared with approaches emitted by mothers of TD children. Although no studies have compared how teachers interact with students with ASD and typically developing students, it is likely that the teacher interactive behavior is also associated with the child's characteristics.

***Differences in adults' verbal responses to children with disabilities and to TD students.*** Cielinski, Vaughn, Seifer, & Contreras (1995) studied interactive behaviors of mothers of DS and TD children matched on developmental age measured by the Gesell Developmental Schedules (Knobloch, Stevens, & Malone, 1980). A total of 39 children with DS and 39 TD children participated in the study. The chronological age of children with DS ranged from 28 to 80 months ($M$ = 46.80, $SD$ = 15.66) and from 18 to 36 months for children in the TD group ($M$ = 27.35, $SD$ = 6.43). The developmental age of children in the DS group ranged from 17 to 44 months ($M$ = 27.00, $SD$ = 7.97) and from 18 to 36 months ($M$ = 27.35, $SD$ = 6.43) for children in the TD group. The authors coded three types of verbal behaviors that were based on 5-minute videotaped sessions in the laboratory using a 15-second interval coding method. These included directiveness (that is, the mothers attempted to lead the child's behavior) and intrusiveness (that is, the child's attention was broken due to the mother's directiveness). Additionally, they coded facilitation (that is, the mother followed the child's lead during play). During sessions,

mothers were instructed to play with the child using toys provided by the researchers. Results indicated that parents of children with DS were more intrusive than parents of TD students. However, the two groups did not differ in facilitation or directiveness. Moreover, for children with DS, playtime with toys was significantly shorter when compared to their TD counterparts. Based on these results, the authors suggested that it is possible that differences in sustained engagement between the two groups of children contributed to the differences in level intrusiveness between mothers of TD children and children with DS. Similar results were also reported in a study that compared maternal behavior of children with developmental disabilities (different etiologies included) to mothers of TD children (Green, Caplan, & Baker, 2013). They showed that mothers of children with developmental disabilities were more intrusive, but did not differ in directiveness.

Green et al. (2013) examined 200 mother-child dyads, consisting of 87 children with developmental disabilities (eight students had ASD) and 113 children with TD. The two groups were matched only on chronological age. Children were assessed at 3 and later at 5 years of age. The scores from the Bayley Mental Developmental Index (Bayley, 1993) showed that that the TD group had a mean standard score of 103, and the DD group had a mean score of 59. Mothers and their children were invited to a 10-minute free play activity in a laboratory, which was videotaped for coding purposes. The authors coded two types of directives, supportive and interference directives. Supportive directives included parental verbal or nonverbal behaviors used to influence the child in

activities in which the child was already engaged (similar to the definition of follow-in directive). Interference directives involved behaviors that redirected the child's behaviors or attention away from an activity. These findings showed that mothers in both groups did not differ in the number of supportive directives. However, parents of children with DD showed twice as many as interfering behaviors as mothers in the TD group.

Engevik et al. (2015) compared teacher directiveness in 14 Norwegian dyads: seven TD students and their preschool teachers (PreschDyads) and seven students with DS and their special education teachers (SpecEdDyads). Students in the SpecEdDyads were between 8 and 9 years of age, and students in the PreschDyads were between 5 and 6 years of age. Based on the subtest of the Wechsler Preschool and Primary Scale of Intelligence-III (Wechsler, 2008), the average raw score for students with DS was 19.6 (*SD* = 2.4) and 27.1 (*SD* = 4.1) for TD students. The authors commented that students with DS varied greatly in communication skills; however, specific language test scores were not reported. Fourteen videotaped sessions were collected at the students' school, during which the teachers from both dyads were told to construct a Duplo house from a model provided by the researchers with the child. The average session duration was 9.5 minutes (range = 6-14.5 minutes) for the SpecEdDyads and 11 minutes for the PreschDyads (range = 5-15 minutes). Directives included utterances that demanded a response from the child (that is, requests, commands, and questions). Additionally, the authors coded the emotional aspects of teacher directives by using a seven-point rating scale adapted from the Qualitative Rating Scale (Owen & Ware, 1996). Low scores on

this scale indicate that interactions are dominated and controlled by the adults, whereas high scores indicate that the teachers acknowledge the child's perspectives. The results showed that on average in PreschDyads, 37.3% of the turns contained a directive utterance, whereas in SpecEdDyads, 46.8% of the turns contained a directive. This represented a statistically significant difference with a large effect size (Cohen's $d = 1.2$). However, the two groups of teachers did not differ significantly in the scores from the Qualitative Rating Scale.

**Summary.** The preceding studies (Cielinski et al., 1995; Green et al., 2013; Engevik et al., 2015) provided evidence that mothers of students with developmental disabilities are different in how they interact with their child when compared to mothers of TD students. They found a difference in the level of intrusiveness, with mothers of students with disabilities being more intrusive. Regarding teacher-student dyads, evidence suggested that special education teachers use more directives with students with Down syndrome compared with teachers of TD students (Engevik et al.). However, it is not clear which specific child characteristics contribute to the differences in the caregiver interactive behavior. Although studies attempted to match the groups on chronological age or developmental age, others child factors may also contribute to the differences in mothers' interactive behavior, such as the child's communication ability.

A review of the existing literature addressing caregiver verbal responsiveness involving children with ASD showed that the majority of studies have examined the effects of verbal responsiveness on the child's language ability (Haebig et al., 2013a;

McDuffie & Yoder, 2010; Siller & Sigman, 2002; 2008), and findings from these studies are mixed. Variability in study outcomes may be in part due to the differences in participants' characteristics. All studies reviewed exclusively examined mother-child dyads. Few studies have focused on the interaction between teachers and students with ASD (Engevik et al., 2015). Even fewer studies have examined the impact of student characteristics on teacher interactive behavior (Doussard-Roosevelt et al., 2003).

Drawing on studies that examined interaction between caregiver and TD children as well as children with developmental disabilities, evidence suggested that caregivers of children with developmental disabilities, including ASD, tend to use more directive approaches compared to caregivers of typically developing children (Doussard-Roosevelt et al.; Engevik et al.). As a result of the evidence generated, it is reasonable to hypothesize that teachers adjust their interactive behavior in response to limitations in children with ASD in linguistic and cognitive domains by being more directive. Driven by this hypothesis, the purpose of the present study was to determine whether teachers respond differently toward three clusters of students with ASD (preschoolers) who differ in language and cognitive abilities.

# Chapter 3 Method

## Participants

This study used baseline data collected from a quasi-experimental group study that examined effectiveness of two comprehensive treatment models for preschoolers with ASD (Boyd et al., 2014). Participants in this study were special education teachers and preschoolers with ASD from three classrooms: TEACCH (Treatment and Education of Autistic and Communication Handicapped Children) (Mesibov, Shea, & Schopler, 2005), LEAP (Learning Experiences and Alternative Program for Preschoolers and Their Parents) (Strain & Hoyson, 2000), and Business as Usual (BAU), a mixture of communication intervention approaches. Students were from a mixture of self-contained and inclusive classrooms.

**Classroom/teachers: Characteristics, inclusion and exclusion criteria.** Forty-eight teachers, all certified to teach students with special needs, participated in the current study (female = 47; male = 1). Approximately 42% had a bachelor's degree, 50% a master's degree, 2% an associate's degree, and 6% had a degree higher than a master's degree. The average teaching experience reported in this sample was 9.03 years (*SD* = 6.19, range = 2 to 28). Additionally, all teachers had at least two years of teaching experience with students experiencing ASD, had a special education license, and met predetermined classroom fidelity criteria. The measure used to make this determination was a validated classroom quality measure, the Professional Development in Autism Program Assessment (PDA) (Professional Development in Autism Center, 2008). The

PDA contains 54 items representing eight domains. The measure is scored using a 5-point scale (5 = full implementation, 1 = minimal/no implementation). The PDA has strong internal consistency, test-retest reliability, and discriminative validity (Hume et al., 2011). All classrooms operated within a public school system.

**Students: Characteristics, inclusion and exclusion criteria.** A total of 112 students with a diagnosis of ASD (male=98, female=14) participated. Of these students, 35 students were from North Carolina, 24 from Colorado, 38 from Florida, and 15 from Minnesota. The number of students from TEACCH, LEAP, and BAU classrooms were 41, 29, and 42, respectively. These students represented a subset of participants who participated in the Boyd study (2014) for whom (a) a 30-minute video of teacher-child interaction was available and (b) the Preschool Language Scale-4$^{th}$ edition (PLS-4) (Zimmerman, Steiner, & Pond, 2002) and the Mullen Scales of Early Learning (MSEL) (Mullen, 1995) were available.

The participants' average age was 3.99 years (*SD* = .61, range = 2.90 to 5.15). The majority were white (81.3%); while the remaining participants were Asian (7.1%), African American (8.0%), and Hispanic (3.6%). All students received early childhood special education services in public schools. Information on specific language and cognitive skills of participants is described in the subheading "Creating Three Clusters of Participants Based on Standardized Assessments".

## Measures

The following standardized measures were administered to the students: Autism Diagnostic Observational Schedule (ADOS) (Lord et al., 2000), Mullen Scales of Early Learning (MSEL) (Mullen, 1995), and Preschool Language Scales, 4th Edition (PLS-4) (Zimmerman, Steiner, & Pond, 2002). The administration of the standardized measures and videotaped free play sessions occurred less than one month apart. These measures were administered by research assistants who were trained to deliver these assessments. All research assistants were ADOS research reliable. Description of the measures and their psychometric properties can be found in Appendix A.

## Creating Clusters of Participants Based on Standardized Assessments

To create three subgroups of students who varied distinctly in cognitive and language ability, *k*-means cluster analysis was used. This procedure partitions a data set by minimizing the sum of squared Euclidean distance in each cluster (Aldenderfer & Blashfield, 1984; Larose, 2014). This analysis was used to form three distinct groups of children with ASD in cognitive and language abilities but homogeneous within each group. The cluster analysis using *k*-means was conducted using SPSS 22. Standard language scores from the PLS-4 and the nonverbal ratio IQ scores from the MSEL were used to identify three subgroups of students with ASD.

The mean Euclidean distance from the center of cluster 1 to that of cluster 2 was 27.56, and from cluster 1 to 3, 38.41. Greater distances between clusters correspond to a greater dissimilarities. The distance between the centers of cluster 1 and cluster 2 was

smaller compared to the distance between clusters 1 and 3, suggesting students in cluster 1 were more different from students in cluster 3 than students in cluster 2. A statistically significant difference between each cluster was confirmed with ANOVA. Between-cluster differences were demonstrated on expressive language skills measured with the PLS-4 [$F(2, 111) = 104.61$, $p < .001$], receptive language skills measured with the PLS-4 [$F(2,111) = 205.02$, $p < .001$], and nonverbal ratio IQ measured using the MSEL [$F(2,111) = 205.34$, $p < .001$].

**Participant characteristics in each cluster.** There were 40, 42, and 30 students in clusters 1, 2, and 3, respectively. Table 2 displays the characteristics for each of these students. Students in cluster 1 had a standard score of 60 or below on the Mullen Scales of Early Leaning ($M = 49.05$, $SD = .32$) and the Preschool Language Scale-4 ($M = 50.95$, $SD = 2.02$). This group represents students who had the most severe impairments in both cognitive and language ability. In contrast, students in cluster 3 (scoring high in both language and cognitive tests) had a standard score of 80 or above on both ELS ($M = 88.37$, $SD = 11.12$) and PLS-4 ($M = 94.37$, $SD = 11.42$). Students in cluster 2 represent a mixed group, with some scoring high on language and low on cognitive tests, or vice versa (early learning composite scores of the Mullen; $M = 60.74$, $SD = 9.25$) and (PLS-4 standard score; $M = 63.45$, $SD = 11.91$). Because there were students in cluster 2 that overlapped with students in cluster 3 on cognitive or language scores, a conservative approach was taken to maximize the separation between groups that were the focus of analyses comparing students. Consequently, the decision was made to rely on

comparisons between clusters 1 and 3, in spite of the significant differences between all three clusters. Conducting a comparison between two clusters of students, rather than among all three clusters, also reduced the probability of type I error (Benjamini, 2010). The number of students receiving each of the three communication intervention strategies (TEACCH, LEAP, and BAU) for clusters 1 and 3 is displayed in Table 3. There were more students from TEACCH classrooms in cluster 1 ($n$ = 20) compared to cluster 3 students ($n$ = 7). The decision was made to let the groups stand as configured but to conduct a post hoc descriptive comparison of the effect of students from the same language intervention group on critical dependent variables based on the results of the statistical comparisons performed across the groups.

[Insert Table 2 here]

[Insert Figure 1 here]

[Insert Table 3 here]

**Independent Variable**

Cluster assignment was treated as the independent variable. It consisted of three groups: cluster 1 (students with low language and low cognitive abilities), cluster 2 (mixed group with some scoring high on language low on cognitive tests or vice versa), and cluster 3 (students with high language and high cognitive abilities).

**Dependent Variables**

Dependent variables in this study were three types of teacher verbal responsiveness (that is, follow-in directives for behaviors, follow-in directive for language, and follow-in

comments) responding to students' current attentional focus and vocal/verbal acts. Several different engagement states were also coded (that is, object manipulation with/without objects, other engagement, not engaged, uncodable).

Sampling conditions established for data collection included a 30-minute special educator-student interaction videotaped sample obtained for each student during a naturally occurring free play session that was part of the ongoing daily routines of participating classrooms. All observations occurred as part of the typical routines within each classroom. Other children and adults who were typically present during the free play portion of the classroom routine were also present during the videotaped sessions. Typically, a licensed special education teacher and two to three paraprofessionals were present during free play in the classrooms. Adults working in classrooms ranged from two to six, with an average of three adults per classroom. On average, the adult to child ratio was 1:3. During free play sessions, students engaged in activities that were typically available within their classroom. Each classroom had age-appropriate toys and activities such as blocks, books, puzzles, dolls, and toy cars, all of which varied across classrooms.

**Coding Procedures**

**General coding procedures.** The teacher-child free play samples were videotaped and captured digitally using a hand-held camera and coded using ProcoderDV (Tapp, 2003; Tapp, Wehby, & Ellis, 1995), a software system that allows frame-by-frame coding of observational data from digital format. Prior to coding, all the videos were transcribed by research assistants. Coding involved two passes through the video

recording of each participant. During the first pass, the researcher coded engagement states and activity type. During the second pass, the researchers coded teacher codes and student verbal/vocal acts following the transcription. A continuous coding procedure was used to code 15 minutes of the video for each child (from the 10th minute to the 25th minute), which was selected from the 30-minute recording. A 15-minute segment for coding was selected to minimize coding during transition times when teachers were likely directing children in and out of activities that preceded the scheduled observation and allowed for warm-up. Consistent with McDuffie & Yoder (2010), consecutive events were required to be separated by 3 seconds or more between teacher or student behaviors to be scored as a new instance. Specific codes and definitions for teacher and student behaviors are described below.

**Teacher codes**. Three types of teacher utterances were coded that involved the teacher's responses to a student's attentional focus and vocal/verbal acts. These included (a) follow-in directives for behavior (FDs-B); (b) follow-in directives for language (FDs-L); (c) follow-in comments (FCs); and other talking (that is, remaining utterances). Definitions are provided below and summarized in Table 4.

[Insert Table 4 Here]

***Follow-in directives for behavior or language.*** Follow-in directives include both follow-in directives for behavior and follow-in directives for language. Follow-in directives for behavior occurred when an utterance was relevant to the student's attentional focus or a student's vocal/verbal act and instructed him/her to change some

aspect of an action. For example, if the student is pushing a car, the teacher says, "Push the car to me!" Another example is when the student says "car" and the teacher says, "Give me the car!" A follow-in directive for behavior involved asking the student to perform an action with a toy that was the focus of a child's attention (for example, the student is blowing bubbles and the teacher says "make it pop." Also coded in this category was a teacher's request to produce the same action with a different toy (for example, the student has put a piggy in a barn and the teacher says, "now put the cow in the barn.") Similar to follow-in directives for behavior, follow-in directives for language required an action from the student, but in this case what was requested was spoken response from the student, which could be a statement ("green") or a question ("what color is it?").

***Follow-in comments***. A follow-in comment occurred when an utterance (a) was relevant to the student's attentional focus or vocal/verbal act; (b) did not require a behavior change in the student; (c) did not convey an expectation that the student communicate about what he or she is doing or communicating; and (d) provided the student with lexical information, in the form of grammatical words, that was related to the child's attention or vocal/verbal acts. For example, if the student is playing with a truck, the teacher says "that is a yellow truck." Another example is when the student says "car;" the teacher says, "right, that is a yellow car."

**Student codes.** Student codes included the type of activities in which students engaged, engagement states, and child vocal/verbal acts that were observed during the 15

minutes. The rationale for coding activity type and engagement states was based on the evidence that different types of classroom activity and student engagement are associated with teacher verbal responses (Girolametto & Weitzman, 2002; McDuffie & Yoder, 2002). Child vocal/verbal acts were coded to understand the extent to which these acts were responded to by teachers within 3 seconds.

***Activity type.*** Observed activities were coded into (a) student-directed activities and (b) teacher-directed activities. Student-directed activities were those chosen by students and resembled free play described in previous studies (Haebig et al., 2013a; McDuffie & Yoder, 2010). A teacher-directed activity was chosen by a teacher and often involved a spoken instruction.

***Student engagement codes.*** The five engagement codes included (a) object manipulation with peers present; (b) object manipulation without peers present; (c) other engagement; (d) not engaged; and (e) uncodable.

*Object manipulation with and without peers.* An object manipulation was coded if the student physically contacted an object. Object engagement with/without peers present was coded to address the possibility that teachers might respond differently in the two situations. When a student was engaged in solitary play without a peer nearby, the teacher may have been be more likely to join the child‘s play.

*Other engagement.* Other engagement was coded if the student was watching another person who was in engaged in an activity or was talking with another person.

*Unengaged.* Unengaged was coded when the student was not physically in contact with an object, was watching another child play, or had a conversation with an adult or another child in the classroom. An example of a student being unengaged was wandering around in the classroom.

*Uncodable.* Uncodable was coded if the student was off screen or if the coder could not see the object the child was looking at or holding.

***Student verbal/vocal acts.*** Student vocalizations, spoken word approximations, and intelligible spoken words or phrases were coded as vocal/verbal acts. Crying was not coded as a verbal/vocal act. This definition is different from a traditional definition of a communicative act (Wetherby & Prizant, 2002). To be coded as a communicative act, the Wetherby and Prizant definition required coordinated attention between objects and adults, while in the present study, coordinated attention was not required for a coding of child vocal/verbal act. This decision was made because joint attention is one of the social impairments in students with ASD (Dawson et al., 2004). Consequently, using Wetherby and Prizant's definition may have resulted in a very low frequency of observed communicative acts, especially among students who had a severe social and communication impairment. Moreover, in some videos, the child's face was not fully visible, making it difficult to judge the presence or absence of coordinated attention.

**Interobserver Reliability**

Reliability was computed by having a separate coder independently record 20% of the randomly selected video samples. The training procedure followed

recommendations from Sharpe and Koperwas (2003), and a user's guide was written for training purposes. First, the primary coder held two meetings with the secondary coder to discuss the definition of each code. Second, the primary coder demonstrated to the secondary observer what each coded behavior looked like by showing sample videos coded in ProcoderDV. During this process, the primary coder sorted the observation file that contained the consensus coding record by codes, showed the secondary coder each video scene, and discussed the codes that the secondary coder would use. The purpose of this procedure was to familiarize the secondary coder with the codes. Third, the primary coder demonstrated how to use ProcoderDV. Finally, the secondary observer independently coded the first five minutes of the training video. Subsequently, the primary and secondary observers independently used ProcoderDV to create an agreement matrix (Yoder and Symon, 2010) to identify types of disagreements. After scoring a disagreement, a discussion was held to resolve the nature of the disagreement. The preceding steps were repeated until the coders reached 80% agreement on all codes for six training videos (Yoder & Symons).

Subsequent to observers establishing reliability, each proceeded to independently code a random sample of 20% of the videos for comparison with the primary observer. Interobserver agreement for teacher codes was computed by dividing the agreements by the total of disagreements and agreements. Kappas were computed for duration codes (that is, types of activities and student engagement states). The average percentage agreement between the two coders was .89 (range = .84-.94), .85 (range = .82-1), .83

(range = .75-1), .95 (range = .92-1) and .82 (.80-1) for follow-in directives for behavior, follow-in directives for language, and follow-in comments, other talking, and child vocal/verbal acts, respectively. The mean interobserver agreement on engagement codes was .88 (range = .82-.97), .92 (range = .85 -1), .87 (range = .81-.98), .86 (range = .91-.96), and .96 (range = .85-1) for object engagement with/without peer, other engagement, not engaged, and uncodable, respectively. The mean Kappa for engagement codes was .82 (object engagement with), .83 (object engagement without peer), .79 (other engagement), and .77 (not engaged). The mean interobserver agreement was .81 and .85 for student-directed and teacher-directed activity, respectively. The mean Kappa value was .75 for student-directed activity and .80 for teacher-directed activity. Kappa for uncodable was .75.

**Data Analysis**

**Descriptive analysis of teacher and student behavior.** Descriptive analyses (distribution, mean, range, and standard deviation) were conducted for both teacher and student variables. Subsequently, bivariate correlations were obtained for follow-in directives for behavior, follow-in directives for language, and follow-in comments and other child measures, including standard scores from MSEL, PLS-4 receptive and expressive language, and autism severity scores derived from the ADOS.

Given that the quantity of responsive utterances delivered by the teachers may have depended on the length of the time that the child was engaged (McDuffie & Yoder, 2012), a rate was computed by dividing the sum of occurrences of follow-in directives for

behavior, follow-in directives for language, and follow-in comments by the total engagement time, as shown in Formula 1. The total engagement was the sum of (a) the duration of object engagement with and without peer(s) present and (b) other engagement.

[Insert Formula 1 here]

**Formula 1.** Computation formula used to compute the rate of follow-in directives for behaviors/language, and comments responding to the child's focus of attention.

$$\text{Rate of FDs-B/FDs-L/FC} = \frac{\text{Number of FDs-B/FDs-L/FCs}}{\text{Total Engagement}}$$

Note. FDs-B = follow-in directives for behavior; FDs-L= follow-in directives for language; FCs = follow-in comments.

To control for the contribution of students' vocal or verbal acts to teachers' responsive utterances, a percentage score was calculated by dividing the sum of follow-in directives for behavior, follow-in directives for language, and follow-in comments that occurred within 3 seconds following child's vocal or verbal acts by a child's total number of vocal or verbal acts (see Formula 2).

**Formula 2.** Computation formula used to compute the percentage of teacher follow-in directives for behaviors combined with follow-in directives for language, and teacher comments in response to a child's vocal or verbal acts within 3 seconds.

$$\text{Percentage of teacher responses} = \frac{\text{Total number of FDs-B/FDs-L/FCs}}{\text{Total number of students' vocal or verbal acts}}$$

**Inferential tests to determine group differences.** The following steps were taken to determine whether significant differences exist between students in clusters 1 and 3 on teachers' responsive utterances. First, distributions of the types of teachers' responsive utterances were examined to determine whether a normality assumption was met for a parametric test. Figures 2a and 2b demonstrate that the distribution of overall responsiveness was highly positively skewed for students in clusters 1 and 3. Similarly, a highly skewed distribution was also revealed in the rate of follow-in directives for behavior (Figures 3a, 3b), follow-in directives for language (Figures 4a, 4b), follow-in comments (Figures 5a, 5b), as well as for the percentage of teachers' responsive utterances that occurred within 3 seconds following children' vocal or verbal acts (Figures 6a, 6b). Consequently, an assumption of normality was likely violated. Therefore, a nonparametric method using the Mann-Whitney U test was implemented to test for group difference (Gibbons & Chakraborti, 2011). Second, because students were recruited from three types of classrooms (TEACCH, LEAP, and BAU), an aligned-ranked procedure was used to test whether types of teachers' responsive utterances differed as a function of being in a TEACCH, LEAP, or BAU classroom. The results demonstrated that students in clusters 1 and 3 did not differ in the overall rate of

responsiveness [$\chi^2$ (2) = 4.43, $p$ = .11], follow-in directives for language [$\chi^2$ (2) = .45, $p$ = .64], rate of follow-in comment [$\chi^2$ (2) = .30, $p$ = .86], and percentage of teachers' responses following students' vocal/verbal acts within 3 seconds [$\chi^2$ (2) = .63, $p$ = .54]. However, students from the TEACCH classrooms received a significantly higher rate of follow-in directives for behaviors compared to students from the LEAP and BAU classrooms, $\chi^2$ (2) = 9.64, $p$ = .008).

[Insert Figures 2a, 2b]

[Insert Figures 3a, 3b]

[Insert Figures 4a, 4b]

[Insert Figures 5a, 5b]

[Insert Figures 6a, 6b]

***Final models used to test cluster difference.*** In the final model regarding follow-in directives for behavior, the classroom type (TEACCH, LEAP, and BAU) was entered as a covariate because clusters 1 and 3 students differed significantly in the rate of follow-in directives for behavior. The analysis followed two steps. First, a regression model was fit with the type of classroom being the predictor and residuals were obtained. Second, a regression model was fit in which the ranked residuals served as the dependent variable and the variable cluster (cluster 1 and 3 students) was the predictor. Because cluster 1 and 3 students did not differ in the rate of overall responsiveness, the rate of follow-in directives for language, the rate of follow-in comments, and the percentage of responsive utterances following students' vocal or verbal acts, a Mann-Whitney U test

was implemented that did not include classroom type as a covariate. Following nonparametric tests, a Poisson regression analysis was implemented to test the sensitivity of the results obtained from nonparametric methods.

To quantify the magnitude of difference between clusters 1 and 3, an effect size was computed using Cohen's *d* (Cohen, 1988). The following guideline for interpreting effect size was recommended by Cohen: small (0.2), medium (0.5), and large (0.8).

## Chapter 4 Results

This study examined the extent to which teachers responded differently to three groups of students with ASD who varied in their cognitive and language abilities. It addressed four questions.

**Research Question 1: Is the Rate of Overall Responsiveness to Attentional Focus and Communicative Acts Produced by Students with ASD Lower for Students Who Have Severe Impairments (Cluster 1), Compared with Students with Less Severe Impairments (Cluster 3)?**

Table 5 presents zero-order correlations among teachers' utterances (follow-in directives for behavior, follow-in directives for language, follow-in comments, and other talking) and student characteristics (language, cognitive ability, and ASD severity). Based on this analysis, follow-in directives for language were significantly positively correlated with the student's expressive language ($r = .33$, $p < .001$), receptive language ($r = .28$, $p < .001$), and cognitive ability ($r = 19$, $p < .001$).

[Insert Table 5 here]

The mean duration (in minutes) for total engagement was 11.62 ($SD = 2.64$) and 11.91 ($SD = 3.33$) for students in clusters 1 and 3, respectively. Mean duration, standard deviation, and range for engagement with/without peer present, and other engagement are presented in Table 6. Students in clusters 1 and 3 did not differ significantly in the

duration of engagement with peer being present (F = 1.95, $p$ = .167), without peer being present ($F$ = 3.70, $p$ = .058), and other engagement (F = 1.74, $p$ = .192).

[Insert Table 6 here]

The mean rate of overall responsiveness (see Formula 1 in the method section) was 3.15 ($SD$ = 2.05) and 3.29 ($SD$ = 2.46) for clusters 1 and 3 students, respectively. Based on results from the Mann-Whitney U test, significant differences were not found among three groups in teachers' overall responsiveness, $\chi^2$ (1) = -.024, $p$ = .981.

To test the sensitivity of the results obtained from the Mann-Whitney U test, Poisson regression was applied. In this analysis, the dependent measure was the total number of responsive utterances, and the independent variable was the three clusters of students with ASD. In addition, the total engagement transformed by logarithm transformation was entered as covariate. Logarithm transformation of predictors in Poisson regression has been recommended to increase the accuracy of the model (Glidden, Shiboski, & McCulloch, 2011). Results obtained from the Poisson regression were consistent with those from the Mann-Whitney U test, $\chi^2$ (2) = .716, $p$ = .699, suggesting the two clusters did not differ in the rate of overall responsiveness. Total engagement duration was a significant predictor of total responsiveness, B= .16, $\chi^2$ (1) = 38.58, $p$ < .001. Overall, these results indicated that the two clusters of students with ASD received similar rates of responsive utterances from their teachers, and the student's level of engagement was positively associated with the amount of responsive utterances from the teacher.

**Research Question 2: Do Teachers Use Higher Rate of Follow-in Directives with Students Who Have Severe Impairments (Cluster 1), Compared with Students with Less Severe Impairments (Cluster 3)?**

**Follow-in directives for behavior.** Descriptive information on the frequency of specific types of teachers' responsive utterances is presented in Table 5. Teachers' use of follow-in directives for behavior occurred more often for students in cluster 1, who had severe language and cognitive impairment ($M$ = 15.93, $SD$ = 13.02) compared with those in cluster 3, who had less severe impairments (cluster 3: $M$ = 10.47, $SD$ = 9.55). The mean rate of follow-in directives for language (per minute) for clusters 1 and 3 was 1.33 ($SD$ = 1.00, range = 0-4.08) and .82 ($SD$ = 1.08, range = 0-3.30).

When classroom type (that is, TEACCH, LEAP, and BAU) was included as a covariate, there was no significant difference between the two clusters in the rate of follow-in directives for behavior [F = 1.47, $p$ = .234]. A Poisson regression obtained similar results, $\chi^2$ (1) = .87, $p$ = .35. However, classroom type was a significant predictor of follow-in directives for behavior, $\chi^2$ (1) = 6.60, $p$ =.01, as well as engagement $\chi^2$ (1) = 33.46, $p$ < .001.

In a post-hoc effort to examine teachers follow in directives for behavior, a descriptive comparison of children who were the recipients of TEACCH intervention and their teachers' responsivity using follow-in directives for behavior was implemented for clusters 1 and 3. Seven students were randomly selected from the 20 students receiving TEACCH instruction in cluster 1. Their receipt of follow-in directives was compared to

the rate received by seven students from cluster 3. Students in cluster 1 had a higher rate of follow-in directives for behavior (mean = 1.44, *SD* = .84, *n* = 7) compared to students in cluster 3 (mean = 1.10, *SD* = 1.14, *n* = 7).

**Follow-in directives for language.** The mean frequency of follow-in directives for language for clusters 1 and 3 was 9.90 (*SD* = 8.83) and 16.43 (*SD* = 14.59). The mean rate of follow-in directives for language (per minute) for clusters 1, 2, and 3 was .81 (*SD* = .64, range = 0-2.45) and 1.31 (*SD* = 1.08, range = 0-5.03). A Mann-Whitney U test showed that the three clusters differed significantly in the rate of follow-in directives for language, Z = -2.09, *p* = .037. These results were confirmed using Poisson regression, $\chi^2$ (2) = 6.44, *p* = .040. Specifically, students in cluster 1 (with severe impairments) received a lower rate of follow-in directives for language than students in cluster 3 (with less severe impairments), *d* = .58, suggesting a large effect size. More results on effect size are presented in Table 7.

[Insert Table 7 here]

**Research Question 3: Do Teachers Use a Lower Rate of Follow-in Comments with Students Who Have Severe Impairments (Cluster 1), Compared with Students with Less Severe Impairments (Cluster 3)?**

As to follow-in comments, the mean frequency of clusters 1, 2, and 3 was 12.03 (*SD* = 10.79), 12.55 (*SD* = 10.22), and 14.57 (*SD* = 13.65). The average rate of follow-in directives for language (per minute) for clusters 1 and 3 was 1.00 (*SD* = .82, range = 0-2.94) and 1.15 (*SD* = .95, range = 0-4.38). According to the Mann-Whitney U test, the

two groups did not differ significantly in the rate of follow-in comments, Z = -.653, $p$ = .514. These findings were confirmed using Poisson regression, $\chi^2$ (2) = 1.47, $p$ = .479.

**Research Question 4: Is the Percentage of Teachers' Responses that Follow Students' Vocal or Verbal Acts within 3 Seconds Lower for Students Who Have More Severe Cognitive and Language Impairments (Cluster 1) Compared with Those Who Have Less Severe Impairments (Cluster 3)?**

In terms of group difference in percentage of teachers' responsive utterances to students' vocal/verbal acts, the mean percentage of student utterances responded to by the teachers was 29.72% (*SD* = 23.42) and 33.76% (*SD* = 17.58) for students in cluster 1 (severe) and cluster 3 (mild), respectively. Results from the Mann-Whitney U indicated that the two groups did not differ significantly in the percentage of utterances responded to by teachers within 3 seconds, Z = 1.00, $p$ = .32. These results were confirmed by a Poisson regression analysis, $\chi^2$ (2) = .610, $p$ = .737.

However, the total number of teachers' responsive utterances following the child's vocal/verbal acts within 3 seconds was on average 8.58 (*SD* = 12.07) and 11.70 (*SD* = 9.64) within 15 minutes of observations for students in clusters 1 and 3. A Krusal-Wallis test suggested that this difference was significant, Z = -2.76, $p$ <.01. Specifically, students with the most severe cognitive and language impairments (cluster 1) received fewest responses from teachers compared with students with less severe impairments (cluster 3), $d$ = .36, suggesting a medium effect size (see Table 7). Additionally, the total vocal/verbal acts produced by students was a significant predictor of the total number of

teacher responses that followed the student's vocal/verbal acts within 3 seconds, $B = .04$, $p < .001$.

## Chapter 5 Discussion

The present study suggested that teachers' overall rate of responsiveness did not differ across two clusters of children who differed significantly in their communication and cognitive status. Students with more severe disabilities (cluster 1) were recipients of a significantly higher rate of follow-in directives for behavior compared to students with less severe communicative and cognitive disabilities (cluster 3). However, this difference disappeared when the type of classroom was controlled. Additionally, a significantly lower rate of follow-in directives for language was observed for students in cluster 1 than students in cluster 3. The two clusters did not differ in follow-in comments.

### Research Question 1: Is the Rate of Overall Responsiveness to Attentional Focus and Communicative Acts Produced by Students with ASD Lower for Students Who Have Severe Impairments (Cluster 1), Compared to Students with Less Severe Impairments (Cluster 3)?

This nonsignificant finding may have involved how the rate of overall verbal responsiveness was defined. In the present study, it was computed as the combined rate of follow-in directives for behavior, follow-in directives for language, and follow-in comments. The two clusters of students may differ significantly in a specific type of responsive utterance, but they experienced similar rate of overall verbal responsiveness. This finding speaks to the importance of how responsiveness was defined as different operational definitions may lead to different findings.

**Research Question 2: Do Teachers Use a Higher Rate of Follow-in Directives with Students Who Have Severe Impairments (Cluster 1), Compared with Students with Less Severe Impairments (Cluster 3)?**

The characteristics of TEACCH and LEAP classrooms may have contributed to the difference in the rate of follow-in directives for behavior between students in clusters 1 and 3 during free play. TEACCH classrooms are more adult led compared to LEAP classrooms. In LEAP classrooms, teachers may use a more inclusive education approach. Thus, fewer instructions in the format of directives may be involved (Boyd et al., 2013). In the current sample, half of the students in cluster 1 (20 out of 40) were from TEACCH classrooms, whereas only 7 out of 20 students were from LEAP classrooms. This overrepresentation of TEACCH classrooms in cluster 1 students may have contributed to the higher rate of follow-in directives for behavior observed in this study. In addition, TEACCH classrooms often included only students with ASD, whereas LEAP classrooms included both students with ASD and typically developing students. Teachers may use a higher rate of follow-in directives for behavior toward a group of students with ASD compared to a mixed group where typically developing children are present as some preliminary evidence has demonstrated that directives for behavior are more likely to elicit responses from students with ASD than comments (Doussard-Roosevelt et al., 2003).

Observed significant differences in follow-in directives for language may be in part explained by students' language comprehension and production abilities. Students in

cluster 1 who comprehended fewer words or sentences compared to students with less severe impairments (cluster 3) may not understand the questions asked by the teachers and consequently may not respond to teachers' questions. This lack of student responsivity may have reduced the probability of teachers producing questions (coded as follow-in directives for language in this study) directed to students with low cognitive and language ability (cluster 1). Another possibility may be that students in cluster 3 spoke more during free play than students with more severe language impairments in cluster 1, and teachers responded to students in cluster 3 by asking questions. This positive relationship between students' language ability and teachers' verbal behavior has been demonstrated in a previous study with children with ASD in a classroom setting (Dykstra, Sabatos-DeVito, Irvin, Boyd, Humn, & Odom, 2013). The Dykstra et al. study showed that children with ASD with higher language levels assessed by the Preschool Language Scale (PLS-4) receive more language input from adults.

**Research Question 3: Do Teachers Use Lower Rate of Follow-in Comments with Students Who Have Severe Impairments (Cluster 1), Compared with Students with Less Severe Impairments (Cluster 3)?**

The rate of follow-in comments was not significantly different between the two clusters of students. This outcome may have been influenced by the definition of engagement in the current study and the characteristics of the classroom setting. Recall that engagement was defined as any contact with a toy, including passive holding. With this definition, engagement duration was similar among the three groups. With a more

stringent definition of engagement, as used in McDuffie and Yoder (2010), in which the child was required to be looking at, actively manipulating, or talking about an object, the three groups may have been different in engagement time. The students with severe impairments (cluster 1) may have emitted the shortest duration of active engagement among the three clusters of students. If so, teachers would have been presented with fewer opportunities to comment on objects of the student's interest. Additionally, students were observed in school settings in the present study, often with peers being present. A different rate of follow-in comments may have been observed if observations had been conducted in homes or in schools with a 1:1 adult to child ratio.

**Research Question 4: Is the Percentage of Teachers Responses That Follow Students' Vocal or Verbal Acts within 3 Seconds Lower for Students Who Have More Severe Cognitive and Language Impairments (Cluster 1) Compared with Those Who Have Less Severe Impairments (Cluster 3)?**

Teachers were equally responsive to vocal/verbal acts produced by the three groups of students. These findings are consistent with a previous study in which Roach et al. (1995) compared mothers' interactive behavior among three groups of children (children with Down syndrome and two groups of typically developing children matched on chronological and mental age). No significant group differences in vocal responses of mothers were found.

In the present study, the number of responses produced by teachers differed significantly across the two clusters. This is because students with less severe

impairments (cluster 3) produced more vocal/verbal acts than students in cluster 1 with the most severe impairments. Consequently, teachers had more opportunities to respond. This difference in language exposure experienced by the two clusters of students as shown in the present study is a small daily difference, but may be paramount if cumulative.

Hart and Risley (1992, 1995) demonstrated the importance of differential longitudinal adult language input with respect to aspects of child language. They observed 42 families (professional, working-class, and welfare families) and their children from 7 to 42 months of age for an hour each month for 2½ years. They estimated that in 4 years, an average child in a professional family would be exposed to 45 million words, an average child in a working-class family 26 million, and an average child in a welfare family 13 million. Although Hart and Risley conducted their investigations in the homes of typically developing and at risk children, the discovery of the importance of a child's cumulative experience with words may also apply to school settings with clusters of children with ASD who differ in cognitive and language abilities. For example, if a student in cluster 1 (with severe impairments) received 10 fewer responsive utterances than their peers in cluster 3 (with less severe impairments) from their teacher every day, this difference would result in the most severely impaired students receiving 10,950 fewer responsive utterances from their teacher over 3 years (Warren & Brady, 2007). These differences in verbal input experienced by students with ASD in the current investigation are of potential concern because studies with children with ASD have

shown that verbal input from parents is directly linked to the student's later language performance (Haebig et al., 2013a; McDuffie et al., 2010; Siller & Sigman, 2002, 2008).

**Limitations of the Current Study**

Several limitations must be acknowledged. First, the correlational design used in the current study does not permit a causal inference about the outcomes. Videos analyzed were recorded in the child's classroom in a manner that may have resulted in the potential for confounding variables. For example, classrooms sometimes had different teacher-student ratios. Some evidence suggests that lower adult to student with ASD ratio is associated with fewer words directed at preschoolers with ASD (Irvin et al., 2013). The tradeoff for this potential confounding variable is that because the observations took place in the child's natural setting, social validity may have been enhanced.

Second, students' gestures were not coded in the current investigation. Students with more significant communicative disabilities may have relied more extensively on gestures to communicate. If this was the case, teacher responsivity comparisons between groups of children may have been influenced.

Next, subgroups of participants were formed as a result of their performance on standardized language and cognitive assessments. Other child factors may also have influenced teacher interactional patterns with the participants. For example, students who engaged in challenging behavior may have received differential responsivity when compared with children who did not engage in problem behavior.

Finally, students in the present studies were from TEACCH, LEAP, or BAU classrooms. Rate of responsive utterances may vary among teachers from these classrooms. Evidence presented in this investigation suggested that teacher responsivity may be related to the teaching model used (particularly in the case of the TEACCH curriculum).

**Future Research Directions on Teacher Responsiveness with Students with ASD**

This study contributed to our knowledge of teachers' responsiveness as a function of intellectual/communicative level of preschoolers with ASD. Several future research directions are discussed in the following paragraphs.

**1. Examining the impact of different types of teachers' spoken utterances on communication outcomes in students with ASD.** Some evidence suggests that follow-in directives for language are positively correlated with language comprehension and production in children with ASD during mother-child interaction at home (Haebig et al., 2013a). It is possible that this is due to a relatively small proportion of other less directive communicative responses and overtures directed to these students. Therefore, with low rates/proportions of other types of utterances occurring on the part of adults, encouraging fewer directives may result in a substantial overall decrease in responsive utterances unless concurrent steps are taken to increase the occurrence of other types of utterances.

**2. Examining teachers' responsiveness toward students' gestures**. The present study focused on teachers' verbal responses following students' vocal/verbal acts. It is important to understand the degree to which teachers respond to gestures produced by

students, especially students who have very limited spoken language and more limited vocal or verbal output. It is possible that students in cluster 1 with more severe impairments produced more gestures compared to students in cluster 3, who have greater language skills. In future investigations, it would be important to learn more about the use of gestures across groups of students who vary in cognitive and communication status. Correspondingly, we know very little about teacher responsivity to children's gestural overtures, and whether teacher responsivity to both modes is similar or influenced by the degree of cognitive and/or communicative impairment.

**3. Comparing dosage of follow-in comments and follow-in directives as a function of different manualized interventions.** Given modest descriptive data from the current investigation, it appeared that the TEACCH curriculum may have resulted in differential use of follow-in directives for behavior. Future research should more directly consider the influence that curricula may have on teacher responsivity.

A number of interventions have been shown to improve outcomes of young children with ASD, such as the Early Start Denver Model (ESDM) (Dawson et al., 2010) and the Early Intensive Behavioral Intervention (EIBI) (Eldevik, Hastings, Hughes, Jahr, Eikeseth, & Cross, 2009). Although studies have provided considerable empirical evidence for the effectiveness of these interventions, there is a need to clarify what active ingredients are critical in obtaining the desirable outcomes (Schreibman et al., 2015). One ingredient may be the frequency of follow-in comments and/or directives used by the interventionists. Given that follow-in comments have been positively associated with

long-term language outcomes in children with ASD (Siller & Sigman, 2002; 2008), examining the extent to which these two interventions may differentially result in the use of follow-in comments may be important to determine.

**4. Studying structures of teachers' spoken input during interactions with students with ASD.** A number of investigators examined the structure of maternal speech directed to children, including syntactic complexity of adults' utterances and frequency of nouns and verb used involving typically developing children as well as children with Down syndrome (Hoff-Ginberg, 1986; Huttenlocher, Vasilyeva, Vevea, Cymerman, & Levine, 2002; van Kleeck, Schwartz, Fey, Kaiser, Miller, & Weitzman, 2010). However, fewer studies have been conducted examining these features of parent or teacher language used during interactions with children who experience ASD. Among studies specifically examining responsivity with this population, most investigations have focused primarily on the pragmatic functions of teachers' verbal responses, such as directives and comments (for example, McDuffie and Yoder, 2010; Siller and Sigman, 2002). Studying the match between speech structure of teachers' spoken input and children's existing comprehension and production skills may better shed light on the degree to which they may actually benefit from the types of responsive acts that were the focus of the current investigation.

## Clinical and Educational Implications

Some evidence has shown that parents of children with ASD can be taught to increase their use of responsive utterances during interaction with their children (Venker, McDuffie, Ellis Weismer, & Abbeduto, 2011). Given the importance of adult responsivity to child communicative acts (Hart and Risley, 1995), it is important to consider intervention strategies that may coach teachers to increase their communicative responsiveness when interacting with students with ASD, especially those with severe impairments.

This investigation found that teachers delivered fewer responsive utterances toward students who produced few or no vocal/verbal acts (cluster 1 students) when compared with students with ASD who produced more vocal/verbal acts (cluster 3 students). Thus, strategies that increase the communicative acts of the students are likely to result in increased verbal responses from the teachers. For students in cluster 1 who have severe cognitive and language impairments, efforts to increase the amount of gestures used by students may also increase verbal responsivity from the teachers. Several strategies have been shown to be effective to increase students' vocal/verbal acts, such as the use of incidental teaching or discrete trials (Odom, Collet-Klingenberg, Rogers, & Hatton, 2010; Paul, Campbell, Gilbert & Tsiouri, 2012).

## Conclusion

This study showed that teachers used a significantly lower rate of follow-in directives for language with students with ASD who had severe cognitive and language

impairments (cluster 1), compared with students with less severe cognitive and language impairments (cluster 3). The two clusters did not differ significantly in the rate of overall verbal responsiveness and the rate of follow-in comments. After controlling for type of classroom, the two clusters did not differ in follow-in directives for behavior. Moreover, students with more cognitive and language impairments produced significantly fewer vocal/verbal acts, which may have resulted in receiving fewer verbal responses from their teachers. The present study provides support for using a transactional framework to understand interaction between caregivers and children with ASD by showing that students' cognitive and communicative abilities are associated with teachers' verbal responsiveness. This framework may lead to a more comprehensive understanding of caregiver-child interaction in ASD and ultimately the development of more individualized teacher-mediated interventions.

Table 1

*Participant Characteristics Described in ASD Studies on Verbal Responsiveness*

| Study | CA (in months) | Cognitive Ability | Language |
|---|---|---|---|
| Siller & Sigman (2002) | 50.3 (11.7) | Cognitive standard scores (M = 46.0, SD = 9.4), measured by the Stanford-Binet Intelligence Scale | Age equivalence (M =16.7, SD = 6.9), measured by Reynell Developmental Language Scale |
| Siller & Sigman (2008) | 45.2(8.4) | Nonverbal IQ (M = 57.5, SD = 19.8), ranging from 25 to 122, measured by MSEL | Overall language (M=48.5, SD= 8.4) based on MSEL or the Reynell Developmental Language Scale |
| McDuffie & Yoder (2010) | 40.65 (8.62) | Cognitive standard scores (M = 51.38, SD = 5.49), measured by MSEL | Vocabulary comprehension (M = 155.47, SD = 103.67, range = 13 to 371) measured by MCDI-WG<br><br>Vocabulary production (M = 52.96, SD = 65.75, range =0-232), measured by MCDI-WG. |
| Haebig et al. (2013a,b) | 31.15(4.37) | NVMA in months (M = 24.24, SD = 4.64), ranging from 17 to 34, measured by | Vocabulary comprehension (M = 151.75, SD = 112.92) measured by MCDI<br>Vocabulary production (M = 60.75, SD = 95.54) |

| | |
|---|---|
| MSEL | PLS-4 comprehension standard score (M = 64.45, SD = 21.53) |
| | PLS-4 production standard score (M = 70.85, SD = 17.66) |

Note. MSEL = Mullen Scale of Early Learning (Mullen, 1995); PLS-4 = Preschool Language Scale, Fourth Edition (PLS-4; Zimmerman, Steiner, & Pond, 2002); NVMA = nonverbal mental age; MCDI-WG = the Word and Gesture subscale of the MacArthur-Bates Communicative Development Inventory (Fenson, 2007).

Table 2

*Mean and Standard Deviation of Cognitive and Language Ability of Students in Three Clusters in the Present Study*

| Measures | Cluster 1 ($n$ = 40) | Cluster 3 ($n$ = 30) | Total ($n$ = 112) |
|---|---|---|---|
| | Mean *(SD)* (range) | Mean*(SD)* (range) | Mean*(SD)* (range) |
| **PLS-4** | | | |
| Expressive | 54.00 (6.27) (50-69) | 90.87(12.77) (71-135) | 68.60(18.04) (50-135) |
| Receptive | 50.85(2.97) (50-63) | 98.70(11.21) (84-125) | 69.08(21.57) (50-125) |
| PLS language | 50.95(2.03) (50-58) | 94.37(11.42) (81-134) | 67.27(19.69) (50-134) |
| Cognitive ability | 49.05(.32) (49-51) | 88.37(11.12) (71-117) | 63.96(17.58) (49-117) |
| Nonverbal IQ | 46.38(10.90) (23-60) | 95.75(9.05) (83-120) | 70.01(22.11) (83-120) |
| ADOS severity | 8.10(1.36) (5-10) | 6.83(1.64) (3-10) | 7.28(1.64) (2-10) |

*Note.* PLS-4 = *Preschool Language Scale, 4th Edition* (PLS-4; Zimmerman, Steiner, & Pond, 2002). PLS language = standard language scores based on PLS-4. Cognitive ability = standard cognitive scores derived from the Mullen Scales of Early Learning (MSEL), Mullen, 1995). Nonverbal IQ = standard scores derived from Gross Motor, Visual Reception, Fine Motor subtests of MSEL. ADOS = Autism Diagnostic Observation Schedule. ADOS severity = severity scores based on ADOS.

**Table 3**

*Number of Students from BAU, TEACCH, and LEAP Classrooms*

| Classroom | Cluster 1 | Cluster 3 | Total |
|---|---|---|---|
| BAU | 11 | 16 | 42 |
| TEACCH | 20 | 7 | 41 |
| LEAP | 9 | 7 | 29 |

Note. BAU = Business as Usual; TEACCH = Treatment and Education of Autistic and Communication Handicapped Children; LEAP = Learning Experiences and Alternative Program for Preschoolers and Their Parents.

Table 4

*Definitions and Examples of the Teacher Verbal Responsiveness and Child Variables*

| Code | Definition | Example |
|---|---|---|
| Follow-in directive for behavior | Teacher verbal utterances that follow into the child's attentional focus or vocal/verbal acts and instruct the child to change some aspect of his or her action. | "Put the car over here!"<br>"Give it to me!"<br>"Dinosaur, don't bite me." (as the child carried a dinosaur) |
| Follow-in directives for language | Teacher verbal utterances that direct the child to produce a communicative act. | "What color is it?"<br>"What did you say?"<br>"Say open." |
| Follow-in comments | Teacher utterances that (1) follow into the child's attentional focus or vocal/verbal acts, (2) do not require a behavior change in the child, (3) do not convey an expectation that the child communication about what he is doing or communicating, and (4) provide the child with lexical information, in the form of grammatical words, that was related to the child's attention or vocal/verbal acts. | "That is a green car."<br>"You are doing a great job putting the puzzles together"<br>"This is a friendly dinosaur." |
| Child vocal/verbal acts | Child vocalizations, spoken word approximations, intelligible spoken words or phrases. Crying and laughing were not coded. | "Ahh."<br>"My turn."<br>"I made a cake for you." |

Table 5

*Correlations between Students' Cognitive and Language Ability and Types of Teacher Responsive Utterances*

| **Child Factors** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1. PLS-expressive | - | | | | | | | | |
| 2. PLS-receptive | .91** | - | | | | | | | |
| 3. PLS language | .80** | .85** | - | | | | | | |
| 4. Cognitive ability | .72** | .78** | .88** | - | | | | | |
| 5. ADOS severity | .-26** | -.28** | -.23* | -.26** | - | | | | |
| **Responsiveness to attentional focus and vocal/verbal acts** | | | | | | | | | |
| 6. FDs-B | -.15 | -.16 | -.12 | -.16 | .22** | - | | | |
| 7. FDs-L | .33** | .28** | .25** | .19* | -.14 | .44** | - | | |
| 8. FCs | .15 | .12 | .11 | .04 | -.03 | .54** | .75** | - | |
| 9. OT | -.32** | -.29** | -.27** | -.35** | .24* | .71** | .31** | .39** | - |

*$P$<.05 **$P$<.01

*Note.* PLS-4= *Preschool Language Scale, 4th Edition* (Zimmerman, Steiner, & Pond, 2002). Expressive = PLS-4 expressive language standard score. Receptive = PLS-4 receptive language standard score. PLS language = standard language score based on both expressive and receptive scores. Cognitive ability = standard cognitive scores derived from the Mullen Scales of Early Learning (Mullen, 1995). ADOS = Autism Diagnostic Observation Schedule. ADOS severity = severity scores based on ADOS. FDs-B: follow-in directives for behavior; FDs-L= follow-in directives for language; FCs = follow-in comments; OT = other talk.

Table 6

*Descriptive Information (mean, SD, and range) on the Students' Engagement States and Types of Teacher's Verbal Utterances*

| | Cluster 1 ($n$ = 40) | | Cluster 2 ($n$ = 42) | | Cluster 3 ($n$ = 30) | | Total ($n$ = 112) | |
|---|---|---|---|---|---|---|---|---|
| Eng (in minutes) | Mean(SD) | Range | Mean(SD) | Range | Mean(SD) | Range | Mean(SD) | Range |
| With peer | 5.66(4.07) | 0-14.97 | 7.69(4.68) | 0-14.90 | 6.99(3.76) | .18-14.92 | 6.78(4.29) | 0-14.97 |
| Without peer | 4.18(4.09) | 0-13.88 | 3.08(4.22) | 0-13.77 | 2.41(3.41) | 0-13.48 | 3.29(4.00) | 0-13.88 |
| Other eng. | 1.80(2.11) | 0-8.85 | 1.73(2.69) | 0-12.58 | 2.51(2.59) | 0-8.20 | 2.47(2.33) | 0-12.58 |
| Unengaged | 2.68(2.57) | 0-8.37 | 1.46(2.22) | 0-12.28 | 2.26(3.26) | 0-13.32 | 2.04(2.65) | 0-13.32 |
| Uncodable | .08(.28) | 0-1.32 | .22(.66) | 0-3.42 | .08(.44) | 0-.50 | .13(.44) | 0-3.42 |
| Responsiveness to attentional focus and vocal acts (frequency) | | | | | | | | |
| FDs-B | 15.93(13.02) | 0-55 | 10.83(8.44) | 1-29 | 10.47(9.55) | 0-42 | 12.55(10.78) | 0-55 |
| FDs-L | 9.90(8.83) | 0-33 | 16.14(12.14) | 0-51 | 16.43(14.59) | 0-64 | 13.99(12.12) | 0-64 |
| FCs | 12.03(10.79) | 0-44 | 12.55(10.22) | 0-47 | 14.57(13.65) | 0-63 | 12.90(11.37) | 0-63 |
| Other talking | 13.87(9.73) | 0-40 | 9.66(6.79) | 0-31 | 5.47 (4.74) | 0-20 | 10.04(8.20) | 0-40 |
| Total | 59.78(36.54) | 0-129 | 53.00(33.58) | 1-144 | 53.73(34.88) | 7-149 | 55.61(34.83) | 0-149 |

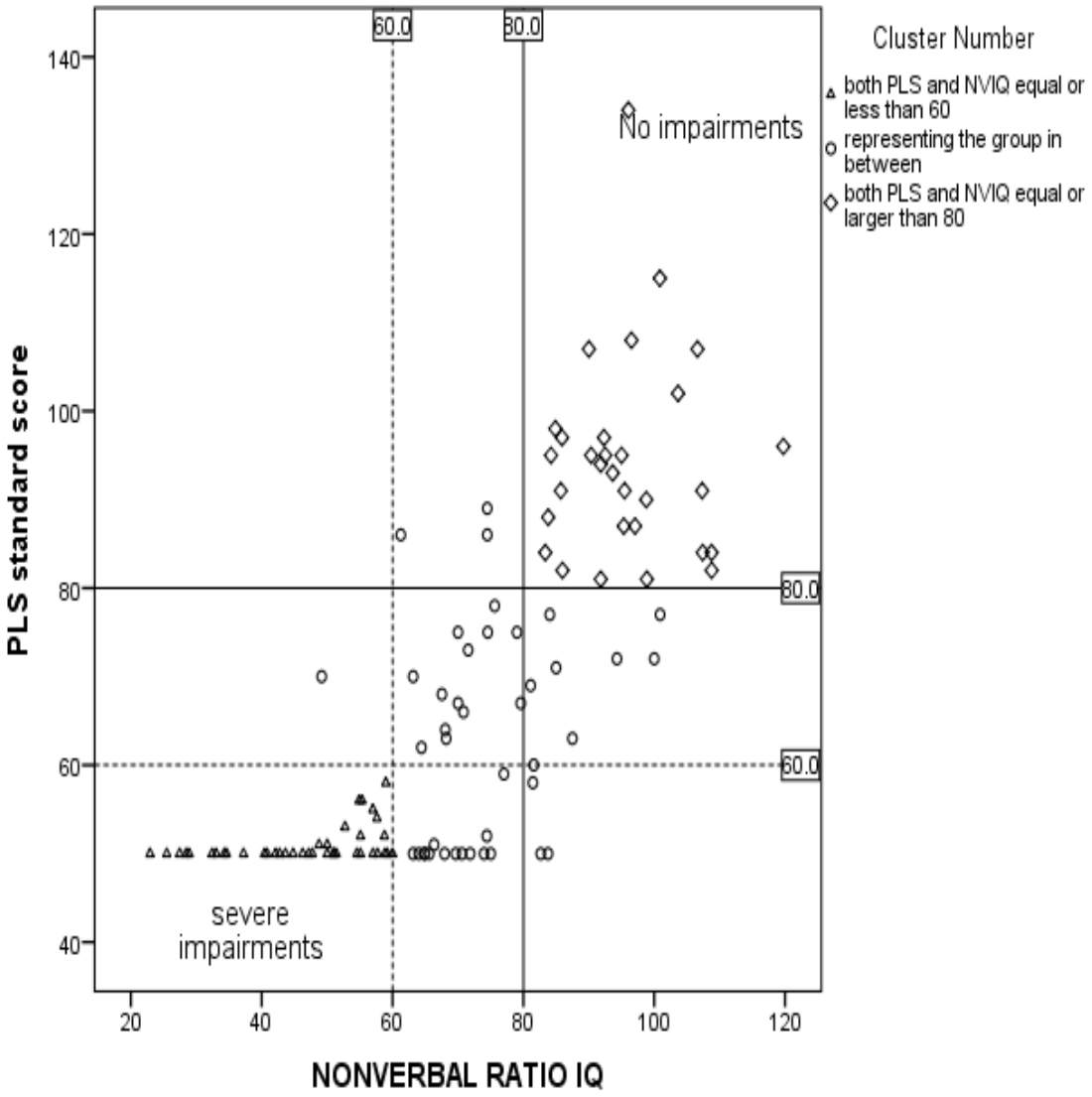
*Note.* Eng = engagement. With peer = object manipulation with peer presence; without peer = object manipulation without peer presence; other eng. = other engagement; Uncodable = off screen, FDs-B = follow-in directives for behavior; FDs-L = follow-in directives for language; FC = follow-in comments.

Table 7

*Results of Multiple Comparisons Tests on Teachers' Responsive Utterances Conducted in This Study*

| Type of utterance | *Z* | *p* | Group comparison | Cohen's *d* |
|---|---|---|---|---|
| Follow-in directives for language | 19.22 | $p < .001$ | Cluster 1<cluster 3 | .54 |
| Utterances responding to child vocal/verbal acts | 18.91 | $p < .001$ | Cluster 1<cluster 3 | .36 |

Note. Utterances responding to child vocal/verbal acts refer to the teacher's utterances that occurred within 3 seconds following the child's vocal/verbal acts.




Note: The triangle, circle and diamond represented cluster 1, 2, 3 respectively.

*Figure 1.* A scatterplot of three clusters of students with ASD identified by K-means clustering method.

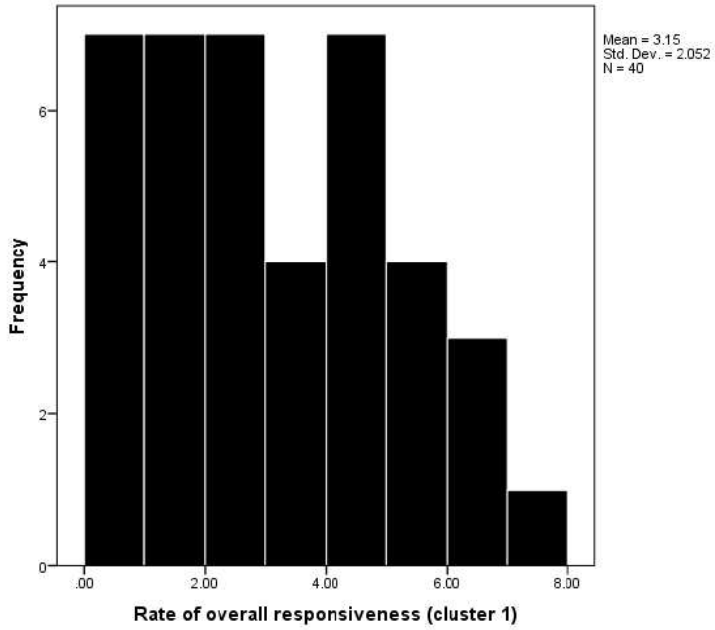



*Figure 2a.* Frequency distribution of the rate of overall responsiveness for cluster 1.

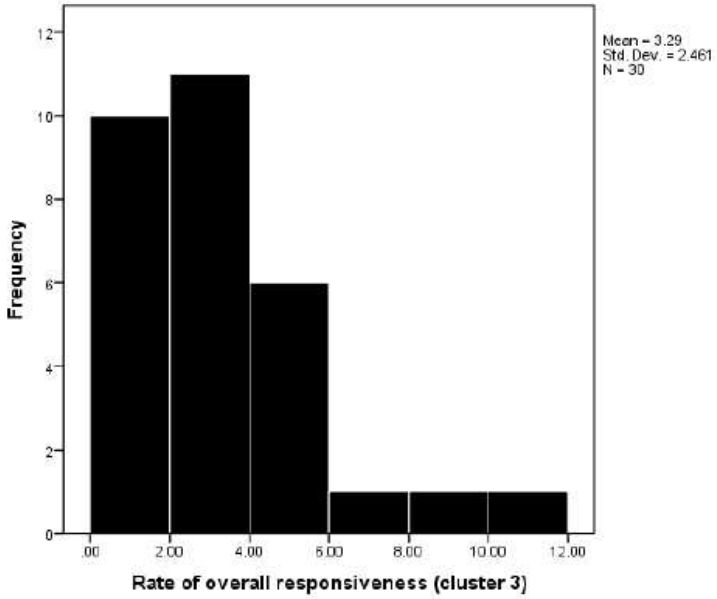



*Figure 2b.* Frequency distribution of the rate of overall responsiveness for cluster 3 students.

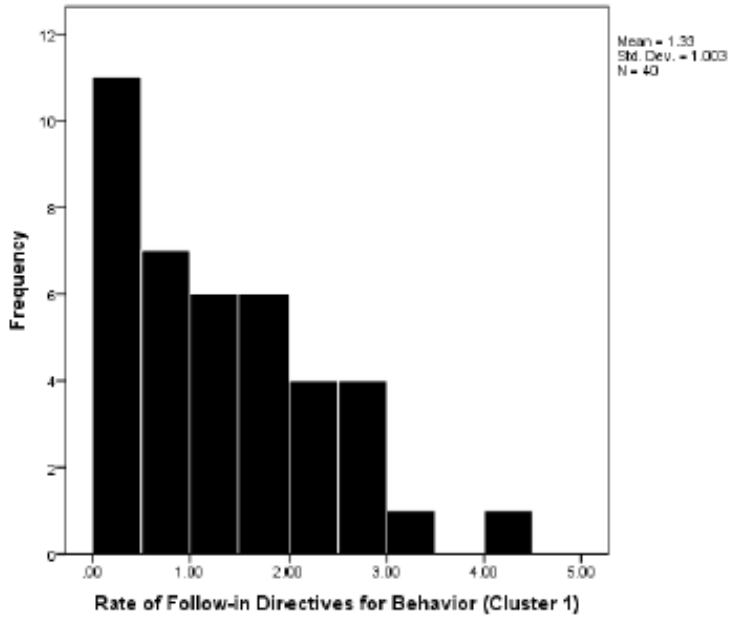



*Figure 3a.* Frequency distribution of rate of follow-in directives for behavior (cluster 1)

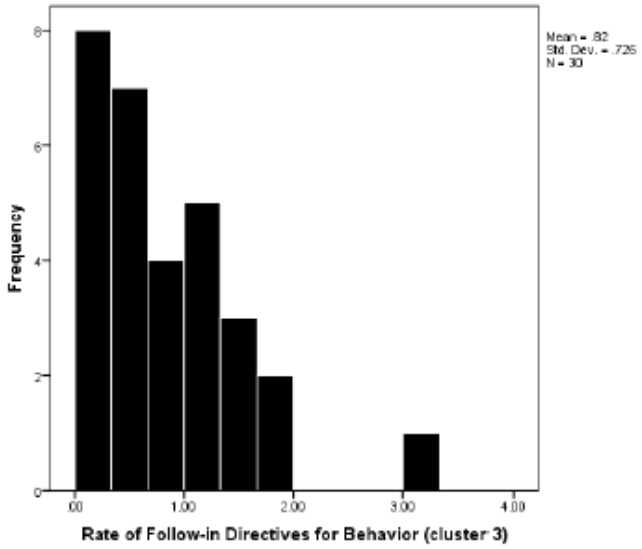



*Figure 3b.* Frequency distribution of rate of follow-in directives for behavior (cluster 3)

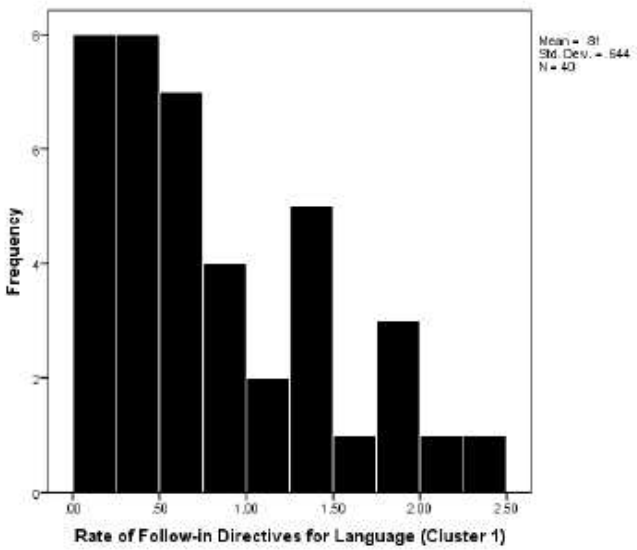



*Figure 4a.* Frequency distribution of rate of follow-in directives for language (cluster 1)

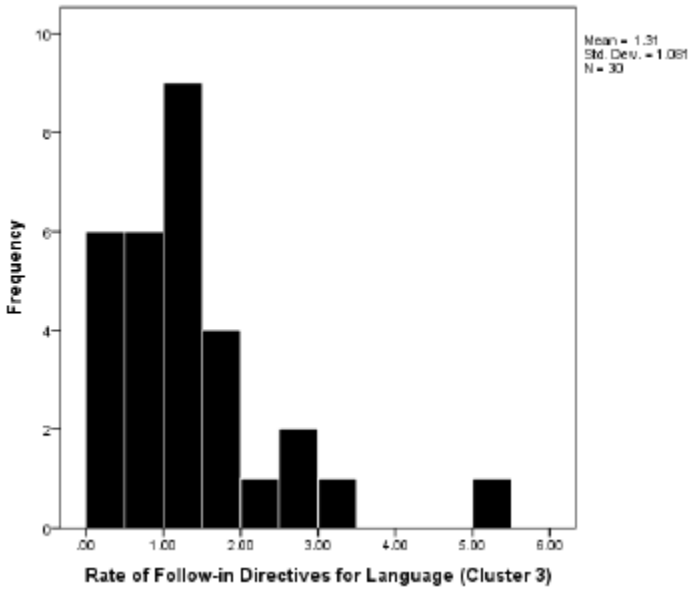



*Figure 4b.* Frequency distribution of rate of follow-in directives for language (cluster 3)

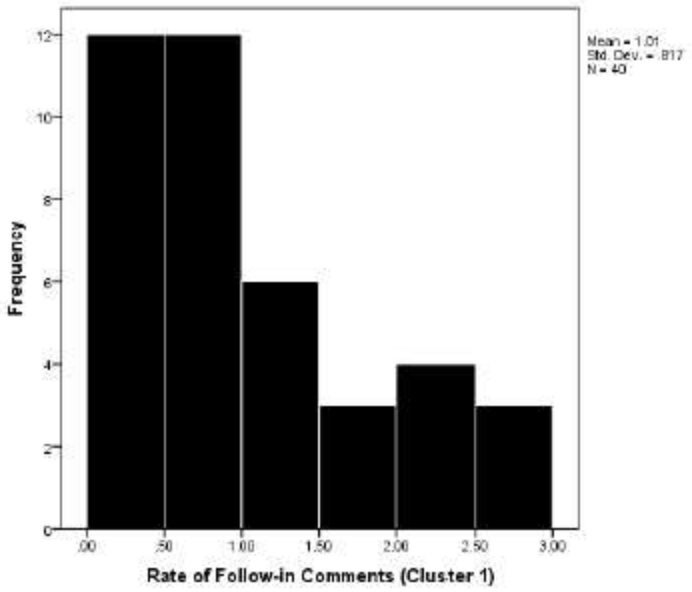



*Figure 5a.* Frequency distribution of rate of follow-in comments (cluster 1)

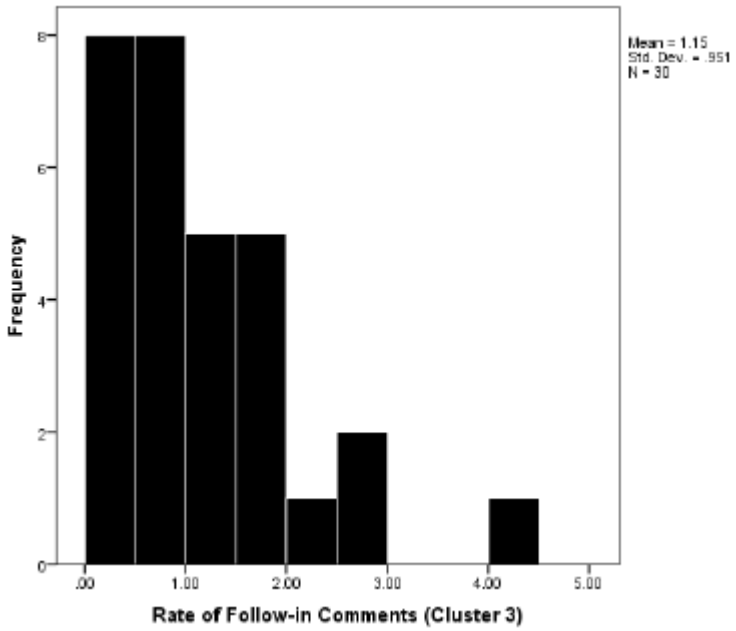



*Figure 5b.* Frequency distribution of rate of follow-in comments (cluster 3)

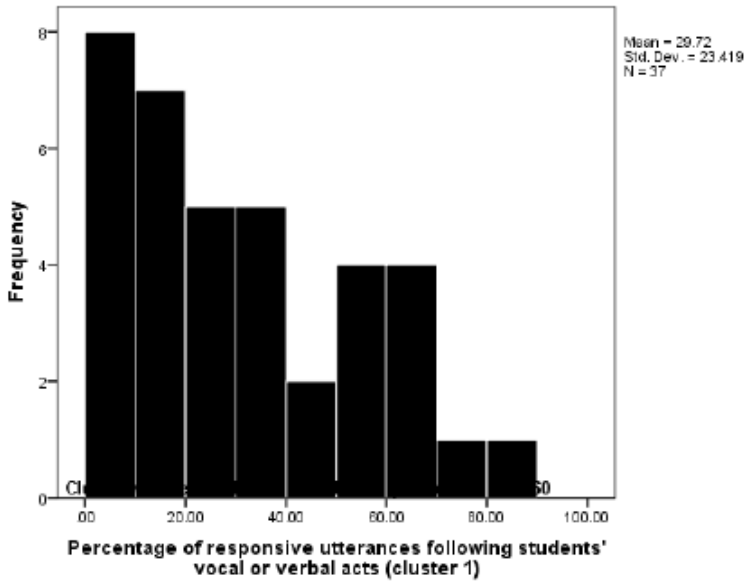



*Figure 6a.* Frequency distribution of percentage of teachers' responsive utterances following students' vocal or verbal acts within 3 seconds (cluster 1).

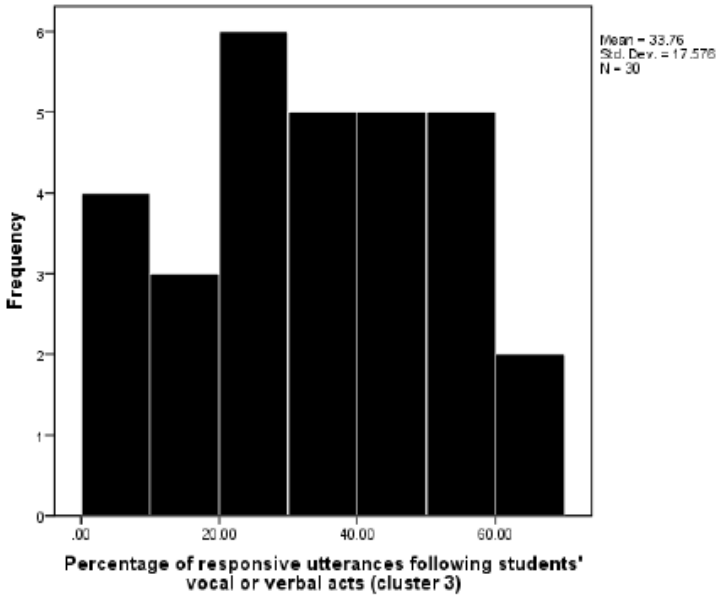



*Figure 6b.* Frequency distribution of percentage of teachers' responsive utterances following students' vocal or verbal acts within 3 seconds (cluster 3).

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## Appendix A

### Psychometric Information of Measures Used in the Current Study

**Autism Diagnostic Observation Schedule.** The ADOS (Lord et al., 2000), a semi-structured instrument commonly used to diagnose ASD, yields an autism severity score ranging from 1 to 10, with scores of 1-3, 4-5, and 6-10 indicating mild, moderate, and severe degree of autistic impairment, respectively (Gotham, Pickles, & Lord, 2009).

**Mullen Scale of Early Learning.** The Mullen Scale of Early Learning (MSEL) is a norm-referenced test that measures students' general developmental outcomes across gross and fine motor, visual reception, and expressive/receptive communication skills (Mullen, 1995). The MSEL provides a measure of cognitive functioning for infants and students ranging from birth to 68 months. Based on these four cognitive scales, a composite score (Early Learning Composite) with a mean of 100 and standard deviation of 15 can be computed. The MSEL also yields a nonverbal ratio IQ score based on the age-equivalent scores. The MSEL has strong concurrent validity with other cognitive and language measures and is commonly used with young students with autism (Bishop, Guthrie, Coffing, & Lord, 2011).

**Preschool Language Scale.** The Preschool Language Scale-4$^{th}$ edition (PLS-4) is a standard norm-referenced test of language skills in students ranging from 2 weeks through 6 years of age (Zimmerman, Steiner, & Pond, 2002). This measure yields raw scores for the Auditory Comprehension and Expressive Communication Subscales. It

also yields a standardized language score with a mean of 100 and a standard deviation of 15.