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Vocalizations of Children with Autism Spectrum Disorders Late in the Second Year of Life

Allison M. Plumb

FLORIDA STATE UNIVERSITY

COLLEGE OF COMMUNICATION

VOCALIZATIONS OF CHILDREN WITH AUTISM SPECTRUM DISORDERS LATE IN THE SECOND YEAR OF LIFE

By

ALLISON M. PLUMB

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The members of the Committee approve the dissertation of Allison M. Plumb defended on July 18, 2008.

Amy Wetherby
Professor Directing Dissertation

Mary Frances Hanline
Outside Committee Member

Michelle Bourgeois
Committee Member

Juliann Woods
Committee Member

John K. Mayo, Dean,
College of Communication

The Office of Graduate Studies has verified and approved the above named committee members.

With a full heart I dedicate this work to Jillian Plumb… my mother, my best friend, and my constant in an ever-changing world. Through her love and support I have learned that every challenge is surmountable and that “this too shall pass.”

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ABSTRACT

Impairment in communication is a primary diagnostic feature of autism spectrum disorders (ASD), however relatively little is known about the early communication development of children with ASD. Vocalizations, which typically begin to emerge within the first year of life, are therefore an area of communication prime for research as a potential behavioral marker of ASD which can be assessed early in life. The purpose of this study was to compare differences in the vocalizations of children between 18 and 24 months of age later diagnosed with ASD ($n = 50$), a mentally and chronologically age-matched group of children with developmental delay (DD; $n = 25$), and a chronologically age-matched group of children with typical development (TD; $n = 50$). In addition, for children with ASD, concurrent and predictive relationships between vocalizations and developmental level were investigated. Precise measures of vocalizations were obtained through systematic observation of videotaped behavior samples from the *Communication and Symbolic Scales Developmental Profile* (Wetherby & Prizant, 2002). Children with ASD used significantly fewer vocalizations and a lower proportion of vocalizations with consonants than children with TD. In addition, children with ASD used a significantly higher proportion of atypical vocalizations than children with TD and a significantly higher proportion of distress vocalizations than both children with TD and DD. For the ASD group, the frequency of vocalizations and the frequency of vocalizations containing recognizable speech sounds correlated significantly with developmental levels in both the second and third years. In addition, communicative vocalizations late in the second year were found to uniquely predict expressive language outcome at age 3 over and above noncommunicative vocalizations. Overall, the results of this study indicated that by 18 to 24 months of age many vocalization measures significantly differentiate children with ASD from children with TD, with a higher proportion of distress vocalization differentiating children with ASD from both children with TD and DD. The importance of communicative vocalizations for later language development is highlighted by the results of this investigation. This study will contribute to the understanding of early vocal communication in children with ASD and assist in early identification.

INTRODUCTION

The positive outcomes associated with early identification and intervention for children with autism spectrum disorders (ASD) are well documented. A growing body of evidence exists suggesting that intervention beginning before 3½ years of age results in greater long term benefits than intervention beginning later in life (Dawson & Osterling, 1997; Fenske, Zalenski, Krantz, & McClannahan, 1985; Harris and Handleman, 2000; McGee, Morrier, & Daly, 1999; NRC, 2001). Despite this knowledge, the average age of diagnosis for autism is still above age 3 (Mandell, Novak, & Zubritsky, 2005; NRC, 2001; Wiggins, Baio, & Rice, 2006). Compounding the difficulty in early identification is the lack of a biological marker for the disorder. As a result, it is even more important for research to continue identifying behavioral markers that can be observed early in life. Communication impairments are one such area of potential.

Impairment in communication is a primary diagnostic feature of autism spectrum disorders (American Psychiatric Association, 2000). According to the *Diagnostic and Statistical Manual of Mental Disorders Fourth edition, text revisions* (DSM-IV-TR; APA, 2000), deficits in communication are demonstrated by delay in or total lack of spoken language and gestures, impairment in initiating or sustaining conversation, stereotyped and repetitive use of language, and/or lack of pretend play. Because the average age of diagnosis is still over 3 years of age, relatively little is known about the early vocal development of children with ASD. In addition, some diagnostic features of ASD related to communication as listed by the DSM-IV-TR are not applicable to very young children, such as sustaining conversation and stereotyped language. Research is therefore important to understand the early communicative profiles of children with ASD under 3 years of age. Vocalizations, which typically develop within the first year of life and are necessary for spoken language, are an area of communication prime for investigation as a potential behavioral marker of ASD which can be assessed early in life.

Vocalizations in Typical Development

Perhaps the most widely accepted descriptions of early vocal development are those of Oller (1980) and Stark (1980). Both stage models are based on the commonalities of past research in the field of infant vocal development (McCarthy, 1952; Oller & Smith, 1977; Stark, 1978; Stark, Rose, & McLagen, 1975; Zlatin, Laufer, &

Horii, 1977) and continue to be supported by the robust findings of extensive longitudinal and cross-sectional investigations of infant vocalizations (Kent & Bauer, 1985; Menyuk, Liebergott, & Schultz, 1986; Mitchell & Kent, 1990; Oller, 1986; Oller, Eilers, Bull, & Carney, 1985; Smith, Brown-Sweeney, & Stoel-Gammon, 1989; Smith & Oller, 1981; Stark, Bernstein, & Demorest, 1993). Although large sample sizes were not obtained for a majority of these studies, the thoroughness of the data collection procedures and the large number of studies providing supporting evidence contribute to the robustness of the findings. Based on the convergent evidence from these well-designed studies, an understanding of typical speech development has emerged which demonstrates a continuity between birth and first words, but also acknowledges the potential for individual variability.

Now referred to as an "infraphonological" perspective, Oller's stages trace vocal development in terms of "speechiness" (1986). Vocalizations are evaluated in terms of speech-like properties that they do or do not possess and described in terms of concrete phonetic speech parameters, such as pitch, vocal quality, resonance pattern, timing, and amplitude. To a great degree, Stark's stages of vocal development (1980; 1986) mirror those of Oller, however, in addition Stark includes classification for reflexive vocalizations (i.e., cries, coughs, hiccups), which cannot be considered "speechy," and are therefore omitted by Oller. Both Oller's and Stark's stages of infant vocal development are based on the commonalities of previous research in infant vocalization. Although there are some differences in terminology and age of emergence estimates, a general overlap exists allowing early vocalizations to be evaluated in terms of typicality.

Of particular relevance to the current study is the emergence of canonical syllables, which are typically found to emerge between 6 and 10 months of age (Oller, 1980). Entry into this stage is usually recognized by the use of reduplicated syllables (e.g., /mama/), although there is not yet indication of sound-meaning correspondence. The consonant inventory is still rather limited at this stage, with stops, nasals, and glides observed the most frequently. Nonreduplicated babbling begins to occur around 11 months of age (Stark, 1986) in typically developing children, in which infants begin to produce single or multisyllablic utterances containing differing consonants or vowels. At this time, the co-occurrence of first words and jargon can also be observed. Although syllables containing consonants and vowels typically begin to occur prior to one year of age, it is important to consider that vowels remain the most frequently observed sound type until 16 to 20 months (Kent & Bauer, 1985; Nathani, Ertmer, & Stark, 2008).

In addition to considering syllable shape and consonant use of transcribable vocalizations (TVs) that contain at least a vowel and are therefore considered syllabic, it is also valuable to consider nontranscribable vocalizations (NTVs) which do not contain vowels or contain vowels with atypical phonation. NTVs include sounds such as laughs, cries, growls, yells, and screams. The earlier developing NTVs, such as cries, emerge shortly after birth, where later developing NTVs, such as squeals and growls, typically emerge between about 4 and 7 months (Oller, 1980). Also included as NTVs are certain phonemes considered consonantal in languages other than English, such as bilabial trills (raspberries), uvular trills, alveolar trills, and tongue clicks. Although not considered consonantal in their native language, English speaking children may produce these sounds during vocal play or exploration and are therefore important to include in this category. With the exception of alveolar trills, these non-English NTVs emerge within the first year of life in typically developing children (Vihman, 1996). Alveolar trills, however, still may not be mastered by typically developing children at 4 years of age (Jimenez, 1987; Linares, 1981).

Wetherby, Cain, Yonclas, and Walker (1988) studied the TVs and NTVs of 15 typically developing children during the prelinguistic, one-word and multiword stages. Results indicated that NTVs were found to decrease significantly from the prelinguistic to the one-word stage whereas the percentage of multisyllable vocalizations increased significantly. In addition, the proportion of single and multisyllablic TVs containing consonants increased from the prelinguistic to the one-word stage for 11 of the 15 participants. By the one-word stage all of the participants used some TVs containing consonants and 13 of 15 used these as their primary vocalization type.

Vocalizations of Preschool Children with ASD

A growing number of studies have been conducted that examine the vocal communication of preschool and early school-age children with ASD. This research provides valuable evidence regarding a deficit in the vocal development of children with ASD, however the findings of each study could be strengthened with larger sample sizes. Wetherby, Yonclas, & Bryan (1989), for example, examined the syllabic shape of vocalizations used in the intentional communicative acts of 3 preschool children with autistic behaviors and mental retardation, 4 preschool children with Down syndrome, and 4 preschool children with Specific Language Impairment (SLI). Analysis of 30 minute communication samples revealed that the children with characteristics of autism and mental retardation used a deficient proportion of vocal acts with a consonant when compared to normative data on typically developing children and also suggested that they displayed an excessive production of NTVs (Wetherby et al., 1988).

Stone, Ousley, Yoder, Hogan, and Hepburn (1997) compared 14 children with ASD ranging from 27 to 38 months (*M* = 32.8, *SD* = 3.5) to 14 children with DD/Language Impaired (LI) matched on CA, MA, and expressive vocabulary and found no significant differences in the use of vocal communicative acts without gestures. Wetherby, Prizant, & Hutchison (1998) compared the *Communication and Symbolic Behavior Scales Developmental Profile* (CSBS DP) Behavior Samples of 22 participants with PDD ranging in age from 17 to 60 months (*M* = 35.9, *SD* = 11.72) to 22 participants with DD ranging in age from 19 to 66 months (*M* = 32.4, *SD* = 9.91). Based on the participants' mean scaled scores, the PDD group used fewer syllables with consonants than the DD group, with a medium effect size obtained and fewer multisyllables with a small effect size achieved. Findings were consistent with those of Stone et al. (1997) who found that preschool children with ASD demonstrated similar use of communicative acts with vocalizations that did not involve gestures as children with DD.

Although also limited by its small sample size, perhaps the most detailed study on vocalizations in children with ASD to date is that of Sheinkopf, Mundy, Oller, & Steffens (2000). These investigators compared the vocalizations of 11 preverbal children with developmental delay to 15 preschool children with ASD matched on nonverbal MA and verbal ability. Vocal samples were coded from video recordings of *Early Social and Communication Scales* (ESCS, 1996) samples. Vocalizations were coded to include breath-group based utterances, syllable structure, vocal quality, and frequency counts of utterance features associated with emotional states, such as laughing and crying. The results indicated that the ASD group used a comparable proportion of syllables containing consonants as the DD group, but a significantly higher proportion of syllables with atypical vocal quality, such as yells, squeals, and growls (*M* =.25, *SD*=.14).

Despite being limited by small sample sizes, the convergent findings of these studies involving preschool children with ASD have documented deficits in vocalizations when compared to peers with typical development. These results highlight the need for research on the vocalization development of children with ASD under 2 years of age in order to better understand their early communicative profiles and whether these deficits may be determined at a younger age.

Profiles of Communicative Functions in Young Children with ASD

There is a growing body of research demonstrating a unique profile of communicative functions or reasons for communicating in young children with ASD. To better understand the vocal abilities of a child with ASD it is important to consider how vocalization deficits may manifest in relation to this unique profile of communicative functions.

By the end of the first year of life typically developing children begin to communicate for three primary functions: behavior regulation, social interaction, and joint attention (Bruner, 1981; Wetherby & Prizant, 2002). Behavior regulation involves communicating in order to regulate the behavior of another for a desired outcome, such as requesting or protesting. Communicating for social interaction involves drawing another's attention to oneself, such as greeting or showing off, while joint attention involves drawing another's attention to an object or event for the purpose of sharing it with others (e.g., requesting information, commenting). In typically developing children these behaviors develop concurrently (Carpenter, Mastergeorge, & Coggins, 1983; Crais, Douglas, & Campbell, 2004; Wetherby, 1986), however in children with ASD differences in the emergence of these functions and their rate of use have been found.

Research has documented that communicating for behavior regulation is an area of strength for children with ASD, while communicating for joint attention is a deficit (McEvoy, Rogers, & Pennington, 1993; Mundy, Sigman, & Kasari, 1990, 1994; Sigman, Mundy, Sherman, & Ungerer, 1986; Wetherby & Prutting, 1984; Wetherby et al., 1998). Research is emerging on children under 2 years of age showing this same profile of communicative functions. Using a large sample drawn from the same participant pool as the current investigation, Shumway (2006) compared 50 children with ASD in the second year of life to 50 chronological age (CA) matched TD children and 25 mental age (MA) matched and CA matched DD children using precise coding of communicative acts with the Noldus Pro Observer©software during CSBS DP Behavior Samples. Results indicated that children with ASD communicated for behavior regulation at a significantly lower rate (*M* = .76, *SD* = .43) than the TD group and a significantly lower rate for joint attention (*M* = .26, *SD* = .45) than the TD and DD groups. The three groups were similar on the rate of acts for social interaction (*M* = .24, *SD* = .26) however, this may be in part due to the low occurrence rate of this behavior across all groups. Because the ASD group used significantly fewer total acts (*M* = 22.42, *SD* = 14.91) than both the TD and DD groups, proportions were also used to measure differences between groups on the use of functions. Based on proportion measures, the ASD group used a significantly higher proportion of acts for behavior regulation (*M* = 65.34, *SD* = 21.89) and social interaction (*M* = 19.97, *SD* = 20.65) than the TD group, but a lower proportion of acts for joint attention (*M* = 14.69, *SD* = 14.91) compared to TD and DD.

In a study using the same sample as Shumway (2006), Wetherby, Watt, Morgan, & Shumway (2007) examined social communication profiles from CSBS DP Behavior Samples videotaped between 18 to 24 months of age (*M* = 21.36; *SD* = 1.90) for 50 children with ASD, 23 with DD, and 50 with TD. Although the samples were identical for these studies it is important to note the difference in their measures. Wetherby and colleagues (2007) based results on the mean scores on the standardized clinical scoring of the CSBS DP Behavior Samples. Shumway (2006) provided additional detail by precisely coding samples using Noldus Pro Observer©software version 5.0 by Noldus Information Technology for each communicative act and its function. Despite the difference in methodology, the findings were similar to those of Shumway (2006) in that children with ASD scored significantly lower on joint attention than children with DD and TD and significantly higher on behavior regulation and social interaction than children with TD.

In summary, previous research provides consistent evidence that communication for joint attention is a core deficit in young children with ASD, with communication for behavior regulation presenting as a relative strength. Therefore, a lower frequency of vocalizations used in acts for JA would potentially be likely during communication samples of children with ASD. To address this profile of strengths and weaknesses across communicative functions, research utilizing proportion measures of vocalizations used for different functions would be important. This will provide information on whether children with ASD are as likely to vocalize for the functions of BR, SI, and JA, as both the TD and DD groups when using vocalizations communicatively.

Vocalizations of Children with ASD under 2 Years of Age

Evidence is beginning to emerge on the vocalizations of children with ASD under 2 years of age. This evidence has come from two primary sources: analysis of home videotapes and systematic observation. Although some of these studies are limited by weaknesses in methodology, they have provided important information that help to direct the study of early vocalizations of young children with ASD.

Analyses of home videotapes. The examination of home videotapes collected from first birthday parties is one methodology used to investigate early social and communication abilities in very young children with ASD, but has provided mixed results in terms of vocalization findings. In one such study, Osterling, Dawson, & Munson (2002) did not find group differences when they compared duration of time spent vocalizing in the first birthday videotapes of 20 children with ASD, 14 children with DD and 20 children with TD, however this may in part be due to a small sample size.

In a later investigation by Werner and Dawson (2005) significant differences were detected when they compared the first and second birthday videotapes of 36 children with ASD, 21 with early onset symptoms and 15 with reported regression, and 18 children with TD. The early onset ASD group differed significantly from the group with regression and the group with TD on measures of complex babbling at 12 months. By 24 months both ASD groups differed from TD on complex babbling. In addition to the use of a larger sample size, this study also measured vocalizations by the frequency of simple and complex babbling. This coding scheme was more detailed than that used by Osterling and colleagues (2002), which did not differentiate vocalizations by levels of complexity. These distinctions may account for their ability to find group differences.

Systematic observation. Research is also emerging for children with ASD under 2 years of age based on direct, systematic observation. One major cohort consists of children identified from a general population screen using the CSBS DP. Wetherby and colleagues (2004) used the *Systematic Observation of Red Flags* (SORF) for Autism Spectrum Disorders in Young Children (Wetherby & Woods, 2002) to investigate a subset of this cohort in the second year of life and found that a lack of communicative vocalizations was one of 13 red flags that differentiated 18 children with ASD from 18 children with TD. The information provided by this study is valuable, but is negated by a relatively small sample and large age range (13.1 to 26.9 months). These factors, in addition to the SORF's restricted scoring range (e.g., 0, 1, 2), limit the study's ability to find group differences. To better understand the communication abilities in young children with ASD, research with larger sample sizes and narrower age ranges is needed.

Results of Wetherby and colleagues' investigation (2007) of the communicative profiles of children with ASD, DD, and TD late in the second year of life indicated that a lack of well-formed syllables containing consonants differentiated children with ASD from children with TD, however not from DD. Building on what was learned from these investigations and using children from the same cohort, Plumb, Wetherby, Kahn, and Barber (2007) investigated vocalizations in the latter half of the second year for 50 children with ASD, 25 children with DD, and 50 children with TD. All vocalizations observed during the videotaped Behavior Samples were precisely coded as TVs or NTVs to determine their frequency of use by type. Supporting the findings of Wetherby & Woods (2002) and Wetherby and colleagues (2007), children with ASD were found to produce significantly fewer TVs than children with TD, but not DD. Although group differences in NTVs were not found, the specific types of NTVs (i.e., laugh, cry, squeal, tongue click) were not included in the coding scheme, rather vocalizations were coded dichotomously as transcribable or nontranscribable. Future research is needed to look more precisely at transcribable and nontranscribable vocalizations, specifically at consonant use and the number of syllables in TVs and specific categories of NTVs used by children with ASD in the second year of life. Investigating in more detail will provide needed information on the early vocalizations of children with ASD, as well as provide additional opportunity to illustrate potential group differences on NTVs that have been demonstrated by previous research with small sample sizes (Sheinkopf et al., 2000; Wetherby et al., 1989).

In addition to examining communicative acts by function, Shumway (2006) also looked at the means of these acts, including both gesture and vocalization use. Results of this investigation indicated that the ASD group used a significantly lower proportion of acts with vocalizations than the TD group. Plumb and colleagues (2007) also looked at the communicative use of vocalizations and found that the ASD group demonstrated significantly fewer TVs in acts than the TD group, however there were no significant differences between the ASD group and the DD group. Proportion measures similarly indicated that the ASD group used significantly lower proportions of TVs within communicative acts than their age matched TD peers. What is not known from this investigation is whether there were group differences in the TVs in terms of syllable structure and consonant use. TVs were coded uniformly and not examined to describe a hierarchy of developmental complexity. Further investigation with increased detail is recommended to provide precise information on the communicative use of specific vocalization types in young children.

In summary, there is a general convergence of evidence that children with ASD use fewer TVs communicatively than children with TD. In addition, evidence is beginning to emerge which indicates that the presence of atypical NTVs, such as squeals, growls, and tongue clicks, can distinguish young children with ASD from young children with DD, making it especially important for early identification. Detailed research is now needed to look at the specific phonologic and syllabic composition of TVs, as well as the types of NTVs being used by children with ASD late in the second year of life. A careful investigation into these areas utilizing a large sample size, a narrow age range, and systematic observation will make it more likely to detect group differences, providing a clearer picture of the vocal communication abilities of young children with ASD.

Relationship between Vocalizations and Later Spoken Language

Although initially debated in the field, research has long supported the theory of continuity existing between prelinguistic babble and speech in typically developing children. Jakobson's (1968) view that children begin with a diverse set of speech sounds during babble and subsequently lose those sounds only to start over with a limited repertoire of consonants and vowels in first words has since been refuted by evidence that the syllable structure, place, and manner of articulation, and vocalization length used most commonly in the canonical babbling period are also found in first word productions (Stoel-Gammon, 1985; Stoel-Gammon & Cooper, 1984; Vihman, Ferguson, & Elbert, 1987; Vihman, Macken, Miller, Simmons, & Miller, 1985). In addition to studies providing evidence on the continuity of phonetic patterns of early babble and speech, longitudinal studies have also provided evidence supporting a relationship between prelinguistic vocalizations and language skills later in childhood (Menyuk, Liebergott, & Schultz, 1986; Stoel-Gammon, 1992, 1998; Vihman & Greenlee, 1987). In a recent investigation of 160 typically developing children, Watt, Wetherby, and Shumway (2006) examined the predictive validity of a collection of prelinguistic skills early and late in the second year using the CSBS DP (Wetherby & Prizant, 2002). Results of this study indicated that inventory of consonants late in the second year significantly predicted language outcome in the third year.

Studies of late talkers have also provided evidence that a link exists between vocalizations and later expressive language abilities. Stoel-Gammon (1989) examined the speech samples of 34 children to determine patterns of babbling and early word productions between 9 and 24 months. Data were gathered in 3 month intervals in structured and unstructured settings. Of particular interest were the performances of two children who differed distinctly from their peers. One of the children produced almost no consonant vowel (CV) syllables between 9 and 21 months and the other child displayed an unusual pattern of sound preferences in his babble. Both of these children demonstrated more limited phonetic repertoires and syllable shapes than their peers at 24 months. In addition, the child who demonstrated a deficit in CV production was the last child to enter into the meaningful speech phase.

A growing body of research on children with Specific Language Impairment (SLI) and DD also supports the relationship between prelinguistic vocalizations and later expressive language skills. McCathren, Yoder, and Warren (1999) investigated the relationship between prelinguistic vocalization and expressive vocabulary 1 year later in 58 children between 17 and 34 months of age with mild to moderate DD. Rate of vocalizations used interactively was found to be a predictor of later expressive language ability, in addition to rate of vocalizations and rate of vocalizations with consonants.

For children with expressive language delay, natural language samples of babble and words were obtained for 37 two-year-olds to predict expressive language ability (Whitehurst, Smith, Fischel, Arnold, & Lonigan, 1991). Results of this investigation indicated that rate of vowel babble was negatively correlated with expressive language measures 5 months later. For children with expressive language disorder, therefore, a preference of vowel babble over consonantal babble predicted lower expressive language skills.

Although only a small number of studies have investigated the relationship between early vocalizations and later expressive language in children with ASD, those that exist do support a relationship between the two. Results of the investigation of

Wetherby et al. (2007) revealed that when compared to performance on the *Mullen Scales of Early Learning* (MSEL; Mullen, 1995) at age 3, both rate of communicating and inventory of consonants were significant predictors of NVDQ and VDQ after controlling for understanding. Plumb and colleagues (2007) found that for the 60 children with ASD between 18 and 24 months of age, the proportion of NTVs was negatively correlated with expressive language abilities at age 3. This result indicated that a high proportion of NTVs and a low the proportion of TVs predicted lower expressive language abilities at age 3.

In summary, substantial evidence supports the existence of a relationship between prelinguistic vocalizations and later spoken language for children with TD and DD. Although a growing number of studies support this relationship in children with ASD, further investigation is needed, with large sample sizes, systematic observation, and precise coding of vocalization variables to provide additional clarity on the relationship.

Child-driven and Transactional Theories of Language Development

An investigation into the relationship between early vocalizations and later spoken language will have potential implications for further understanding the child-driven and transactional theories of language development. Child-driven theories propose that the better an infant vocalizes, the more sounds the infant may have on which to map meaning (Stoel-Gammon, 1989) or that infants with better motoric abilities and neurological development will be better babblers (Locke, 1989). While this information is indeed beneficial, it is equally important to consider a transactional hypothesis in which characteristics of both the child and the environment, in particular parental responsiveness, are taken into consideration when explaining later expressive language outcome. Many potential explanations exist in regard to the importance of the transactional model when considering prelinguistic vocalizations as potential predictors of spoken language. A primary example of such explanations would involve a parent's attribution of meaning to a child's interactive vocalizations and subsequent provision of word models, aiding in vocabulary development. The more frequently a child vocalizes in the presence of a parent, the more feedback a child will likely receive, thereby increasing language learning opportunities (McCune, 1992).

As social and communication skills are core deficits of ASD, the investigation of a transactional hypothesis with this population is of particular importance. The variability of complexity and use of prelinguistic vocalizations among children with ASD makes it even more crucial to look not only at the quantity and quality of these vocalizations in isolation, but also at whether or not they serve a communicative purpose, particularly their presence or absence within a communicative act. By incorporating the social realm into the investigation of vocalizations researchers will be able to get a more complete picture of the relationship between the child's prelinguistic vocalizations and later spoken language abilities.

Summary and Rationale for this Study

Information provided by the existing investigations of vocalizations in young children with ASD indicates that young children with ASD use fewer TVs than children with TD. In addition, research supports that the presence of atypical NTVs distinguishes children with ASD from both children with TD and DD. Similar patterns are found in the presence of vocalizations used communicatively, in that children with ASD are less likely than children with TD to communicate by vocalizing. Current research supports the existence of a relationship between early vocalizations and later spoken language, although most of the research in this area is on populations other than ASD.

Although this information is valuable, limited research is available on the vocalizations of children with ASD younger than 2 years of age. Further research is needed to examine vocalizations in children with ASD in the second year of life to better understand the development of early vocal communication of this population and its relationship with later language development. Knowing the vocal strengths and weaknesses of children with ASD late in the second year will help inform early identification efforts, as well as provide potential targets for early intervention. The need for additional evaluation in this area is heightened because of the small number of studies that currently exist in this area. Of the studies that do exist, many of their findings are compromised by small sample sizes with limited methodologies. Further investigation with larger sample sizes using systematic observation is warranted because of the limited methodologies utilized by previous investigations. In addition, precise coding of vocalizations in terms of consonant use, syllable structure, and nontranscribable type is needed in this area to provide more specific information on vocalizations late in the second year of life for children with ASD.

Statement of Purpose and Research Questions

Impairment in communication skills is a core feature of ASD (APA, 2000). Vocalizations emerge within the first year of life in typically developing children and are therefore an important area for investigation to assist in the identification of early behavioral markers of ASD. Research using large samples of children, systematic observation, and precise measurement is needed to improve understanding of the early vocal development of these children.

The purpose of this study was to compare differences in the vocalizations of children between 18 and 24 months of age later diagnosed with ASD, an MA and CA matched group of children with DD, and a CA matched group of children with TD. In addition, for children with ASD, concurrent and predictive relationships between vocalizations and developmental level were investigated.

The following research questions were addressed:

1. For each diagnostic group, were there differences between the rate of vocalizations produced during structured versus unstructured contexts?
2. Were there group differences in the frequency or proportion of transcribable vocalizations by level of phonetic complexity and by number of syllables?
3. Were there group differences in the frequency or proportion of nontranscribable vocalizations by category?
4. Were there group differences in the frequency or proportion of vocalizations used communicatively or noncommunicatively?
5. Were there group differences in the proportion of transcribable vocalizations used in communicatively for the functions of behavior regulation, social interaction, and/or joint attention?
6. Were there group differences in the frequency or proportion of nontranscribable vocalizations used communicatively or noncommunicatively?
7. Were there group differences in the proportion of nontranscribable vocalizations used communicatively for the functions of behavior regulation, social interaction, and/or joint attention?

8. For children with ASD, what was the concurrent relationship between precise measures of vocalization using Noldus Observer software from behavior samples collected between 18 and 24 months and CSBS DP composite raw scores using the clinical scoring procedures from the same samples at the same age?
9. For children with ASD, what was the predictive relationship between precise measures of vocalization using Noldus Observer software from behavior samples collected between 18 and 24 months and Mullen NVDQ and VDQ at age 3?
10. For children with ASD, did the frequency of communicative vocalization by type predict VDQ above and beyond the frequency of noncommunicative vocalizations by type?

Expected Outcomes

It is anticipated that the findings of the current investigation will support and extend the findings of current research in the area of vocalizations in young children with ASD. Use of a large sample size, systematic observation and precise measurement will create a strong study with adequate power to detect group differences. By coding TVs by level of developmental complexity in terms of consonant use and number of syllables it is expected that TVs will more precisely differentiate children with ASD from TD and potentially children with DD. In addition, by coding NTVs by category, specific NTV categories that are atypical may differentiate children with ASD from children with TD and possibly DD. Significant relationships between TVs in the second year and expressive language development at age 3 are also anticipated and that these results will support a transactional hypothesis for this relationship.

METHOD

Participant Recruitment

There were 125 participants in this study, 50 with a clinical diagnosis of ASD, 25 with DD in which ASD had been ruled out, and 50 with TD. Wetherby et al. (2007), Watt (2006), and Shumway (2006) have reported on 123 of these participants. Children were recruited from the ongoing longitudinal, prospective study of the FIRST WORDS® Project using the CSBS DP to identify children under 24 months of age at risk for delay. The CSBS DP includes a one page, 24-item Infant-Toddler Checklist for screening and a Behavior Sample. The Behavior Sample is a face-to-face evaluation of the child interacting with a parent and clinician that is videotaped for later analysis. In order to participate in the study, an Infant-Toddler Checklist had to be completed by the family when the child was under 24 months of age and a CSBS DP Behavior Sample had to be videotaped when the child was at least 18 months of age. In addition, the MSEL was completed when the child was over 2 years of age. Additional selection criteria for each group are described below.

ASD group. Children were included in the ASD group upon meeting the following selection criteria: (1) demonstrated a communication delay during the second year of life based on performance in the bottom tenth percentile on the Social or Symbolic Composites of the CSBS DP Behavior Sample; and (2) were diagnosed with ASD based on information gathered during a follow-up multidisciplinary evaluation conducted by a licensed speech-language pathologist and a psychologist. The team made a *best estimate diagnosis* of Autistic Disorder or Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS) as defined by the DSM-IV diagnostic criteria (APA, 2000). Diagnoses were made based on the following criteria: (1) information provided on developmental level through performance on the MSEL administered between approximately 2 and 3 years of age; (2) performance on *Vineland Adaptive Behavior Scale* (VABS; Sparrow, Balla, & Cicchetti, 1984), which provides information in the domains of Communication, Daily Living, Social, and Motor skills, as well as an Adaptive Behavior Composite; (3) performance on the *Autism Diagnostic Observation Schedule* (ADOS; Lord, Rutter, DiLavore, & Rissi, 1999), a standardized evaluation of communication, social interaction, and play for children referred for the possibility of autism and (4) information provided from the *Social Communication Questionnaire* (SCQ; Lifetime Version; Rutter, Bailey, Berumenta, Lord, & Pickles, 2001) to provide parent report of symptoms of ASD. Information gathered from these evaluations was used to make a *best estimate* diagnosis of ASD defined in the DSM-IV-TR (APA, 2000). The term *best estimate* is used because the team was allowed to decide how to put the information together to make a diagnosis. In order to receive a diagnosis of ASD, a child needed to receive a Communication and Social Interaction Total score on the ADOS which fell at or above the cutoff for ASD. A diagnosis of Asperger Disorder was not made or ruled out due to the young age of these children. Children were assigned to the ASD group if they received a diagnosis of Autistic Disorder or PDD-NOS and their Communication and Social Interaction Total on the ADOS fell at or above the cut-off for autism spectrum; otherwise they were assigned to the DD group. Of the 75 children with a communication delay, 50 were assigned to the ASD group and 25 to the DD group.

DD group. Children were included in the DD group upon meeting the following criteria: (1) demonstrated a communication delay in the second year of life based on performance in the bottom 10^{th} percentile on the Social or Symbolic composite of the CSBS DP Behavior Sample; (2) they scored more than 1 standard deviation below the mean on at least 1 of the 4 scales of the MSEL in their follow-up evaluations, and (3) a diagnosis of ASD was ruled out using the same diagnostic procedure used for the ASD group. Participants in the DD group were matched group-wise to the ASD group on: (1) chronological age at the time of the Behavior Sample; (2) Symbolic Composite score of CSBS DP in the second year as a measure of developmental functioning that is not dependent on expressive language, and (3) nonverbal developmental quotient (DQ) from the MSEL. In order to match the range of intellectual functioning within the ASD group, the DD group included children with general developmental delays and children with speech, language, or motor delays. Children with known genetic disorders or chromosomal abnormalities (i.e., fragile X, Down syndrome) were not excluded from either the ASD or the DD groups.

TD group. Children were included in the TD group who scored above the 25^{th} percentile on the Social, Speech, and Symbolic Composites of the CSBS DP Behavior Sample in the second year, within normal limits on the MSEL, and no concerns about ASD reported by either the clinician or parent. The SCQ (Rutter et al., 2001) was mailed out to the families of children in the TD group in an effort to further rule out the possibility of ASD. The SCQ is a 40-item parent report tool for diagnostic screening of ASD appropriate for young children (Corsello, Cook, & Leventhal, 2003). The SCQ total score of 15 or higher indicates risk for ASD. The SCQ was returned by 26 families, which is 44% of the children in the TD group. These children received an average score of 6.1, with a range of 0 to 12 and all had a negative screen, meaning their scores were below the cutoff for ASD. Children in the TD group were matched individually to the ASD group on gender and CA at the time of the Behavior Sample.

Participant demographics. A summary of participant demographics is presented in Table 1. All three groups are well matched on mother's education and mother's age at

Table 1
Summary of Participant Demographics

Demographic	ASD (*n* =50)		DD (*n* =25)		TD (*n* =50)		*F* value	*p value* of pairwise differences	
								DD-ASD	TD-ASD
Parent's education in years completed									
Mother (*M, SD*)	15.48_a	2.08	15.22_a	2.47	15.19_a	2.25	0.24	0.96	0.88
Father (*M, SD*)	15.73_a	2.52	15.52_a	2.71	15.40_a	2.57	0.22	0.99	0.88
Parent's age at child's birth in years									
Mother (*M, SD*)	31.19_a	4.93	31.94_a	6.37	31.24_a	5.56	0.13	0.94	1.00
Father (*M, SD*)	32.99_a	6.82	35.91_a	5.50	33.71_a	6.04	1.95	0.16	0.93
Males (%)	86.0		76.0		86.0				
First born (%)	44.0		36.0		38.0				
Ethnicity (%)									
Caucasian	72.0		68.0		84.0				
African American	16.0		20.0		14.0				
Hispanic	8.0		8.0		2.0				
Asian	4.0		4.0		0.0				

Note: Means in the same row with different subscripts differ significantly at $p < .05$ on the post-hoc Dunnet *T3* comparison.
F -values are Welch corrected when necessary for violation of homogeneity of variance as assessed by Levene's test.

time of child's birth using & the criteria of $p > .50$ on tests of group differences for purposes of matching (Mervis Klein-Tasman, 2004), suggesting that the groups are comparable on socioeconomic status. A lack of significant difference between groups on the father's education at the time of the child's birth ($p < .232$) indicates that this variable is also matched, although not as strongly as the other three demographic variables. The ASD group has slightly more Hispanic children and Asian children than the TD Group and the DD group had slightly more African American children than both other groups. Thus the groups were fairly similar with regard to most aspects of demographics.

Participant Developmental Characteristics. A summary of participant developmental characteristics is presented in Table 2. Developmental performance was ascertained for all three groups from the CSBS DP Behavior Sample gathered in the

Table 2
Summary of Developmental Characteristics

	ASD (n=50)		DD (n=25)		TD (n=50)			p value of pairwise differences	
Characteristic	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F* value	DD-ASD	TD-ASD
CSBS DP behavior sample[d]									
Age in months	21.29_a	1.92	20.64_a	1.56	21.07_a	1.75	1.23	0.32	0.91
Social composite	5.00_a	2.36	7.92_b	3.21	11.38_c	2.57	82.77***	0.00	0.00
Speech composite	5.82_a	2.62	7.16_a	2.59	10.26_b	2.43	39.86***	0.12	0.00
Symbolic composite	5.82_a	3.07	6.52_a	2.60	10.96_b	2.56	48.77***	0.66	0.00
Total	73.88_a	12.62	81.64_b	11.86	102.54_c	11.26	75.77***	0.04	0.00
Mullen scales of early learning[e]									
Age in months	38.98_a	9.83	35.85_a	6.11	35.45_a	5.42	1.23	0.26	0.09
Nonverbal DQ	76.00_a	25.81	84.48_a	20.12	114.08_b	17.48	44.45***	0.33	0.00
Verbal DQ	68.00_a	31.11	77.26_a	21.04	108.93_b	15.52	46.96***	0.35	0.00

Note: Means in the same row with different subscripts differ significantly at $p<.05$ on the post-hoc Dunnet *T3* comparison; *F*-values are Welch corrected when necessary for violation of homogeneity of variance as assessed by Levene's test.

[d] Standard Scores based on a *M* of 10 and *SD* of 3 for the Composite and *M* of 100 and *SD* of 15 for the Total.

[e] Developmental Quotients (DQ) based on age equivalent divided by chronological age multiplied by 100.

[f] Standard Scores based on a *M* of 100 and *SD* of 15.

*$p<.05$ **$p<.01$ ***$p<.001$

second year and the follow-up diagnostic evaluation. The children ranged in age from 18.01 to 26.86 months at the Behavior Sample. The ASD group was matched on age with the TD and DD groups. The ASD group was significantly different from the TD group on all three CSBS DP composites and the total, but not significantly different from the DD group on either the symbolic or speech composites, indicating they were comparable on developmental level in the second year

The three groups were also well matched on age at the time of the follow-up evaluation. A developmental quotient (DQ) based on age equivalent divided by CA multiplied by 100, was used to more fully characterize individual variation because several participants achieved the lowest possible standard score on the MSEL. A nonverbal developmental quotient (NVDQ) was calculated from the average of the fine motor and visual reception scales, and a verbal developmental quotient (VDQ)was calculated from the average of the receptive and expressive fine motor and visual reception scales. The MSEL scores presented in Table 2 indicate that the ASD and DD groups show a wide range of cognitive functioning. As expected, the ASD group was significantly different than the TD group on NVDQ and VDQ. The ASD group was not significantly different than the DD group on nonverbal or VDQ.

Because the purpose of the current investigation was to investigate the early vocalizations of young children, it was important to consider the linguistic background of the participants. A small number of participants in each group were reported to live in a home in which they were exposed to a language in addition to English. Participants in the ASD group were reported to be from homes in which Spanish (n = 4), French (n = 1), Ukranian (n = 1), and Korean (n = 1) were spoken. Parents reported that DD participants were exposed to Russian (n = 1) and Spanish (n = 5) within the home and TD participants were from homes in which American Sign Language (n = 1), French (n = 1), and Spanish (n = 3) were reported to be spoken. When evaluating the production of certain non-English NTVs (e.g., the alveolar trill used in the Spanish language), it was therefore important to examine whether inclusion of participants from bilingual homes in any of the diagnostic groups would not inflate the results of measures of non-English NTVs due to exposure in the home environment.

Second Year Measures

CSBS DP behavior samples. Between the ages of 18 and 24 months, CSBS DP Behavior Samples were collected for all participants. The child had time to become familiar with the setting and the clinician during a warm-up period of approximately 10 to 15 minutes. Following the warm-up, a series of communicative temptations were presented to coax the child to communicate spontaneously. Temptations included a wind-up toy, a balloon, bubbles, bags of toys, and a jar of cheerios. Book sharing, comprehension probes, and opportunities for both symbolic and constructive play were also presented to the child. Caregivers were present and were encouraged to engage naturally with their child and to actively participate during the evaluation. They were cautioned to avoid direction of the child's behavior. Caregivers were asked to complete a Caregiver Perception Rating form at the end of the evaluation. If it was reported that the child's performance during the evaluation was less than typical, consideration was given to conducting another sample or observing the child in a different context. All samples were videotaped and archived for later analysis. The CSBS DP has been normed on a national sample and has been shown to have good internal consistency (Wetherby & Prizant, 2002), test-retest reliability over a 4-month interval (Wetherby, Allen, Cleary, Kublin, & Goldstein, 2002), as well as good predictive validity of receptive and expressive language outcomes at two and three years of age (Wetherby, Goldstein, Cleary, Allen, & Kublin, 2003).

The Behavior Sample of the CSBS DP uses a standard, but flexible format for sampling the behavior of young children. It includes activities that are structured, as well as unstructured in order gain a complete picture of the child's abilities in both of these situations. Structured activities involve a greater amount of clinician and parent scaffolding and include communicative temptations designed to encourage spontaneous communication behavior, such as a wind up toy, a jar with cheerios, bubbles and a bag of toys. Book sharing is also included as a structured activity. Behaviors are also sampled during unstructured activities, which include opportunities to engage in symbolic play with a feeding and cooking set. Coding during these structured and unstructured activities was compared in analysis so that differences in sampling contexts could be investigated.

Vocalizations. The CSBS DP served as the basis for the behavioral coding scheme for vocalizations used in this study, in addition to a detailed literature review of early vocalization use previously reported in young children with TD, DD, and ASD. An undergraduate coder, blind to participant diagnoses and the purpose of the study, was trained on the detailed coding definitions. The training process initially involved consensus coding with the author for three pilot children not included in the study, but representative of those in the investigation. The undergraduate coder was then trained to use the vocalization coding scheme to an agreement criterion of 80% or above and kappa > .6 with the author for at least 10 out of 10 samples. The videotaped *CSBS DP* Behavior Samples were then coded using the Noldus Pro Observer© software version XT by Noldus Information Technology for this study. This allowed for precise measurement of the frequency and co-occurrence of all behaviors coded for this study and behaviors coded in the ongoing research of the FIRST WORDS® Project for other studies of the same children (e.g., Shumway, 2006).

Categories of vocalizations. All vocalizations produced by the child were coded, including NTVs, such as grunts, squeals, and raspberries. Detailed coding definitions are provided in Appendix A. Vocalizations were coded during all activities with the exception of comprehension and constructive play to match the previously completed coding of communicative acts. The initial coding of vocalizations as TVs or NTVs was completed for a prior investigation using children from the same cohort (Plumb et al., 2007). All vocalizations observed during the videotaped behavior samples were coded for that investigation to determine their frequency of use by type. Once identified as a vocalization, a coder identified and coded the type of vocalization, using the following 3 categories:

1) TV - A transcribable vocalization is a syllabic vocalization that contains at least a vowel and may also contain a consonant

2) NTV - A nontranscribable vocalization is a vocalization that does not contain a recognizable consonant or vowel or contains a vowel with atypical phonation, such as laughing, crying, squealing, tongue clicks, or raspberries

3) Could not be Determined - A vocalization in which it is not clear whether it is a TV or NTV (e.g., there is not a clear auditory signal)

Transcribable vocalizations. For the current investigation, precision was increased by coding TVs according to the presence or absence of consonants. The following codes were used to modify each transcribable vocalization to target phonetic complexity:

1. Level I – a vocalization containing a vowel (e.g., /i/), a single syllabic consonant (e.g., a prolonged /s/), a CV containing /h/, /w/, /j/, or a glottal

2. Level II – a vocalization containing a true, well-formed single consonant or identical consonants

3. Level III – a vocalization containing two or more different consonants, not including consonant clusters or vocalizations containing consonants differing solely in voicing

4. Level IV – a vocalization containing a well-formed consonant cluster

TVs were also coded for this investigation to assess whether or not they are single syllables or multisyllables. Each TV was coded to reflect this assessment.

Nontranscribable vocalizations. NTVs were coded based on the following specific categories:

1. Laugh – an audible, vocal expulsion of air from the lungs that can range from a loud burst of sound (e.g., /ha/) to a series of quiet chuckles and is usually associated with pleasure

2. Distress sound – a vocalization associated with a negative emotional state including a *cry/whine* (high pitched, plaintive vocalization) or a *scream* (loud, long, intense cry)

3. Atypical vocal quality – a vocalization that demonstrates atypical phonation, including a *yell* (loud, non distress vocalizations), a *grunt* (short vocalization produced with low pitch and increased force), a *squeal* (vocalization that at some point enter into maximally high pitch or falsetto), and a *growl* (low-pitch, often creaky-voice vocalization (Sheinkopf, Mundy, Oller & Steffens, 2000)

4. Non-English – a vocalization that is not considered consonantal in English and does not contain a vowel sound, including a *lip smack* (bilabial click; a short noise made by compressing and opening the lip), a *tongue click* (a quick, sucking sound made by the tongue pressing against and releasing from the roof of the mouth), a *raspberry* (bilabial trill produced by lips vibrating repeatedly against one another and often produced as playful vocalizations), an *alveolar trill* (the rapid vibration of the tongue against the alveolar ridge, and a *uvular trill* (the uvula against the back of the tongue)

5. Single consonant – a consonant produced with no accompanying vowel, such as a sustained /s/ or an /m/ produced in isolation; may or may not be prolonged

6. Other – an vocalization which is not captured in the previous NTV categories

Communicative acts. Communicative acts were previously coded for a prior investigation of the FIRST WORDS® Project (Shumway, 2006) with detailed coding definitions available in that study. The coding of onset and offset of each communicative act allowed for vocalizations to be coded and analyzed within and outside of communicative acts. Once a communicative act was identified, the function or purpose of the act was coded using the following three major categories (Bruner, 1981; Wetherby & Prizant, 2002):

1. Behavior regulation (BR): acts used to regulate the behavior of another to obtain a specific result, such as requesting or protesting;

2. Social interaction (SI): acts used to attract or maintain another's attention to oneself, such as requesting comfort, greeting, or showing off; and

3. Joint attention (JA): acts used to direct another's attention to an object, event, or topic, such as commenting on an object/action or requesting information.

Interrater Reliability

Interrater reliability was calculated using Cohen's kappa coefficients and percent agreement. Cohen's kappa has values ranging from 0 to 1, with values between .40 and .60 indicating fair agreement, .60 to .75 indicating good agreement, and values over .75 indicating excellent agreement (Fleiss, 1981). Prior to coding data for this study, coders were trained to the criterion level of at least .60, calculated using kappa coefficients and to percent agreement of .80 or above. After the training period samples were randomly selected from all three groups of participants in this study to assess reliability. The reliability samples were coded in an ongoing manner throughout the data coding to detect coder drift and inaccuracies so that ongoing training could be carried out as it was needed.

Transcribable and nontranscribable vocalizations. Interrater reliability for the coding vocalizations as TVs or NTVs was calculated based on the coding of a prior investigation of the FIRST WORDS® Project using children from the same cohort (Plumb et al., 2007). All vocalizations were precisely coded as TVs or NTVs using the definitions provided in this investigation. Thirty-nine videos were randomly selected

(31.2% of the sample) and coded for vocalization reliability. The kappa coefficient for total vocalizations across all groups (ASD, DD, and TD) was .81, with percent agreement of 89.6%., indicating strong agreement. The kappa value range for the ASD, DD, and TD groups individually was between .64 and .84, with percent agreements for groups individually of at least 85.5%. Percent agreement was also calculated for the categories of vocalizations individually (TV, NTV). TV percent agreement ranged between 87.8% and 91.2%. Interrater reliability for NTVs was slightly lower, with a range from 72.8% and 85.5% agreement across groups.

Transcribable vocalization categories. For the current investigation, the confusion matrix included agreement on both level of phonetic complexity and whether the TV was a single syllable or a multisyllable. As shown in Table 3 the pooled kappas indicate excellent agreement for the combined TV categories. Strong agreement is indicated overall and across the three diagnostic groups individually. Percent agreement values were also determined using the confusion matrix. For the groups combined, all percent agreement scores indicate excellent agreement. When examined across groups, however, some behaviors appeared to have lower percent agreement due to a much lower rate of occurrence of these behaviors, in particular level II, single syllable for the TD group and level III, multisyllable for the ASD group. In addition, it should be noted that level III, single syllable vocalizations were not demonstrated by the group of randomly selected ASD children and could therefore not be measured. In addition, level IV, single syllable or multisyllable vocalizations were not produced by any of the groups of randomly selected participants. Interrater reliability could therefore not be measured for these behaviors.

Nontranscribable vocalization categories. Table 3 also illustrates the interrater reliability measures for the NTV categories that were coded for the current investigation. Kappa coefficients and percent agreement for the NTV categories combined indicate excellent agreement both within and across groups. Percent agreement results for the individual NTV categories were similar to those of the TV categories. A majority of the percent agreement scores indicate excellent agreement, however low occurrence of some of the behaviors within the individual groups resulted in somewhat lower percent agreement. The percent agreement scores negatively impacted in one or all diagnostic groups were non-English, atypical, and other NTVs.

Table 3

Reliability Kappas and Percent Agreement

Reliability Kappa's and Percent Agreement

	Kappa				% Agreement			
Measure	All (n = 32	ASD (n=14)	DD (n=9)	TD (n=9)	All (n=32	ASD (n=14)	DD (n=9)	TD (n=9)
Transcribable Vocalizations								
TV Modifiers Combined	0.86	0.88	0.87	0.83	0.90	0.91	0.85	0.86
Level I; Single Syllable					0.86	0.90	0.96	0.80
Level I; Multisyllable					0.83	0.80	0.90	0.82
Level II; Single Syllable					0.80	0.78	0.80	0.92
Level II Multisyllable					0.85	0.88	0.84	0.85
Level III; Single Syllable					0.86		1.00	0.67
Level III; Multisyllable					0.80	0.73	0.50	0.69
Level IV; Single Syllable								
Level IV; Multisyllable								
Nontranscribable Vocalizations								
NTV Modifiers Combined	0.94	0.91	0.84	1.00	0.95	0.94	0.85	1.00
Laugh					0.93	0.93	0.80	1.00
Distress					0.88	0.91		
Non-English					0.75	0.67	1.00	
Atypical					0.93	0.90		0.50
Consonant					0.94	0.89	0.83	0.96
Other					0.91	0.88	0.75	

Communicative acts. Interrater reliability for communicative acts was previously calculated for a prior investigation of the FIRST WORDS® Project (Shumway, 2006). Thirty random selected videos (24% of the current sample) were coded for communicative acts reliability. The kappa coefficient for total communicative acts was .78, with ASD, TD and DD values ranging between .78 and .81. Percent agreement for total acts was 88.7%, with all groups individually ranging from 88.08 to 90.21%, indicating excellent agreement. Percent agreement was also calculated by function. BR ranged between 81.40% and 91.4% for groups individually. SI had slightly lower percent agreement and ranged between 71.43% and 81.58%, however it should be noted that this function had the lowest occurrence rate and was therefore more difficult to achieve stronger percent agreement scores. Percent agreement on acts for JA was strong and the individual groups ranged from 83.61% and 91.18%.

RESULTS

Vocalization Measures Derived from the Noldus Pro Observer

Two measures were derived for analysis in this investigation, frequency and proportion. Vocalizations were coded throughout all activities of the Behavior Sample with the exception of the comprehension probes and constructive play (i.e., stacking blocks). The mean length of the sample, excluding comprehension and constructive play was 18 minutes and 10 seconds (SD = 4:52) for the ASD group, 17 minutes and 56 seconds (SD = 2:50) for the DD group, and 19 minutes and 22 seconds for the TD group (SD = 3:47), which was not significantly different across groups, $F = 1.02$, $p = .36$.

In addition to examining total vocalizations the categories of TVs, NTVs, and CBDs were examined. Because group differences in vocalizations have been shown in past research, it was determined that proportions would also be investigated to insure that any differences in TVs or NTVs would not simply be the result of a group using fewer vocalizations, and therefore having less opportunity to demonstrate these modifiers. Proportion of TVs and NTVs were computed by dividing the behavior of interest (i.e., TVs, NTVs) by total vocals.

Specific categories of both TVs and NTVs were also coded. It was decided that proportions would be calculated to insure that any differences in phonetic complexity, number of syllables, or NTV categories would not simply be the result of a group using fewer vocalizations therefore having less opportunity to demonstrate any one category. TVs were coded to address level of phonetic complexity and the number of syllables. Each TV was therefore coded for level and number of syllables (e.g., level I, single syllable). The proportion measures for the TV codes were computed using the frequency of the behavior of interest (e.g., level I) out of total TVs. NTVs were coded for each specific category and both frequencies and proportion measures were determined. The proportion of categories out of total NTVs were also calculated to address the frequency differences by dividing the total number in each category (i.e., atypical) by the total number of NTVs.

To investigate communicative vocalizations, frequency measures of total vocals in acts and TVs and NTVs in all acts, as well as individually within the functions of BR, SI, and JA were examined. Proportion measures were derived in order to address the possibility that any difference in communicative vocalizations may reflect a difference in frequency, but not necessarily those used communicatively. These proportion measures were computed by dividing the frequency of the relevant behavior used within acts by the total number of this behavior (e.g., total vocals in communicative acts divided by the total number of vocals used). These proportion measures could be calculated for all participants ($N = 125$) because all children in the study communicated using both TVs and NTVs. An additional measure included in the current investigation was to determine the proportion of TVs and NTVs used in acts by function. This measure was calculated by dividing the frequency of vocal by type (e.g., TV) used in a particular communicative function (i.e., BR) by the frequency of the same vocal used in all acts.

It should be noted that these proportion measures could not be calculated for children who had no TVs or NTVs coded within communicative acts. Therefore the number of children in each group that communicated with TVs and NTVs within acts varied. For TVs, 45 children with ASD (90%), 23 children with DD (92%) and 50 children with TD (100%) were found to use TVs in communicative acts. For NTVs, 36 children with ASD (72%), 21 children with DD (84%), and 38 children with TD (76%) were found to use NTVs in communicative acts. Therefore, because some children did not use TVs and/or NTVs within communicative acts, the sample size was smaller for the analysis examining group differences in proportion of TVs and NTVs in acts for BR, SI, and JA out of TVs and NTVs in total acts.

Preliminary Data Analyses

Vocalizations. The distribution of the data was examined for the three groups for all variables to identify possible outliers and to assess skewness and kurtosis. Examination of the data indicated that all measures had one or more univariate outlier in at least one group. For all of the behaviors these outliers were above the mean. All outliers were examined to determine whether they genuinely represented the distribution and were found to be accurate data points and reflect the great amount of heterogeneity in early communication skills. All outliers were therefore considered valid and not excluded or changed.

In order to adequately examine the distributional characteristics of the data, the data were examined for skewness and kurtosis using histograms and box plots for each variable (Maxwell & Delaney, 2003). The distributions of most variables appeared reasonably normally distributed for all groups. However, given the potential impact of the distributions on the results of the study, variables with skewness greater than 2 or less than -2 and kurtosis values greater than 3 or approaching 0 are reported below.

For the ASD group, the following frequency measures were found to be positively skewed, with scores clustered at the low values: level III TVs; level IV TVs; non-English NTVs; and other NTVs. These measures, along with single syllable TVs and consonant NTVs appeared platykurtic in the ASD group, with many scores in the tails of the distribution.

For the DD group, the measures found to be positively skewed were: level III TVs; level IV TVs; distress NTVs; non-English NTVs; atypical NTVs; consonant NTVs; and other NTVs. These scores indicate scores clustering at the low values of the distribution. In addition these measures were somewhat leptokurtic with fewer scores in the tails of the distribution. In addition, the nonskewed measures for the ASD group which were also leptokurtically distributed were total vocals, total TVs, level II TVs, and multisyllable TVs.

The measures of the DD group found to be positively skewed and leptokurtically distributed were: level IV TVs, distress NTVs, non-English NTVs, atypical NTVs, and other NTVs. In addition, total vocals, TVs, and level II TVs were nonskewed, however, were slightly platykurtic, indicating a higher number of scores in the tails of the distribution.

For the TD group, level IV TVs, distress NTVs, non-English NTVs, atypical NTVs and other NTVs were found to be positively skewed, with scores clustered at the higher end of the distribution. The TD group also showed leptokurtic distribution for these variables, in addition to total vocals, TVs, level I TVs, single syllable TVs, NTVs, and laugh NTVs.

Communicative acts. The distribution of the communicative acts data used in this investigation was examined by Shumway (2006) to identify outliers and to assess skewness and kurtosis. Based on this examination of the data for measures of acts by function, all three groups contained at least one univariate outlier, with a majority of these outliers occurring above the mean. Further investigation of these outliers revealed their legitimacy as accurate data points because of the heterogeneity of the sample. Histograms and boxplots were also examined for skewness and kurtosis for each variable.

Results of this examination indicated that the distributions of most variables were reasonably normally distributed for most groups. Further information on the assessment of normality in is available in that study.

Determination of analysis procedures. Although skewness and kurtosis values for some measures in each group indicated varying degrees of nonnormality, analysis of variance (ANOVA) was judged to be an acceptable statistical test based on a review of the literature indicating ANOVA's robustness to the assumption of nonnormality (Maxwell & Delaney, 2003). A similar investigation of the literature was used to support the acceptability of Pearson's product-moment correlation coefficient for the current investigation. Pearson's findings (1929; 1931) indicated conclusively that the frequency distribution of r was largely unaffected by non-normal distributions. Based on this information it was determined that both of these parametric procedures would be appropriate statistical tests for the analysis of the current data. In addition, based on the normality of Shumway's data drawn from the same participant pool (2006), multiple regression was judged to be an appropriate statistical analysis to assess the predictive ability of communicative vocalizations over noncommunicative vocalizations in the second year for children with ASD.

Rate of Vocalizations in Structured and Unstructured Contexts

Paired samples t-tests were used to compare the production of vocalizations across structured and unstructured contexts. Rate of vocalizations per minute was used as a measurement of comparison because the mean lengths of the structured (M = 14:30, SD = 3:30) and unstructured activities (M = 4.20, SD = 1:20) were significantly different ($t(124) = 34.67$, $p < .001$). The mean scores for the rate of total vocalizations per minute are presented in Table 4. Based on these results, the ASD, DD, and TD groups each demonstrated a significantly higher rate per minute of vocalizations in the structured context when compared to the unstructured context. The structured and unstructured contexts were combined for all other analyses, since this pattern was similar across groups.

Group Differences in Vocalizations

A series of one-way ANOVA were used to examine group differences of frequency of total vocalizations in addition to frequency and proportion of TVs and NTVs. Group differences were also examined for the associated codes of phonetic complexity and number of syllables for TVs. Group differences in all NTV categories were also examined using ANOVA. Levene's test for homogeneity of variance was used

Table 4
Rate of Vocalization in Structured Compared to Unstructured Contexts

	Structured		Unstructured		Mean differences		
	M	*SD*	*M*	*SD*	*t*	*p* value	Effect size[d]
Total Vocalizations							
ASD	2.95	2.07	2.18	2.01	2.805*	.01	0.39
DD	4.24	2.69	2.09	2.02	6.905***	.00	0.90
TD	5.57	2.09	3.26	1.88	10.698***	.00	1.16

Note. Effect size based on Cohen's $d \geq .20$ is small, .50 is medium, and .80 is large
*p <.05 **p <.01 ***p <.001

to test for lack of homogeneity of variance due to unequal sample sizes and the Welch correction was used in cases where Levene's test was significant. In addition the Linear Step-Up method (Benjamini & Hochberg, 1995) was utilized to control for Type I error rate. Significant effects were followed-up with pair-wise comparisons to evaluate differences in the three groups using the Dunnett T3. Cohen's *d* was used as a measure of effect size. Positive or negative values of .2, .5, and .8 are interpreted as small, medium, and large effect sizes (Cohen, 1988), respectively.

Total vocalizations. The mean scores for the frequency of total vocalizations are presented in Table 5 and illustrated in Figure 1. A significant group difference was found for this measure. The ASD group used significantly fewer total vocalizations (M = 46.92, SD = 28.96) than participants in the TD group (M = 94.94, SD = 41.34), with a large effect size observed. Although a significant difference was not observed with the DD group (M = 66.60, SD = 44.60), a medium effect size was detected for this measure.

Transcribable vocalizations. The mean scores for the frequency measures for TVs can be found in Table 5 and Figure 1. Related proportion measures can be found in Table 6 and are shown in Figures 2, 3, and 4. The ASD group used as significantly lower frequency and proportion of TVs than the TD group, with a large effect size observed (frequency, p = .00, d = -1.34; proportion, p = .00, d = -0.95). In comparison to the DD group, the ASD group did not demonstrate a significant difference in the frequency or

Table 5

Group Differences in Frequency Measures of Vocalizations

	ASD (n=50)		DD (n=25)		TD (n=50)			DD-ASD		TD-ASD	
	M	SD	M	SD	M	SD	F value	p value	Effect size[d]	p value	Effect size[d]
Total Vocalizations	46.92_a	28.96	66.60_a	44.60	94.94_b	41.34	20.51***	.15	-0.52	.00	-1.35
Total TV	33.38_a	28.98	55.04_a	41.75	81.50_b	41.09	21.35***	.07	-0.59	.00	-1.34
Level I	15.92_a	13.81	30.72_b	23.66	30.60_b	20.20	9.27***	.02	-0.76	.00	-0.84
Level II	13.76_a	16.38	20.48_a	18.57	38.66_b	22.27	21.56***	.34	-0.38	.00	-1.27
Level III	3.58_a	8.36	3.80_a	6.08	11.96_b	12.41	10.65***	.00	-0.03	.00	-0.79
Level IV	0.48_a	0.07	0.20_a	0.04	0.76_a	0.11	1.74	.67	0.22	.51	-0.25
Single Syllable	14.62_a	14.69	28.48_{ab}	25.53	37.04_b	21.58	15.81***	.05	-0.67	.00	-1.22
Multi Syllable	18.76_a	17.86	26.56_a	22.66	44.50_b	26.55	16.62***	.36	-0.41	.00	-1.14
Total NTV	13.54_a	10.72	11.56_a	8.44	13.44_a	11.66	0.33	.77	0.21	.00	0.01
Laugh	3.22_a	4.47	4.48_a	4.81	4.76_a	5.22	1.36	.62	-0.27	.31	-0.32
Distress	2.72_a	3.76	0.96_b	1.93	1.60_a	4.10	2.29	.03	0.59	.40	0.29
Non-english	0.24_a	0.77	0.44_a	0.69	0.64_a	1.27	2.10	.62	-0.27	.15	-0.39
Atypical	2.24_a	3.35	1.32_{ab}	1.82	0.76_b	1.52	4.55*	.34	0.34	.02	0.56
Consonant	4.84_a	6.57	4.36_a	5.13	5.68_a	6.26	0.44	.98	0.08	.88	-0.13
Other	0.28_a	0.23	0.45_a	0.00	0.08_a	0.48	1.40	.26	0.34	.57	0.23
CBD	2.02_a	5.32	0.60_a	1.26	0.66_a	1.21	2.33	0.22	0.37	0.23	0.35

Note: Means in the same row with different subscripts differ significantly at $p<.05$ on the post-hoc Dunnet *T3* corrected comparison.
F-values are Welch corrected when necessary for violation of homogeneity of variance as assessed by Levene's test.
[d] Effect size based on Cohen's $d \geq .20$ is small, .50 is medium, and .80 is large
$*p<.05$ $**p<.01$ $***p<.001$

Table 6

Group Differences in Proportion Measures of Vocalizations

	ASD (n=50)		DD (n=25)		TD (n=50)			Pairwise group differences: DD-ASD		Pairwise group differences: TD-ASD	
	M	SD	M	SD	M	SD	F value	p value	Effect size[d]	p value	Effect size[d]
Proportion of Vocal Type out of Total Vocals											
TV	0.64_a	0.25	0.75_{ab}	0.19	0.85_b	0.15	11.72***	.08	-0.52	.00	0.95
NTV	0.36_a	0.25	0.24_{ab}	0.19	0.15_b	0.15	11.72***	.08	0.52	.00	0.94
Proportion of TV Categories out of Total TV											
Level I	0.51_{ab}	0.29	0.63_a	0.24	0.41_b	0.23	6.07**	.22	-0.426	.15	0.39
Level II	0.41_{ab}	0.26	0.32_a	0.21	0.46_b	0.16	3.28.*	.31	0.37	.63	-0.22
Level III	0.07_{ab}	0.12	0.05_a	0.08	0.13_b	0.12	4.90**	.67	0.37	.08	-0.54
Level IV	0.00_a	0.01	0.00_a	0.00	0.00_a	0.01	0.73	.50	-0.52	.93	-0.05
Single Syllable	0.44_a	0.23	0.56_a	0.23	0.46_a	0.16	3.57	.08	-0.56	.95	-0.10
Multi Syllable	0.56_a	0.23	0.44_a	0.23	0.54_a	0.16	2.31	.08	0.46	.95	0.08
Proportion of NTV Categories out of Total NTV											
Laugh	0.24_a	0.29	0.38_a	0.32	0.36_a	0.31	2.86	.18	-0.47	.11	-0.42
Distress	0.21_a	0.25	0.06_b	0.11	0.08_b	0.17	6.51**	.00	0.77	.02	0.61
Non-english	0.03_a	0.09	0.05_a	0.11	0.06_a	0.16	0.99	.74	-0.20	.47	-0.23
Atypical	0.15_a	0.20	0.09_{ab}	0.11	0.05_b	0.10	4.34*	.31	0.35	.01	0.55
Consonant	0.36_a	0.31	0.41_a	0.37	0.43_a	0.33	0.62	.89	-0.14	.63	0.22
Other	0.02_a	0.07	0.00a	0.00	0.01_a	0.04	1.54	.10	0.40	.65	0.17

Note: Means in the same row with different subscripts differ significantly at p<.05 on the post-hoc Dunnet *T3* corrected comparison.
F-values are Welch corrected when necessary for violation of homogeneity of variance as assessed by Levene's test.
[d] Effect size based on Cohen's $d \geq .20$ is small, .50 is medium, and .80 is large

*p<.05 **p<.01 ***p<.001

proportion of TVs used, however a medium effect size was observed (d = -0.52) for the proportion of TVs used out of total vocalizations used. This indicates that when vocalizing a smaller proportion of these vocalizations were TVs as compared to the DD group with a marginal trend (p = .08).

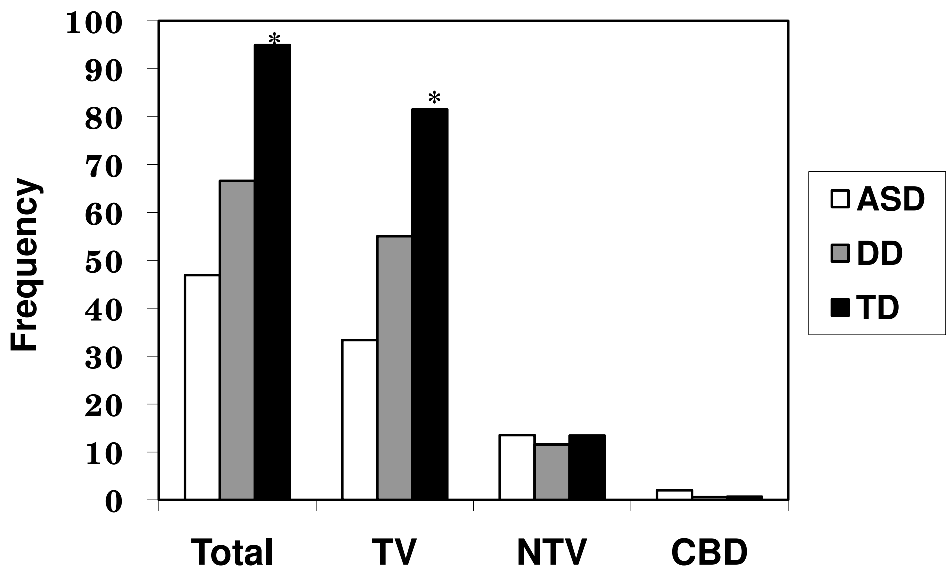

Figure 1. Frequency of vocalizations by type
** Significantly different than the ASD group*

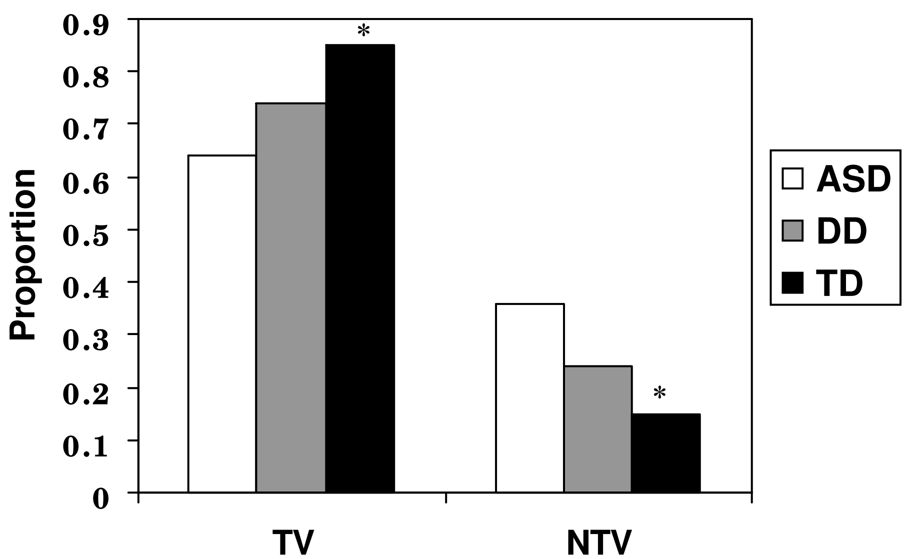

Figure 2. Proportion of TVs and NTVs out of total vocalizations
** Significantly different than the ASD group*

The ASD group used significantly fewer level I TVs than both the TD *(p = .00, d = -0.84)* and the DD group (p = .02, d = -0.76), however no significant differences were demonstrated between the ASD group and either group for the proportion of level I TVs. Significant differences were found between the ASD group and the TD group for the frequency of level II (p = .00, d = -1.27) and III TVs (p = .00, d = -0.79), but no significant differences were found with the DD group for these measures. All three groups were similar on the proportion of level II and level III TVs. No group differences were observed in either the frequency or proportion of level IV TVs. As shown in Figure 3, these results indicate that when using TVs the ASD group is as likely to use all levels of phonetic complexity as both the TD and the DD groups.

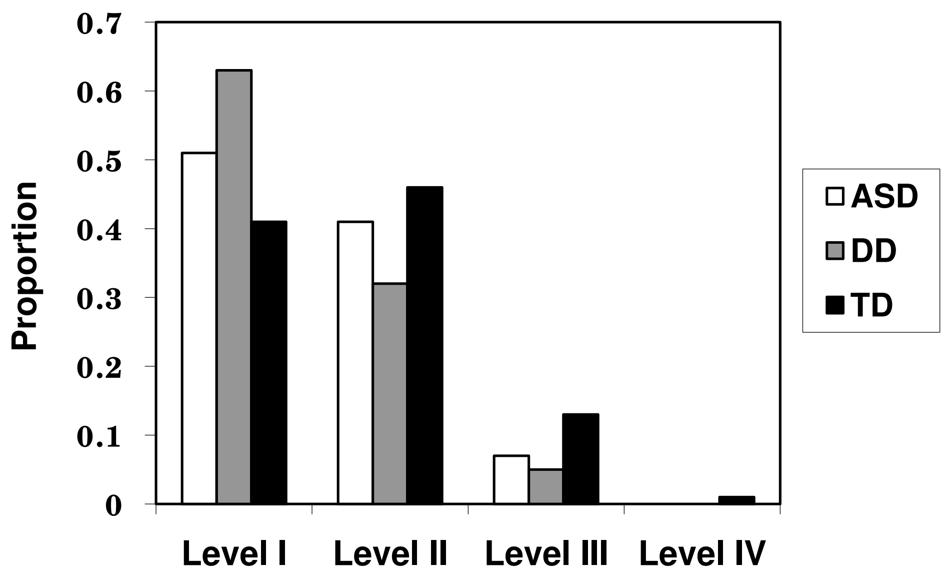

Figure 3. Proportion of TV levels out of total TVs
* *Significantly different than the ASD group*

The ASD group used significantly fewer single syllable (p = .00, d = -1.22) and multisyllable TVs (p = .00, d = -1.14) than the TD group, with large effect sizes detected for both measures. Although significant differences in the frequency were not detected on this measure between the ASD and DD groups, a medium effect size of marginal significance was observed for single syllables (p = *.05,* d = -0.67), indicating a trend children with ASD to a use smaller number of single syllable vocalizations. Although a significant difference in the proportion of single syllable TVs was not found between the ASD and TD groups, a difference of marginal significance with a medium effect size (p =

.08, *d* = -0.56) was found between the ASD and DD groups. All three groups demonstrated similar proportions of multisyllable TVs, with no group differences detected. As shown in Figure 4 when vocalizing with TVs children with ASD are as likely to use multisyllable vocalizations as both the TD and DD groups.

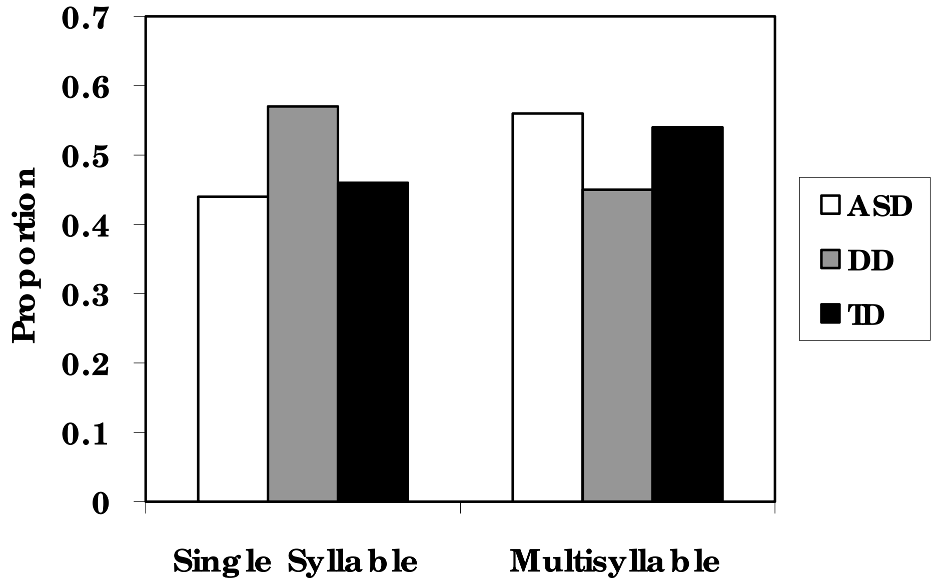

Figure 4. Proportion of single syllable and multisyllable TVs out of total TVs
** Significantly different than the ASD group*

Nontranscribable vocalizations. The mean scores for the frequency measures for TVs can be found in Table 5 and Figure 1. Related proportion measures can be found in Table 6 and are shown in Figures 2 and 5. No group differences were noted in the frequency of NTV use between groups, however the ASD group used a significantly larger proportion of NTVs than the TD group as demonstrated in Figure 2. The ASD group also used a higher proportion of NTVs then the DD group. Although nonsignificant, a medium effect size was observed for this difference. All three groups demonstrated comparable frequencies and proportions of laugh, non-English, consonant, and other NTVs. The ASD group demonstrated a significantly higher frequency of distress NTVs than the DD group (p = .03, d = 0.59), but a similar frequency of distress NTVs to the TD group. For the proportion of distress NTVs, however, Figure 5 shows that the ASD group demonstrated a significantly higher proportion of distress NTVs than both the TD (p = .02, d = 0.61) and the DD groups (p = .00, d = 0.77). The ASD group demonstrated significantly higher frequency (p = .02, d = 0.56) and proportion (p = .02, *d* = 0.55) of atypical NTVs than the TD group, however nonsignificant differences were found between the ASD and DD groups on this measure.

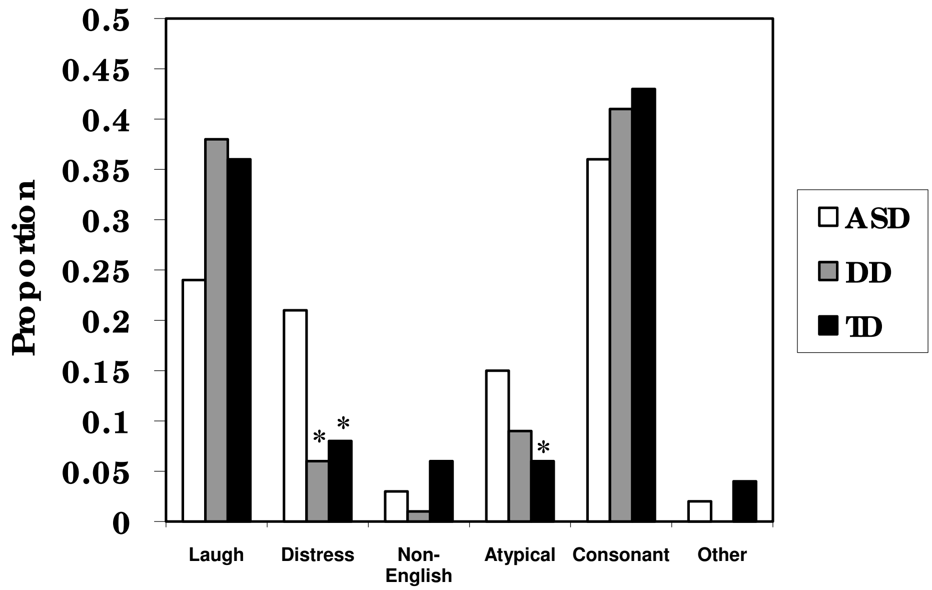

Figure 5. Proportions of NTV categories by group.
** Significantly different than the ASD group*

A series of Mann-Whitney U Tests were also conducted to assess whether children in each diagnostic category from bilingual homes in which they were exposed to languages other than English were more likely to use non-English NTVs than children monolingual homes. No significant differences were found between children from bilingual and monolingual homes for the ASD (z = -1.33, p = .42), DD (z = 0.97, p = .44), or TD groups (z = .57, p = .63). Based on these results participation of children from bilingual homes does appear to inflate the frequency measures of non-English NTVs for any of the diagnostic groups.

Group Differences in Communicative Vocalizations

A series of one-way ANOVA were used to examine group differences of frequency and proportion of total vocalizations, TVs, and NTVs in communicative acts and by each function. As with vocalizations, Levene's test was used to test for lack of homogeneity of variance and a Welch correction was used in cases where Levene's test was significant. The Linear-Step Up method was then used to control for Type I error. Significant group differences were then followed up with pair-wise comparisons using the Dunnett T3 to evaluate differences among the three groups.

Total vocalizations in communicative acts. The mean scores for the frequency measures of communicative vocalizations are provided in Table 7 and the mean scores for the proportion measures are provided in Table 8 and are shown in Figure 6. The ASD group used a significantly lower proportion of total vocalizations in communicative acts than the TD group (p = .00, d = -0.70). No significant differences were observed between the ASD and the DD group on either the frequency of total vocals in acts or the proportion of total vocals in acts out of total vocals produced.

Transcribable vocalizations in communicative acts. The mean scores for the frequency measures of communicative TVs are provided in Table 7 and the mean scores for the proportion measures are provided in Table 8 and are shown in Figure 7. The ASD group used a significantly lower frequency of TVs in total acts than the TD group (p = .00, d = -1.28) in addition to a lower proportion of TVs used in acts out of total TVs (p = .00, d = -0.51). No significant differences were noted on these measures with the DD group, however a medium effect size was observed for the frequency of TVs used in acts (p = .08, d = -0.56), indicating that the ASD group used marginally fewer TVs communicatively than the DD group. The ASD group used significantly fewer TVs in acts for BR (p = .00, d = -1.17) and JA (p = .00, d = -1.07) than the TD group, but a comparable number to the DD group.

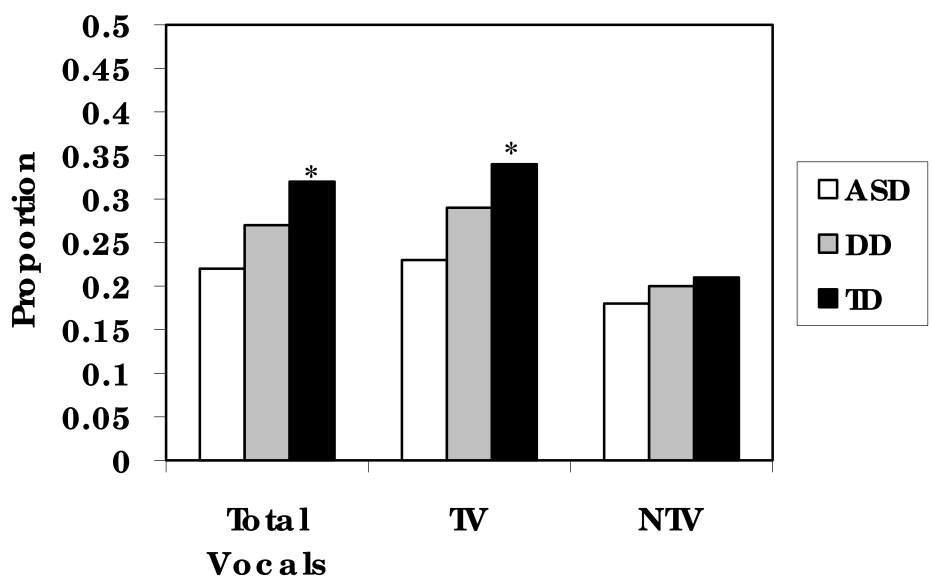

Figure 6. Proportion of communicative vocalizations by group
**Significantly different than ASD group*

Table 7

Group Differences in Frequency Measures of Communicative Vocalizations

	ASD (*n* =50)		DD (*n* =25)		TD (*n* =50)			Pairwise group differences			
								DD-ASD		TD-ASD	
Frequency Measures	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F* value	*p* value	Effect size[d]	*p* value	Effect size[d]
Total Communicative Vocalizations	11.60_a	14.04	18.72_b	14.38	29.04_b	13.45	19.88***	.13	- 0.50	.00	-1.27
Communicative TVs											
TV in total acts	8.86_a	13.70	16.72_a	14.24	26.18_b	13.45	19.98***	.08	-0.56	.00	-1.28
TV in acts for Behavior Regulation	3.28_a	4.52	6.88_{ab}	6.60	10.32_b	7.19	16.43***	.06	-0.63	.00	-1.17
TV in acts for Social Interaction	1.64_a	2.94	1.52_a	2.18	2.60a	2.79	2.01	.99	0.05	.26	-0.33
TV in acts for Joint Attention	3.64_a	8.32	7.88_a	7.38	12.74_b	8.70	14.97***	.08	-0.54	.00	-1.07
Communicative NTVs											
NTV in total acts	2.48_a	3.02	1.92_a	1.47	2.64_a	3.35	0.48	.72	0.20	.98	-0.39
NTV in acts for Behavior Regulation	1.58_a	2.4	0.76_a	1.01	1.54_a	2.23	1.46	.13	0.44	1.00	0.00
NTV in acts for Social Interaction	1.10_a	0.14	0.87_a	0.17	0.60_a	0.09	1.58	.98	-0.08	.40	0.29
NTV in acts for Joint Attention	0.24_a	0.82	0.56_a	0.92	0.82_a	1.82	2.40	.38	-0.35	.12	-0.41
Total Noncommunicative Vocalizations	35.32_a	20.29	47.88_b	33.75	65.90_b	32.96	14.25***	.26	-0.45	.00	-1.12
Noncommunicative TVs	24.52_a	19.46	38.32_b	30.47	55.32_b	32.07	15.89***	.13	-0.54	.00	-1.16
Noncommunicative NTVs	11.06_a	9.32	9.56_a	7.90	10.74_a	9.12	0.24	.85	0.17	1.00	0.03

Note: Means in the same row with different subscripts differ significantly at p <.05 on the post-hoc Dunnet *T3* corrected comparison.
F -values are Welch corrected when necessary for violation of homogeneity of variance as assessed by Levene's test.
[d] Effect size based on Cohen's $d \geq .20$ is small, .50 is medium, and .80 is large

Table 8

Group Differences in Proportion Measures of Communicative Vocalizations

	ASD (*n* =50)		DD (*n* =25)		TD (*n* =50)			Pairwise group differences: DD-ASD		Pairwise group differences: TD-ASD	
	M	*SD*	*M*	*SD*	*M*	*SD*	*F* value	*p* value	Effect size[d]	*p* value	Effect size[d]
Proportion of Total Communicative Vocalizations											
Communicative	0.22_a	0.16	0.27_{ab}	0.13	0.32_b	0.11	6.20**	.50	-0.30	.00	-0.70
Noncommunicative	0.78_a	0.16	0.73_{ab}	0.13	0.68_b	0.11	6.20**	.50	0.30	.00	0.70
Proportion of Transcribable Vocalizations											
Communicative	0.22_a	0.19	0.29_{ab}	0.16	0.34_b	0.13	6.23**	.36	-0.27	.00	-0.51
Noncommunicative	0.78_a	0.19	0.71_{ab}	0.16	0.66_b	0.13	6.23**	.36	0.27	.00	0.51
Proportion of Nontranscribable Vocalizations											
Communicative	0.18_a	0.19	0.20_a	0.15	0.21_a	0.23	0.23	.98	-0.09	.89	-0.13
Noncommunicative	0.82_a	0.19	0.80_a	0.15	0.79_a	0.23	0.23	.98	0.09	.89	0.13
Proportion of TV in acts by Function											
Behavior Regulation	0.38_a	0.34	0.39_a	0.29	0.41_a	0.24	0.10	1.00	-0.05	.96	-0.09
Social Interaction	0.25_a	0.34	0.11_b	0.23	0.10_b	0.10	4.86	.15	0.47	.03	0.58
Joint Attention	0.31_a	0.31	0.46_b	0.29	0.48_b	0.22	5.10**	.13	-0.52	.01	-0.64
Unclear	0.07_a	0.18	0.04_a	0.07	0.02_a	0.04	0.10	.67	0.22	.22	0.38
Proportion of NTV in acts by Function											
Behavior Regulation	0.63_a	0.37	0.36_b	0.40	0.60_b	0.40	3.68*	.04	0.70	.98	0.08
Social Interaction	0.22_a	0.30	0.28_a	0.35	0.14_a	0.30	1.37	.88	-0.19	.63	0.26
Joint Attention	0.09_a	0.22	0.32_a	0.39	0.24_a	0.35	3.95*	.06	-0.73	.08	-0.52
Unclear	0.05_a	0.18	0.05_a	0.15	0.02_a	0.08	0.53	1.00	0.00	.73	0.22

Note: Means in the same row with different subscripts differ significantly at p <.05 on the post-hoc Dunnet *T3* corrected comparison.
F -values are Welch corrected when necessary for violation of homogeneity of variance as assessed by Levene's test.
[d] Effect size based on Cohen's $d \geq .20$ is small, .50 is medium, and .80 is large

group. No significant differences were detected between groups in the number of TVs in acts for SI. When vocalizing in communicative acts all three groups used a comparable proportion of TVs for BR. When using TVs communicatively, the ASD group used a significantly higher proportion of TVs in acts for SI (p = .03, d = 0.58) and a significantly lower proportion of TVs in acts for JA (p = .01, d = -0.64) than the TD group.

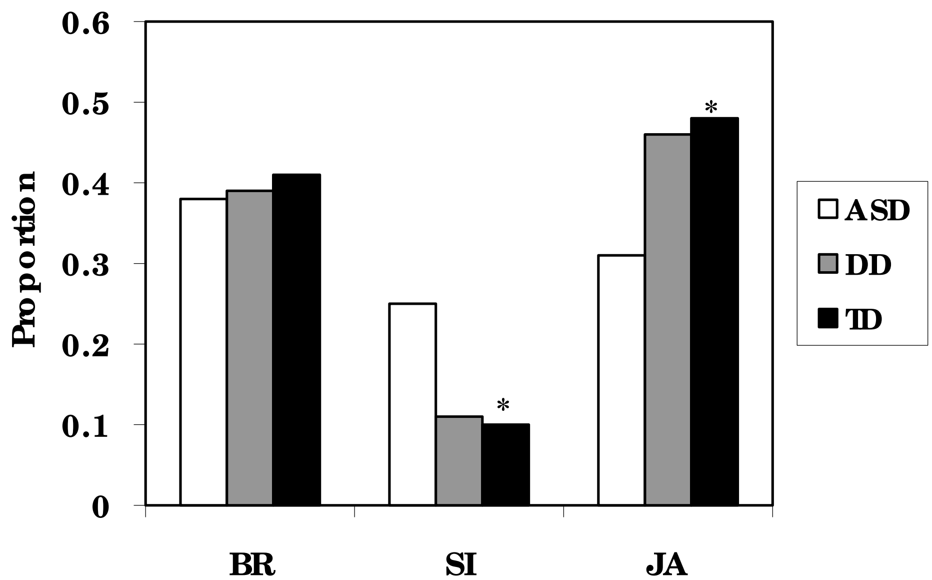

Figure 7. Proportion of communicative TVs in acts for functions of BR, SI, and JA
**Significantly different than the ASD group*

Nontranscribable vocalizations in communicative acts. The mean scores for the frequency measures of communicative NTVs are provided in Table 7 and the mean scores for the proportion measures are provided in Table 8 and are shown in Figure 8. All three groups used a comparable number of NTVs in total acts, and for the functions of BR, SI, and JA. No significant differences were found between groups in the proportion of NTVs used communicatively out of total NTVs. When vocalizing within a communicative act the ASD group used similar proportions of NTVs in acts for SI and JA, but a significantly higher proportion of NTVs in acts for BR than the DD group (p = .04, d = 0.70). No group differences were demonstrated between the ASD and the DD group on the proportion of NTVs used communicatively by function.

Noncommunicative Vocalizations. The frequency measures of noncommunicative vocalizations are presented in Table 7 and the proportion results are found in Table 8 and shown in Figure 8. Children with ASD used significantly lower frequencies of total noncommunicative vocalizations (*p* = .00, *d* = -1.12) and noncommunicative TVs (*p* = .00, *d* = -1.16) than the TD group, however no significant differences were found between the ASD and DD groups. The ASD group also used a significantly lower proportion of total noncommunicative vocals (*p* = .00, *d* = 0.70) and TVs (*p* = .00, *d* = 0.51) than the TD group. No significant differences were found for noncommunicative NTVs for any of the groups.

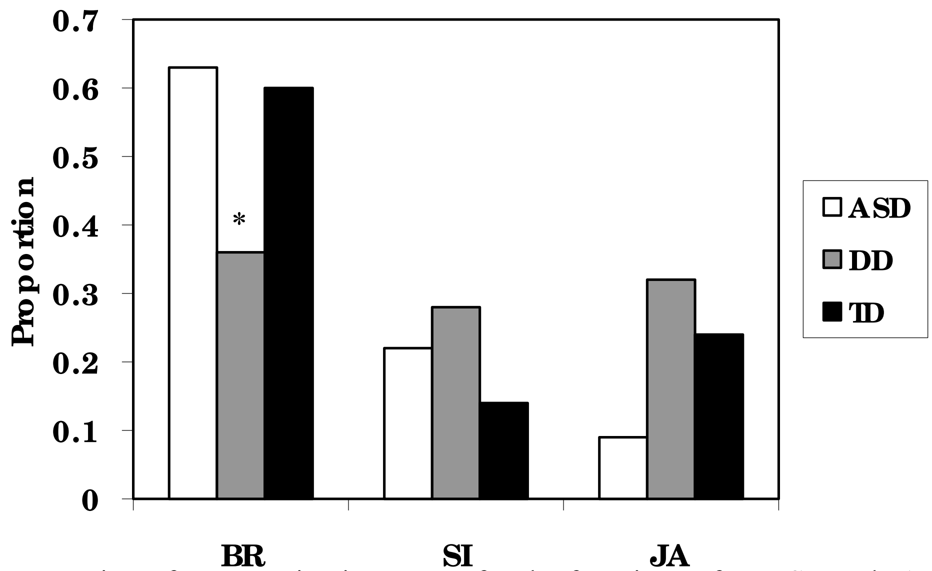

Figure 8. Proportion of communicative NTVs for the functions of BR, SI, and JA
** Significantly different than the ASD group*

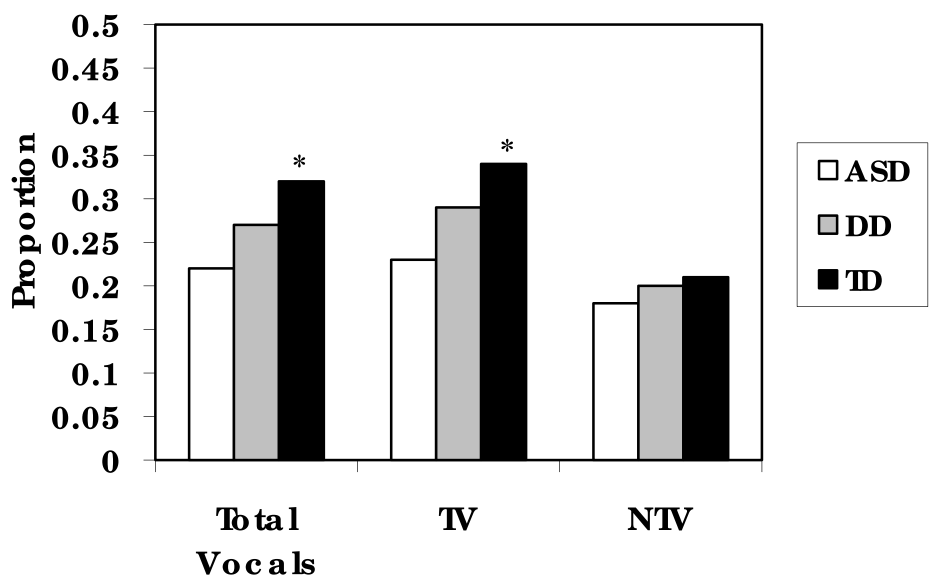

Figure 9. Proportion of noncommunicative vocalizations by group
**Significantly different than ASD group*

Concurrent Relations with CSBS DP Measures in the Second Year

Vocalizations. To examine concurrent relations among vocalizations in the second year and the CSBS DP composites, the CSBS DP composite raw scores were used because raw scores are more comparable to the measures of this study and give better representation of performance than the standard scores. Pearson product-moment correlation coefficients controlling for the effects of age were computed for the ASD group (n = 50) and are presented in Table 9. Moderate to large correlations were observed between the following frequency measures and the social, speech, and symbolic composites of the CSBS DP: total vocalizations, level II and level III TVs, single and multisyllable vocalizations. A moderate significant negative correlation was also found between the frequency of distress NTVs late in the second year and performance on the symbolic composite of the BS. In addition a moderate significant correlation was found between the proportion of TVs out of total vocals and all three CSBS DP composites and a moderate negative correlation was found between the proportion of NTVs out of total vocals and all three CSBS DP composites.

Communicative and noncommunicative vocalizations. Pearson product-moment correlation coefficients controlling for the effects of age were also computed to examine concurrent relations among communicative and noncommunicative vocalizations in the second year and the CSBS DP composites for the ASD group (n = 50). The results are presented in Table 10. When controlling for age, moderate to large correlations were found between the frequency of total vocals in acts and the frequency of TVs in acts across all functions and the speech, social, and symbolic composites of the CSBS DP. In addition, moderate to large significant correlations were found between all three CSBS DP composites and the proportion of communicative vocals out of total vocals and the proportion of communicative TVs out of total TVs.

Moderate to large significant correlations were found between the frequency of noncommunicative TVs and all three CSBS DP composites. Moderate correlations were found between the frequency of total noncommunicative vocalizations and the CSBS DP speech and symbolic composites. The proportion of total noncommunicative vocalizations and noncommunicative TVs were moderately negatively correlated with the CSBS DP social, speech, and symbolic composites. No significant correlations were detected between NTV frequency or proportion measures and any of the CSBS DP composites.

Table 9
Correlations among the Vocalization Measures and Developmental Measures in the Second Year and at Age 3 for children with Autism Spectrum Disorders (*n* = 50)

	CSBS Composites			Mullen Scales	
	Social	Speech	Symbolic	Nonverbal DQ	Verbal DQ
Frequency of Total Vocalizations	0.50***	0.63***	0.54***	0.39**	0.47**
Frequency of Total TV	0.55***	0.71***	0.58***	0.36*	0.46**
Level 1	0.33*	0.14	0.29*	0.17	0.19
Level 2	0.52***	0.74***	0.50***	0.30*	0.44**
Level 3	0.32*	0.76***	0.55***	0.38*	0.45**
Level 4	0.12	0.17	0.14	0.00	0.03
Single Syllable	0.57***	0.50**	0.51**	0.34*	0.41**
Multisyllable	0.42**	0.74***	0.52**	0.30*	0.42**
Frequency of Total NTV	-0.14	-0.20	-0.13	0.10	0.01
Laugh	0.00	- 0.11	-0.17	0.10	0.15
Distress	- 0.25	-0.19	-0.32*	-0.04	-0.10
Non-English	-0.06	0.19	0.01	0.09	0.08
Atypical	-0.07	-0.11	-0.11	0.02	0.00
Consonant	-0.02	-0.08	0.16	0.15	0.00
Other	-0.12	-0.07	-0.13	-0.29	-0.19
Proportion of TV out of Vocals	0.46**	0.47**	0.42*	0.25	0.32*
Proportion of NTV out of Vocals	-0.46*	-0.47*	-0.42*	-0.25	-0.32*

Note : Nonverbal and Verbal Developmental Quotients (DQ) are based on age equivalent divided by chronological age multiplied by 100 on the Mullen Scales of Early Learning.
*p <.05; **p <.01, ***p <.001

Predictive Relations with Developmental Outcome at Age 3

Vocalizations. To examine predictive relations between vocalizations in the second year and developmental outcome at age 3, bivariate correlations between the vocalization measures gathered in the current investigation and NVDQ and VDQ from the MSEL. Pearson product-moment correlation coefficients controlling for the effects of age are presented in the right column on Table 9. Moderate correlations were found with both the NVDQ and VDQ at 3 years and the frequency of total vocalizations, total TVs, levels II and III TVs, and single and multisyllable TVs. No significant correlations were found between any of the NTV frequency measures, however a significant negative correlation was found between the proportion of NTVs demonstrated in the second year and the VDQ at age 3.

Communicative and noncommunicative vocalizations. Pearson product-moment correlation coefficients controlling for the effects of age were also computed for predictive relationships between communicative and noncommunicative vocalizations in the second year and nonverbal and verbal development in the third year for the ASD group (n = 50). The results are presented in Table 10. Significant moderate correlations were found between both the NVDQ and VDQ and the frequencies of total vocals in acts, TVs in acts, and TVs in acts for BR and JA. In addition, TVs in acts for SI were moderately correlated with the VDQ. Significant moderate correlations were also found between both NVDQ and the proportion of total vocals and TVs used communicatively. A significant correlation approaching the benchmark to be considered medium in size (r = 0.29) was found between the proportion of TVs used communicatively and the VDQ. No significant correlations were detected for the measures of communicative NTVs.
A significant moderate correlation was found between the frequency of total noncommunicative vocalizations and noncommunicative TVs and the VDQ. A moderate significant negative correlation was found between NVDQ and the proportions of total noncommunicative and noncommunicative TVs. A significant negative correlation approaching the criterion of a medium relationship was found between the VDQ and the proportion of noncommunicative TVs.

Table 10

Correlations among the Communicative Vocalization Measures and Developmental Measures in the Second Year and at Age 3 for children with Autism Spectrum Disorders (*n* = 50)

	CSBS Composites			Mullen Scales	
	Social	Speech	Symbolic	Nonverbal DQ	Verbal DQ
Frequency of Total Vocals in Acts	0.67***	0.72***	0.65***	0.46**	0.46**
Frequency of TV in all Acts	0.66***	0.76***	0.64***	0.40**	0.45**
Tv in acts for BR	0.71***	0.61***	0.64***	0.47**	0.43**
TV in acts for SI	0.36*	0.58***	0.37*	0.24	0.31*
TV in acts for JA	0.55***	0.69***	0.57***	0.30*	0.39*
Frequency of NTV in all acts	-0.12	-0.10	0.14	0.30*	0.07
NTV in acts for BR	-0.06	-0.02	0.15	0.22	0.03
NTV in acts for SI	0.06	-0.18	-0.08	0.15	0.08
NTV in acts for JA	0.23	-0.37	0.21	0.31	0.16
Frequency of Noncommunicative Vocals					
Total Vocals	0.26	0.42**	0.32*	0.25	0.36*
TV	0.36*	0.52***	0.42**	0.25	0.37*
NTV	-0.20	-0.20	-0.19	0.02	0.01
Proportion of Communicative Vocals					
Total Vocals	0.58***	0.45**	0.49**	0.39**	0.24
TV	0.56***	0.43***	0.37**	0.34*	0.29*
NTV	0.19	-0.06	0.17	0.22	0.03
Proportion of Noncommunicative Vocals					
Total Vocals	-0.58***	-0.45**	-0.49***	-0.39**	-0.24
TV	-0.56***	-0.43**	-0.37**	-0.34*	-0.29*
NTV	-0.19	-0.06	-0.17	-0.22	-0.03
Proportion of TV in acts by Function					
BR	0.26	0.01	0.29	0.28	0.18
SI	-0.19	-0.12	-0.27	-0.20	-0.20
JA	-0.04	0.14	0.06	-0.03	0.06
Proportion of NTV in acts by Function					
BR	-0.19	0.01	-0.07	- 0.11	-0.17
SI	0.11	-0.12	-0.02	0.11	0.12
JA	0.37	0.30	-0.30	0.24	0.29

Note : Nonverbal and Verbal Developmental Quotients (DQ) are based on age equivalent divided by chronological age multiplied by 100 on the Mullen Scales of Early Learning. *p<.05; **p<.01, ***p<.001

Unique contribution of communicative vocalizations. For the ASD group (n = 50) a series of hierarchical regression analyses were conducted to calculate the collective and unique contributions of noncommunicative and communicative vocalizations to language outcome at age 3, as indicated in Table 11. The regression analyses were calculated for communicative and noncommunicative total vocals, TVs, and NTVs separately. In each regression the subsets of vocalizations were entered into the regression models in the order of their developmental emergence: noncommunicative followed by communicative vocalizations.

For each vocalization type, the contribution of noncommunicative vocalizations was first examined separately. Communicative vocalizations were then added in combination in the final set of regressions. In each regression, the change in R^2 as a result of adding communicative vocalizations was calculated. The total R^2 and unique contributions of communicative vocalizations in the final models containing both communicative and noncommunicative vocalizations were then considered. The effect size f^2 was calculated using the following formula: $f^2 = \Delta R^2/1 - R^2$ for the change in total variance accounted for by the addition of noncommunicative and then communicative vocalizations; $f^2 = sr^2/1 - R^2$ for the individual vocalization types within the set, where sr^2 refers to the squared part (semipartial) correlations; and $f^2 = R^2/1 - R^2$ for the noncommunicative vocalizations which were present in model 1. Cohen's (1988) benchmark figures for interpreting these effect sizes are as follows: small = .02, medium = .15, and large = .35. The results of the regression predicting expressive language outcome from vocalizations measured early in the second year are presented in Table 11. In the first model for total vocalizations, the noncommunicative vocalizations accounted for 19% of expressive language outcome, which is a medium effect size. Communicative vocalizations were then added in the second model which resulted in a significant change in total variance with medium effects (ΔR^2 = .11; f^2 = .16). Communicative total vocalizations contributed significant unique variance to expressive language outcome. Noncommunicative TVs accounted for 20% of the expressive language outcome with medium effects. In the second TV model, communicative TVs then contributed significant unique variance predicting expressive language outcome and this contribution approached the benchmark of a medium effect (ΔR^2 = .09; f^2 = .11). Neither NTV models contributed significant unique variance to expressive language.

Table 11
Hierarchical Regression Results for Communicative Vocalizations

Sample Items	R^2	ΔR^2	β	sr^2	f^2
		Total Vocalizations			
Model 1: Noncommunicative	0.19*				0.24
Noncommunicative			0.34*	0.12*	0.15
Model 2: Noncommunicative + Communicative	0.30*	0.11*			0.16
Noncommunicative			0.18	0.03	0.03
Communicative			0.37*	0.11*	0.16
		Transcribable Vocalizations			
Model 1: Noncommunicative	0.20*				0.25
Noncommunicative			0.36*	0.13*	0.16
Model 2: Noncommunicative + Communicative	0.29*	0.09			0.13
Noncommunicative			0.18	0.03	0.04
Communicative			0.35*	0.08*	0.11
		Nontranscribable Vocalizations			
Model 1: Noncommunicative	0.07				0.08
Noncommunicative			-0.06	0.00	0.00
Model 2: Noncommunicative + Communicative	0.08	0.01			0.01
Noncommunicative			-0.40	0.00	0.00
Communicative			0.08	0.00	0.00

Note. Age was controlled for in all models. Effect size $f^2 = \Delta R^2/1 - R^2$ for R^2 change; $f^2 = sr^2/1 - R^2$ for individual predictors; small $f^2 = .02$, medium $f^2 = .15$, and large $f^2 = .35$ (Cohen, 1988).

DISCUSSION

Impairment in communication is one of the core areas of deficit in ASD. Because the average age of diagnosis is still above age 3, however, little is known about the vocal communication of these children under 3 years of age. Research available on the early vocalizations of children with ASD is limited and what information exists is variable. The purpose of this study was to precisely examine the vocalizations of children with ASD between 18 and 24 months of age from systematic video recorded observations. Group differences were explored by comparing the ASD group to a group of children with DD in which ASD was ruled out matched group-wise on CA and MA and a group of children with TD matched individually on CA and gender. Both frequency and proportion of vocalizations within and outside of communicative acts were investigated. In addition, concurrent and predictive relationships between vocalization and developmental measures were examined for the ASD group.

The current investigation is one of the few studies that has investigated communicative and noncommunicative vocalizations for children with ASD under 24 months of age through systematic observation. Additionally, it is the first of these studies to provide this level of precision and detail in terms of information on phonetic complexity, number of syllables, and NTV categories. The study provides information on the vocalizations in children late in the second year of life by utilizing precise measures and a large sample size within a narrow age range, thereby addressing many of the methodological limitations of previous studies. Direct observation and systematic sampling procedures were used in order to avoid problems associated with analyses of home videotapes and parental report measures. In addition, by identifying the children prospectively it was possible to allow for blind administration, thereby reducing coder bias and increasing internal validity.

Findings from this study provide important information on the vocal communication deficits of children with ASD in the second half of the second year of life and shed light on the similarities and differences in communicative and noncommunicative vocalization use in children with ASD and children with DD and TD. This discussion will highlight findings on communicative and noncommunicative vocalizations in children with ASD between 18 and 24 months, including phonetic complexity, number of syllables, and NTV category. Features of vocalizations that differentiate children with ASD under two years of age from CA matched children with TD and CA and MA matched DD children will be discussed.

Communication Sampling in Structured and Unstructured Contexts

The participants in each diagnostic group vocalized at a significantly higher rate in the structured activities of the CSBS DP. These results support previous research findings that structured activities are an effective procedure to sample communication in young children (Coggins, Olswang, & Guthrie, 1987; Wetherby & Rodriguez, 1992). Although using only unstructured activities may be insufficient to provide information on the entire range of a child's vocalization productions, it is still important to include both contexts in order to gain a complete picture of their abilities in situations with different levels of structure provided by the adult.

Vocalizations Between 18 and 24 Months of Age

The results of this investigation indicated that children with ASD between 18 and 24 months of age used significantly fewer total vocalizations and TVs than children with TD, which extends the findings of previous investigations of the FIRST WORDS® Project (Plumb, Wetherby, Kahn, & Barber, 2007; Wetherby et al., 2007) in addition to providing support to the findings of additional studies in the field for children with ASD under 2 years of age (Wetherby et al., 1988; Werner & Dawson, 2005). Although children with ASD used nonsignificantly fewer total vocalizations and TVs than children with DD for both of these measures, a medium effect size was observed which is of interest. In addition, large variances were observed for both measures as demonstrated in Table 5. Group differences between the ASD and DD may have been masked, therefore, as variance is inversely related to power. In addition, when vocalizing the ASD group was less likely to use syllabic vocalizations containing recognizable consonants and vowels and more likely to use NTVs than the TD group.

In regard to phonetic complexity, when vocalizing the ASD group was as likely to use comparable vocalic syllables and syllables with consonants as the TD and DD groups. The group differences in the frequency measures of these behaviors are therefore most likely reflective of an overall group difference in the frequency of total TVs rather than difficulty with consonant use. Similarly, when vocalizing with TVs, the ASD group was as likely to use both single and multisyllable TVs as the other two groups, indicating that children with ASD do not have a unique difficulty producing single or multisyllabic vocalizations.

The ASD group was more likely to use NTVs and less likely to use TVs than the TD group when vocalizing. In addition, the ASD group used a nonsignificantly higher proportion of NTVs than the DD group with a medium effect size. Similar to the results found in the TV analysis, large variances were observed for this measure as demonstrated in Table 4, which may mask group differences between the ASD and DD groups, suggesting that a higher proportion of NTVs out of total vocalizations could potentially differentiate children with ASD from DD under 24 months of age.

Although no significant differences were found between groups for the NTV categories of laugh, non-English, consonant, or other NTVs, the ASD group did use more distress NTVs than the TD group. When vocalizing with NTVs, the ASD group was more likely to use distress vocalizations than both the TD and DD groups. The higher proportion of distress NTVs differentiated the ASD participants from both groups under 2 years of age. This increased proportion is most likely due to the well documented issues with emotional regulation that children with ASD demonstrate (Anzalone & Williamson, 2000; Dawson & Lewy, 1989; Degangi, 2000).

The ASD group also used a higher frequency and proportion of atypical vocalizations than the TD group. However, there was not a significant difference between the ASD and DD groups on frequency or proportion of atypical vocalizations. Although this does not directly support the findings of Sheinkopf et al (2000), large variances were observed for the frequency and proportion of atypical vocalizations for both the ASD and DD group suggesting that group differences may be masked. Additional factors may have also influenced the discrepancy between the current findings and those of Sheinkopf and colleagues. The prior investigation utilized older children (ASD, M = 44.67 months, DD M = 36.09 months) and a smaller sample size (*ASD, n* = 15; DD*, n* = 11). It is possible that atypical vocalizations do not significantly differentiate children with ASD from children with DD until later in childhood. Additionally, the increased power of the current study due to a larger sample indicates that perhaps there truly is no significant group difference in the use of atypical vocalizations between young children with ASD and DD.

Communicative Vocalizations Between 18 and 24 Months of Age.

The ASD group was less likely to use vocalizations communicatively than the TD group. Although a statistically significant difference was not found between the ASD and DD groups, a medium effect size was detected. When communicating vocally, children with ASD were less likely to use these vocalizations in acts for JA, which is likely reflective of the well-documented deficit that children with ASD have in communicating for JA (McEvoy et al., 1993; Mundy et al., 1990, 1994; Shumway, 2006; Sigman et al., 1986; Wetherby & Prutting, 1984; Wetherby et al., 1998).

The ASD group was as likely to use NTVs communicatively as both the TD and DD groups. When communicating vocally, the ASD group was more likely to use NTVs in acts for BR than participants with DD, however. A potential explanation for this finding is that the ASD group's proportion of communicating in acts for BR was high in relation to their low proportion of vocalizing in acts for JA, a known weakness. Although statistically significant group differences were not found for the proportion of communicative NTVs in acts for JA, medium effect sizes were detected for this measure with both the TD and the DD groups, indicating a clinically meaningful difference.

Concurrent Relations with Developmental Measure at in the Second Year

When controlling for age, moderate to large correlations were observed for a majority of the TV measures with the CSBS DP social, speech, and symbolic composites indicating that a relationship exists among these domains late in the second year of life. In addition, a larger proportion of TVs was related to higher performance on the CSBS DP composites and a larger proportion of NTVs correlated with lower performance on all three CSBS DP composites. The moderate to large correlations detected between level II and III TVs and all three composites indicate that consonant use in the second year appears to be tied in with developmental measures in the second year. In addition, single syllable and multisyllable use were correlated significantly with the CSBS DP social, speech and symbolic composites indicating that the production of syllabic vocalizations is related to concurrent developmental measures of social communication. Higher frequencies and proportions of communicative vocalizations and TVs were also found to be significantly correlated with better performance on all three composites of the CSBS DP. Interestingly, although a higher frequency of total noncommunicative vocalizations and noncommunicative TVs correlated with higher raw scores on all three composites of the CSBS DP, a higher proportion of total noncommunicative vocals and TVs was related to lower raw scores on all three composites. Children who have more vocalizations, whether they are TVs or NTVs will have higher composite scores on the CSBS DP, although if a high proportion of their vocalizations are NTVs this will result in lower scores on all three composites. Children can use NTVs frequently, therefore, but they must use a higher proportion of TVs in order to perform better on this developmental measure late in the second year of life.

Predictive Relations with Developmental Outcome at Age Three

Moderate to large correlations were detected between several TV modifiers and the MSEL NVDQ and VDQ at age 3 when controlling for age. Although moderate significant relationships were found between levels II and III and the VDQ, no significant correlation was found between level I and this measure. This finding indicates that consonant use is important for later verbal development. Although level IV TVs were not significantly correlated with either the NVDQ or VDQ, this is potentially due to the low frequency of occurrence of this behavior. The floor effect and restricted range created by the low frequency of level IV TVs makes finding a significant correlation unlikely. The positive correlation between VDQ and proportion of TVs and the negative correlation between VDQ and proportion of NTVs indicates that more TVs than NTVs in the second year are associated with better performance on VDQ age 3 and vice versa. It is also of interest that although the proportion of total vocals and TVs used communicatively were correlated with both the NVDQ and VDQ, the proportion of communicative TVs used for BR, SI and JA were not. High proportion of vocalizations in acts for BR and low proportion for JA and SI, however, could have possibly created ceiling and floor effects, respectively, making it difficult to find significant correlations. Although a higher frequency of noncommunicative TVs correlated with higher raw scores and both NVDQ and VDQ, a higher proportion of total noncommunicative vocalizations and noncommunicative TVs was related to lower scores on the VDQ. If a child with ASD vocalizes communicatively more often than noncommunicatively late in the second year, expressive language abilities are more likely to be better at age 3. This finding supports the transactional hypothesis of language development. The more a child vocalizes communicatively, the more feedback a child is likely to receive from communicative partners, which will increase language learning opportunities (McCathren, Yoder, & Warren, 1999; McCune, 1992).

Unique contribution of communicative vocalizations. Results of the current investigation reflect the importance of communicative vocalizations and further support the transactional hypothesis of language development. In the multiple regression analysis communicative total vocalizations and TVs in the second year were found to predict performance on VDQ at age 3 over and above noncommunicative vocalizations. This finding demonstrates that although vocalizing for noncommunicative purposes does contribute to later expressive language development to some degree, children who also use more vocalizations communicatively will perform better on the VDQ at age 3. The support of this hypothesis for children with ASD is particularly important because of their known deficits in social communication. It is not only important to look at the phonetic complexity and syllable structure of their vocalizations early in life, but more importantly whether or not they serve a communicative purpose.

Clinical Implications

Results of the current investigation on the vocalizations of children with ASD, TD, and DD between 18 and 24 months of age have potentially important implications for both early identification and early intervention. These findings indicate that many TV frequency and proportion measures in this investigation help to distinguish children with ASD from children with TD in the second half of the second year of life. Atypical NTVs were also found to differentiate children with ASD from children with TD. In addition a higher proportion of distress NTVs significantly differentiated children with ASD from both children with DD and children with TD. Potentially reflective of the difficulties children with ASD have with emotional regulation, this finding is of particular importance for the purpose of early identification, indicating that distress NTVs should be carefully monitored during screening and assessment measures.

VDQ at age 3 was predicted by the frequency of total vocalizations and the frequency of TVs, specifically the frequency of level II and III TVs. This finding is similar to those on other populations, such as SLI (McCathren et al., 2000), as well as results on previous research on children with ASD (Wetherby et al., 2000). The ability to produce TVs, particularly those with consonants, is therefore an important skill for young children with ASD similar to children with other developmental delays. The ability to produce TVs communicatively may be more important to language development than the ability to use TVs noncommunicatively, as suggested by the transactional hypothesis. The transactional hypothesis is supported by the prediction of VDQ by communicative TVs above and beyond noncommunicative TVs. This is an important and clinically relevant finding which provides a direction for intervention.

The transactional hypothesis highlights the importance of being able to use vocalizations for a communicative purpose. Increasing the frequency of communicative TVs is therefore a priority for intervention based on the support provided by the current investigation for this hypothesis. The information gathered from the present investigation on the effectiveness of structured contexts in facilitating and increasing the frequency of vocalizations is also of interest for planning intervention. The structured activities of the CSBS DP involve the adult's use of a facilitative interaction style (Mirenda & Donnellan, 1986). To encourage communication from the child, the adult presents the child with a communicative temptation by structuring the activity, giving the child sufficient time to initiate communication, and following the child's lead by commenting on what the child is paying attention to. The higher rates of vocalizations demonstrated during the structured communication sampling in this investigation suggest that scaffolding through the use of a facilitative interaction style may be a beneficial intervention method to encourage expressive language development and could also be effective within the natural environment.

At the same time, children with ASD used a significantly higher proportion of distress NTVs than both the TD and DD groups, which is also of importance to address in intervention. During periods of dysregulation such as distress, a child is not at an optimal state of arousal (DeGangi, 2000) which is important for learning and development. An additional goal of intervention should potentially be to improve emotional regulation (ER), as suggested by the SCERTS Model (Prizant, Wetherby, Ruben, Laurent, & Rydell, 2006), through the use of behavioral strategies targeted at both self-regulation (ER strategies which are self-initiated and directed) and mutual regulation (ER strategies that involve requesting assistance or responding to assistance from others) so that the child will be able to maintain an optimal arousal state. Through the use of a comprehensive, family centered intervention program such as the SCERTS model, clinicians can target increasing communicative TVs while at the same time decreasing any periods of distress and dysregulation which may be causing the high frequency and proportion of distress NTVs.

Limitations

Limitations of this study must be considered when interpreting the results. The heterogeneity of the ASD group is both a limitation and a strength. The ASD population is known to be heterogeneous. The heterogeneity of the sample is therefore representative of the population which increases the external validity. The ASD participants shared a large variance on social communication abilities as well as developmental level. Therefore in order to match the wide range of intellectual functioning in the ASD group, the participants in the DD group were heterogeneous as well. This heterogeneity was reflected in the wide range of variance observed in the ASD and DD groups on many variables and may have limited the ability to detect group differences.

In addition, the ASD group consisted of children with both autistic disorder and PDD-NOS. Findings of previous research suggest that children with PDD-NOS are more likely to engage socially than children with ASD (e.g., Mars, Mauk, & Dowrick, 1998). Therefore it may have been those children with PDD-NOS that were more likely to vocalize communicatively, potentially inflating the means on these measures. Also, outliers were revealed in all groups on several measures, impacting the distribution of the data and the results of the study. It is important to consider that in addition to much within group variance, group differences may not individually translate to individual children with ASD, DD, or TD.

The enrollment of the ASD participants in this sample into early intervention services is another area of limitation. These children were identified in the second year of life as having social communication delays and began receiving early intervention to address these deficits, among which vocal communication is often a primary objective. This may have impacted both the communicative and noncommunicative vocalizations in a positive direction, including TVs, levels of phonetic complexity, and number of syllables. This potential also exists for the presence of NTVs and its categories. It is possible that frequency and proportion measures of NTVs would decline as TVs increase, thereby impacting the results of these measures.

The potential impact of the sampling procedures on the findings of the investigation should also be considered. A strength of the current study was the use of direct and systematic observation, however, the provision of the CSBS DP in a clinical setting, as opposed to the natural environment has the potential to encourage vocalizations from the child that may be different in frequency or type than would be produced in the home. The results of the comparison of the sampling context showed that children vocalized more when in a structured context rather than an unstructured context. Therefore it is possible that the vocalization measures may be somewhat inflated compared to what they would be in a natural environment. Although the structured context has the potential to inflate the frequency count to some degree it also has the ability to give a broader picture of the child's abilities in a shorter period of time, which accounts for its importance in the communication sampling of young children.

Another potential limitation of the study that must be considered is the measure of interrater reliability. Although combined measures of interrater reliability indicated adequate reliability between raters for vocalizations, some modifiers (i.e., level IV TVs, other NTVs) occurred rarely in the investigation and were therefore more difficult to achieve expected kappa coefficient and percent agreement scores. Because of this, coder reliability may have limited the ability to find group differences for these variables, which should be considered in interpretation of the results.

Future Directions

The findings from this investigation have significant implications for future research in the area of early vocalizations in young children with ASD. This is one of the few studies to measure vocalizations in children with ASD under 2 years of age through systematic observation. In addition, this is the only study of its kind to measure vocalizations to the level of precision involving phonetic complexity and number of syllables of TVs and categories of NTVs. At the same time, the current investigation measured vocalizations at a single point in time. Longitudinal research on vocalizations is needed to further explore how the vocalizations of children with ASD change over the first years of life.

Because overlaps in symptomatology exist between children with ASD and DD the addition of a comparison group of younger children with TD matched on MA would strengthen future research. It would allow the researcher to determine if these differences were still present at the younger age, thereby providing support to whether or not the results were due to the diagnosis of ASD or cognitive functioning level.

Finally, a comparative study utilizing structured and unstructured contexts in the natural environment is an avenue of future research. Investigating vocalizations in the natural environment would provide important information on their communicative vocalizations within a setting in which the child may be more comfortable. It would be of interest to see if the frequency or proportion measures of distress NTVs would be reduced as a result of this change in environment. Having access to information on the child's performance in the natural environment could also aid in planning functional treatment goals that are of the most use to the child and family on an everyday basis. Sampling communication in both structured and unstructured contexts within the natural environment would also provide important information on the value of more structure within the home in order to encourage children to communicate.

Summary

The results of this study indicate that by 18 to 24 months children with ASD are differentiated from children with TD through their use of fewer total vocalizations and TVs. When using TVs, however, they are as likely to use consonants as their TD counterparts. Children with ASD are strikingly differentiated from both children with TD and DD through their higher proportion of distress NTVs and differentiated from children with TD through their use of a higher frequency and proportion of atypical NTVs, with a trend identified that suggests the possibility that with the addition of a larger sample size of smaller variance this behavior has the potential to differentiate them from the DD group as well. Communicatively, when children with ASD vocalized they were less likely to use TVs than the TD group, but similar use was found between the ASD and DD groups. When vocalizing within communicative acts, children with ASD were less likely to use vocalizations in acts for JA than both the TD and DD groups, which supports the previous findings that indicate JA as an area of deficit for children with ASD.

For the ASD group, examination of relationships between vocalization measures and the CSBS DP social, speech, and symbolic composites revealed that the use of TVs with consonants and the frequency and proportion of TVs used communicatively were all strongly related with both composites when controlling for age, indicating the possibility of a relationship between these domains late in the second year of life. The use of TVs with consonants significantly predicted verbal development in the third year when controlling for age, and the proportion of vocals used communicatively was predictive of both the VDQ. In addition communicative vocalizations were found to provide expressive language in the third year over and above noncommunicative vocalizations, supporting the transactional hypothesis of language development.

In summary, children with ASD showed a pattern of vocalization use that significantly differentiates them from typically developing children, with frequency of distress NTVs differentiating the ASD group from both children with TD and children with DD. In addition, the potential for atypical vocalizations late in the second year of life to distinguish the ASD and DD groups is suggested by the large variance detected for that measure, which may be masking a group difference. Both concurrent and predictive relationships have been found between vocalizations in the second half of the second year of life and developmental measures in the second and third years. Communicative vocalizations have been found to uniquely predict expressive language at age 3. Findings from this study contribute to the understanding communication deficits in children with ASD in the second half of the second year of life. This improved understanding will assist in early detection and potentially lead to earlier intervention for young children with ASD.

APPENDIX A

CODING DEFINITIONS FOR VOCALIZATIONS

A vocalization is a behavior class that will be coded as an <u>event</u>. Vocalizations may be part of a communicative act, as defined above, but may also occur without a communicative act. Therefore, ALL vocalizations should be coded; including vocalizations seemingly *not* part of a communicative act.

A vocalization will first be coded as a **Transcribable Vocalization (TV)** or a **Nontranscribable Vocalization (NTV)**, unless a sufficient acoustic signal is not present to make this distinction. In this case a vocalization would be coded as **Could Not Be Determined (CBD)**. TVs and NTVs will then be further modified. All coding will be based on the following definitions:

The **onset** of a vocalization occurs when the child **begins** producing sound. (Tip: When locating the onset of a vocal, slowly rewind to find when the mouth first starts to open, or close, or take on the general shape/position maintained during the sound). To code a vocalization, the coder should watch it in real time in its entirety, then loop back to the beginning of the vocalization and code it as the child first begins the vocalization (based on when it is first heard). All vocals are bound by <u>**one second**</u> of child silence on either side of the vocalization, unless the vocalization changes from TV to NTV, NTV to TV, or from one NTV category to another (see Specific Rules for Coding for further information). A vocalization ends, therefore when there is one second of silence after the sound associated with that vocalization is no longer heard.

Transcribable Vocalization (TV) - TVs are syllabic vocalizations that contain recognizable speech sounds. In order to be considered transcribable, vocalizations must contain at least a vowel. A vowel is a sound produced with an open vocal tract so there is no build up of air pressure at any point above the glottis. Consonants are vocalizations in which there is constriction or closure at some point along the vocal tract. Vowels are considered to be syllabic where as consonants in isolation are not. For that reason consonant-only vocalizations are to be considered NTVs (see following section for more information). TVs will first be modified according to the following levels of phonetic complexity:

A. Level I. A vocalization containing a vowel (e.g., /i/), or a CV containing /h/ or a glottal stop. Vocalizations will be considered vowel-like when the child's mouth is clearly open, the sound does not fall into a NTV category, and does not contain a true consonant. To consider all utterances of breathy phonation or glottalization as consonants can greatly inflate the inventories of infant vocalizations (Kent & Murray, 1982), therefore, CV vocalizations containing /h/ or a glottal stop are coded as Level I.

B. Level II. A vocalization containing a vowel and a true, well-formed single consonant (e.g., /bʌ/, /ʌp/) or identical consonants (e.g., /mam/, /dædi/) not represented in Level I.

C. Level III. A vocalization containing two or more different consonants, not including consonant clusters (i.e., /dagi/ , /kʌp/) or vocalization containing consonants differing solely in voicing (e.g., /bʌpi/).

D. Level IV. A vocalization containing a well-formed consonant cluster (i.e., /glæs/, /grin/, /trʌk/, /drɪŋk/, /slip/, /stap/, /stɪk/, /krim/, /fri/, /flɪp/, /klin/, /prɪnt/).

All TVs will also be coded for syllable structure. Following the coding of phonetic complexity, the coder should code the TV as either a **single syllable** or a **multisyllable**. A syllable must contain a vowel and may contain one or more consonants on either side of the vowel. A single syllable is a TV with only one vowel (i.e., /ɑ/, /ki/, /bɪg/) and a multisyllable must have at least two vowels, which may be the same or different (i.e., /bada/, /gʌwidu/, /dædi/). To consider a vocalization as multisyllabic the coder should make sure that there is not more than a second between syllables. If there is, the vocalizations should be coded as two or more single syllable and/or multisyllable TVs.

Nontranscribable Vocalization (NTV) - NTVs are not considered syllabic and are vocalizations that either do not do not contain a recognizable vowel or contain a vowel vocalized with abnormal phonation, such as a cry/whine. NTVs will be modified to identify their specific category based on the following definitions:

A. **Laugh** – an audible, vocal expulsion of air from the lungs that can range from a loud burst of sound (e.g., /ha/) to a series of quiet chuckles and is usually associated with pleasure.

B. **Distress sound – a** vocalization associated with a negative emotional state including a *cry/whine* (high pitched, plaintive vocalization) or a *scream* (loud, long, intense cry).

C. **Atypical vocal quality** – a vocalization that demonstrates atypical phonation, including a *yell* (loud, non distress vocalizations), a *grunt* (short vocalization produced with low pitch and increased force), a *squeal* (vocalization that at some point enter into maximally high pitch or falsetto), and a *growl* (low-pitch, often creaky-voice vocalization (Sheinkopf, Mundy, Oller & Steffens, 2000).

D. **Non English–** a vocalization that is not considered consonantal in English and does not contain a vowel sound, including a *lip smack* **(**bilabial click; a short noise made by compressing and opening the lip), a *tongue click* (a quick, sucking sound made by the tongue pressing against and releasing from the roof of the mouth), a *raspberry* (bilabial trill produced by lips vibrating repeatedly against one another and often produced as playful vocalizations), an *alveolar trill* (the rapid vibration of the tongue against the alveolar ridge, and a *uvular trill* (the uvula against the back of the tongue).

E. **Single consonant** – a consonant produced with no accompanying vowel, such as a sustained /s/ or a /m/ produced in isolation; may or may not be prolonged.

F. **Other** – NTV which is not captured in the previous categories.

Specific Rules for Coding

A TV consists of a single vowel which may be in the presence of a consonant. TVs will be coded at their highest level of phonetic complexity. For example if a child produces /bʌbə/ and then less than a second later /gʌ/ the vocalizations will be coded as Level III, multisyllable.

A string of vowels or CV combinations may also be considered a single TV if they are produced within one second of each other. If there is more than one second between them, they are considered different TVs. For example, if /bʌ/ and /gʌ/ were produced within one second of each other they would be a Level III multisyllable. If there was more than a second between them, however, they would be considered separate Level II single syllables.

NTVs of the same category are also judged to end when there is one second between them. For example if a child laughs and then laughs again with more than one second between them it would be considered two NTVs. If there is less than one second between the laughs it would be coded as only one NTV. There does not need to be a second between NTVs of different categories, however. For example, if a child laughs, and then produces a single consonant, both NTVs would be coded separately. It is possible for a child to string together nontranscribable and transcribable sounds in one vocalization, without there being a second in between. Therefore, if different types of vocalizations are produced in a single vocalization, code each type. For example, within one breath group, the child laughs, says “bye-bye,” then smacks his lips, one would code: An NTV (laugh), a TV, Level II, and another NTV (lip smack).

To distinguish between TVs and NTVs, the coder can use one of two pieces of evidence: **1.) There is a clear view of child’s mouth; 2.) The acoustical signal is clear.** Vocalizations that occur within one or both of these conditions may be coded per the definitions of vocal elements. For example, if a vocalization is produced while the child is turned away from the camera, and it is not clear whether the vocalization was a NTV or a vowel, the vocalization will be coded only as “**could not be determined**.” However, if the view of the child’s mouth is obstructed, and the child clearly says, “ball,” the vocalization would be coded as a TV. If another child is in the room, and it is unclear if the child being coded, or another child, produced the vocal, do not code it.

APPENDIX B

HUMAN SUBJECTS CLEARANCE AND PARENTAL PERMISSION

Subject	Use of Human Subjects in Research - Approval Memorandum
From	Human Subjects <humansubjects@magnet.fsu.edu>
Date	Monday, May 19, 2008 3:16 pm
To	amp04u@fsu.edu
Cc	amwetherby@fsu.edu , alathrop@admin.fsu.edu

Office of the Vice President For Research
Human Subjects Committee
Tallahassee, Florida 32306-2742
(850) 644-8673 · FAX (850) 644-4392

APPROVAL MEMORANDUM

Date: 5/19/2008

To: Allison Plumb

Address: 2750 Old St. Augustine Rd
Dept.: COMMUNICATION DISORDERS

From: Thomas L. Jacobson, Chair

Re: Use of Human Subjects in Research
FIRST WORDS Project: Vocalizations of Children with Speech, Language, Communication and Autism Spectrum Disorders

The application that you submitted to this office in regard to the use of human subjects in the research proposal referenced above has been reviewed by the Human Subjects Committee at its meeting on 05/14/2008. Your project was approved by the Committee.

The Human Subjects Committee has not evaluated your proposal for scientific merit, except to weigh the risk to the human participants and the aspects of the proposal related to potential risk and benefit. This approval does not replace any departmental or other approvals, which may be required.

If you submitted a proposed consent form with your application, the approved stamped consent form is attached to this approval notice. Only the stamped version of the consent form may be used in recruiting research subjects.

If the project has not been completed by 5/13/2009 you must request a renewal of approval for continuation of the project. As a courtesy, a renewal notice will be sent to you prior to your expiration date; however, it is your responsibility as the Principal Investigator to timely request renewal of your approval from the Committee.

You are advised that any change in protocol for this project must be reviewed and approved by the Committee prior to implementation of the proposed change in the protocol. A protocol change/amendment form is required to be submitted for approval by the Committee. In addition, federal regulations require that the Principal Investigator promptly report, in writing any unanticipated problems or adverse events involving risks to research subjects or others.

By copy of this memorandum, the Chair of your department and/or your major professor is reminded that he/she is responsible for being informed concerning research projects involving human subjects in the department, and should review protocols as often as needed to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

This institution has an Assurance on file with the Office for Human Research Protection. The Assurance Number is IRB00000446.

Cc: Amy Wetherby, Advisor
HSC No. 2008.1361

FLORIDA STATE UNIVERSITY | *FIRST WORDS® Project*

Providing Early Identification & Referral for Families of Infants & Toddlers with Communication Delays

Parent Permission Form

The FIRST WORDS® Project is a federally-funded research study of early communication development in young children. We are interested in studying both children with typical development and children whose families have concerns about their child's development. The *Infant-Toddler Checklist* is used as the first step in screening for communication delays to decide if a communication evaluation is needed.

The FIRST WORDS Project will send you a report to tell you how your child did on the Checklist. If your child is not developing as expected for his/her age based on the information that you provide on the Checklist, we will invite you to bring your child for a communication evaluation at no charge. However, you are under no obligation to provide any further information or have your child evaluated. We are also asking you to complete the attached Child and Family Information Form so that we can contact you if an evaluation is needed and so we have background information about you and your child for our research. In order to estimate the percentage of young children with communication disorders born in the panhandle of Florida, we will be gathering information from your child's birth certificate records obtained from the Florida Department of Health.

The information you provide may help your child access early intervention services and will help us identify children with communication problems earlier. Please be assured that the names of all children and families participating in the FIRST WORDS Project will be kept strictly confidential to the extent allowed by law.

By signing this permission form you are indicating that you have read this form and agree to have the information that you provide about your child and family included in this research project. If you have any questions about this study, please don't hesitate to call the FIRST WORDS Project at (850) 488-5780. If you have any questions about your participation in this research, you can also contact the Chair of the FSU Human Subjects Committee, Institutional Review Board at (850) 644-8633.

I, ____________________________, as legal guardian of ______________________________
Parent/Legal Guardian's Name *(print clearly)* Child's Name *(print clearly)*

have read this form and give my permission for my child to be included in this research study.

______________________________________ Today's Date: _____/_____/_____
Signature of Parent or Legal Guardian Month Day Year

FLORIDA STATE UNIVERSITY INSTITUTIONAL REVIEW BOARD
Approved: 1/23/08
HS No. 07.741
Void After 9/10/08

625B North Adams Street Tallahassee, Florida 32301
Telephone 850.488.5780 Fax 850.644.3644

FLORIDA STATE UNIVERSITY | *FIRST WORDS® Project*

Providing Early Identification & Referral for Families of Infants & Toddlers with Communication Delays

AGREEMENT TO PARTICIPATE IN A CLINICAL RESEARCH STUDY

Project Title: FIRST WORDS Project: Early Identification of Speech, Language, Communication, and Autism Spectrum Disorders

Principal Investigator: Amy M. Wetherby, Ph.D., CCC-SLP

Your child is being asked to participate in a research project as described in this form below. All such research projects carried out at the University are governed by the rules of both the federal government and Florida State University. These rules require that you give your signed agreement for your child to participate in this project.

The research staff who will evaluate your child will explain to you, in detail, the purpose of the project, the procedures to be used, and the potential benefits and possible risks of participation. You may ask any questions you have to help you understand the project. A basic explanation of the project is written below. Please read this explanation and discuss with the research staff any questions you might have.

If you then decide that your child may participate in the project, please sign this form in the presence of the person who explained the project to you. You will be given a copy of this form to keep.

1. **Nature and Purpose of the Project**: The purpose of this study is to determine if communication disorders can be identified in very young children who demonstrate delays in early communication development. Being late in talking is often the first symptom evident to parents and professionals of children with communication disorders. Because children usually begin acquiring words between 12 and 18 months of age, a child may not be referred for a language delay until at best 20 to 24 months, but more typically, after 30 months. This longitudinal study of communication development in infants and toddlers will provide information on the predictive value of our checklist and early measures of social communication and play development in relation to performance on follow-up evaluations. We hope that this research project will help to develop better tools to guide referrals of children at risk for speech, language, communication, autism spectrum, and other developmental disorders at earlier ages. Early identification may lead to earlier treatment and support for children and families, which would have a positive effect on a children's development.

2. **Explanation of Procedures**: You and your child will be asked to participate in a number of procedures as part of this project. We will be giving you a questionnaire to complete to provide information about how your child communicates and plays with objects. Your child will participate in an evaluation lasting approximately 30-40 minutes. Activities during the session include standard assessment procedures for young children to measure eye gaze, gestures, sounds, words, understanding, and play. This involves the presentation of toys and interesting materials to encourage our child to communicate and simple instructions. We will ask your permission to videotape the evaluation session to help us score behavior accurately. We will give you a summary of the results of this evaluation. If your child shows any red flags of autism spectrum disorders, we will invite your for a diagnostic evaluation to identify or rule-out autism spectrum. We may ask you to return to for a follow-up evaluation in 3 to 6 months in order to follow the

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development of your child. However, the diagnostic evaluation for autism and the follow-up visit is optional, and you can decide to refuse at a later time. We will save the videotape of this evaluation session so we can continue to study precise measures of social communication and play of your child over the course of this longitudinal project. Because this study is exploratory in nature, research staff may review your child's videotape at a later time to rate more precise measures of social communication and play. Your child's scores on questionnaires and ratings of the videotape will become part of the FIRST WORDS Project database and may be used to study early indicators of typical development and communication delays.

3. **Discomforts and Risks**: All of the procedures to be used are commonly used with young children one to two years of age. Therefore, they do not involve activities that would cause discomfort to your child or put your child at any risk. However, if your child should become upset for any reason, the evaluation will be stopped, and rescheduled with your permission.

4. **Benefits**: You and your child may benefit from involvement in this project in a number of ways. First, we will provide you with information about your child's social communication and play development. Second, the results of this study will provide information for professionals regarding patterns of early communication development, which will help with the early identification of communication delays in children. This information should lead to earlier and more appropriate services to young children and their families.

5. **Confidentiality**: All records relating to this project will be handled and safeguarded according to standard clinical policy for all patient records and will remain confidential to the extent allowed by law. Any research reports will carry no identifying information of individual children or families.

6. **Refusal/Withdrawal**: At any time during your participation in this study, you will have the opportunity to refuse to participate in any procedures or withdraw from the study at any time without prejudice or effect on you and your child. If you would like to remove your child's records from the research database at any time in the future, call the project at 850-488-5780 to let us know.

7. **Risks**: We do not expect any unusual risks as a direct result of participation in this project, since all testing procedures are part of standard routine clinical test batteries.

8. **Videotaping**: You and your child will be videotaped by the clinician during the evaluation session. These videotapes will be kept by project staff in a locked room and will be saved indefinitely. These videotapes will be accessible only to research staff, unless otherwise specified by you. We may ask your permission to use segments of these videotapes for educational purposes; however, this is optional.

I acknowledge that I have read and fully understand the above explanation of the project, all of my questions have been satisfactorily answered, and I give permission for my child to participate in this research project. If I have any questions about my rights as a participant in this research, or if I feel I have been placed at risk, I can contact the chair of the human subjects committee, institutional review board, through the vice president for the office of research at (850) 644-8633.

____

Signature of Parent Date

FLORIDA STATE UNIVERSITY
Approved: 1/23/08
HS No. 07.741
Void After 9/10/08
INSTITUTIONAL REVIEW BOARD

FLORIDA STATE UNIVERSITY | *FIRST WORDS® Project*

Providing Early Identification & Referral for Families of Infants & Toddlers with Communication Delays

AGREEMENT TO PARTICIPATE IN A CLINICAL RESEARCH STUDY

Project Title: FIRST WORDS Project: Early Identification of Speech, Language, Communication, and Autism Spectrum Disorders

Principal Investigator: Amy M. Wetherby, Ph.D., CCC-SLP

Your child is being asked to participate in a follow-up research project as described in this form below. All such research projects carried out at the University are governed by the rules of both the federal government and Florida State University. These rules require that you give your signed agreement for your child to participate in this project.

The research staff who will evaluate your child will explain to you, in detail, the purpose of the project, the procedures to be used, and the potential benefits and possible risks of participation. You may ask any questions you have to help you understand the project. A basic explanation of the project is written below. Please read this explanation and discuss with the research staff any questions you might have.

If you then decide that your child may participate in the project, please sign this form in the presence of the person who explained the project to you. You will be given a copy of this form to keep.

1. **Nature and Purpose of the Project**: The purpose of this study is to determine if communication disorders can be identified in very young children who demonstrate delays in early communication development. Being late in talking is often the first symptom evident to parents and professionals of children with communication disorders. Because children usually begin acquiring words between 12 and 18 months of age, a child may not be referred for a language delay until at best 20 to 24 months, but more typically, after 30 months. This longitudinal study of communication development in infants and toddlers will provide information on the predictive value of our checklist and early measures of social communication and play development in relation to performance on follow-up evaluations until 5 years of age. We hope that this research project will help to develop better tools to guide referrals of children at risk for speech, language, communication, autism spectrum, and other developmental disorders at earlier ages. This project will also help estimate the percentage of children born in the panhandle of Florida who have communication disorders. Early identification may lead to earlier treatment and support for children and families, which would have a positive effect on a children's development.

2. **Explanation of Procedures**: You and your child will be asked to participate in a number of procedures as part of this project. We will be giving you questionnaires to complete to provide information about your child's development and experience. Your child will participate in an evaluation lasting approximately 60-90 minutes scheduled on one or two days. Activities during the session include standard assessment procedures for young children to measure social communication, language, nonverbal cognitive and emergent literacy skills. This involves the presentation of toys and interesting materials to encourage our child to communicate and will require your child to follow instructions, repeat sounds and words, name pictures, rhyme, and answer questions. We will ask your permission to videotape the evaluation session to help us

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score behavior accurately. We will give you a summary of the results of this evaluation. If your child shows any red flags of autism spectrum disorders, we will invite your for a diagnostic evaluation to identify or rule-out autism spectrum. We may ask you to return to for a follow-up evaluation in 6 to 12 months in order to follow the development of your child. However, the diagnostic evaluation for autism and follow-up evaluation is optional, and you can decide to refuse at a later time. We will save the videotape of this evaluation session so we can continue to study precise measures of social communication and play of your child over the course of this longitudinal project. Because this study is exploratory in nature, research staff may review your child's videotape at a later time to rate more precise measures of social communication and play. Your child's scores on questionnaires, standardized tests, and ratings of the videotape will become part of the FIRST WORDS Project database and may be used to study early indicators of typical development and communication delays in relation to developmental outcomes.

3. **Discomforts and Risks**: All of the procedures to be used are commonly used with toddlers and preschool children. Therefore, they do not involve activities that would cause discomfort to your child or put your child at any risk. However, if your child should become upset for any reason, the evaluation will be stopped, and rescheduled with your permission.

4. **Benefits**: You and your child may benefit from involvement in this project in a number of ways. First, we will provide you with information about your child's social communication and play development. Second, the results of this study will provide information for professionals regarding patterns of early communication development, which will help with the early identification of communication delays in children. This information should lead to earlier and more appropriate services to young children and their families.

5. **Confidentiality**: All records relating to this project will be handled and safeguarded according to standard clinical policy for all patient records and will remain confidential to the extent allowed by law. Any research reports will carry no identifying information of individual children or families.

6. **Refusal/Withdrawal**: At any time during your participation in this study, you will have the opportunity to refuse to participate in any procedures or withdraw from the study at any time without prejudice or effect on you and your child. If you would like to remove your child's records from the research database at any time in the future, call the project at 850-488-5780 to let us know.

7. **Risks**: We do not expect any unusual risks as a direct result of participation in this project, since all testing procedures are part of standard routine clinical test batteries.

8. **Videotaping**: You and your child will be videotaped by the clinician during the evaluation session. These videotapes will be kept by project staff in a locked room and will be saved indefinitely. These videotapes will be accessible only to research staff, unless otherwise specified by you. We may ask your permission to use segments of these videotapes for educational purposes; however, this is optional.

I acknowledge that I have read and fully understand the above explanation of the project, all of my questions have been satisfactorily answered, and I give permission for my child to participate in this research project. If I have any questions about my rights as a participant in this research, or if I feel I have been placed at risk, I can contact the chair of the human subjects committee, institutional review board, through the vice president for the office of research at (850) 644-8633.

Signature of Parent ________________________________ Date

FLORIDA STATE UNIVERSITY | *FIRST WORDS® Project*

Providing Early Identification & Referral for Families of Infants & Toddlers with Communication Delays

PERMISSION FOR USING VIDEOTAPES FOR EDUCATIONAL PURPOSES

I, ____ (Parent's or Guardian's name), as

parent or guardian of ____________________________________ (child's name) hereby give my consent that any portion of the videotapes of this evaluation session of my child and myself or any reproduction of these same materials made by Dr. Amy Wetherby and research assistants in the Department of Communication Disorders may be used for instruction or educational purposes. Signing this form does not in any way obligate me to give permission for broader use of these video clips.

I understand that I will receive no financial compensation for the use of these recorded materials. I also understand that if in the future, I decide to revoke permission to use the video of me and/or my child, a concerted effort will be made to remove that segment of the educational video, but this cannot be guaranteed. The reason for this is that once the educational video has been developed, it is difficult to remove a segment without needing to rework the entire product.

I have read the foregoing statements and agree to abide by them.

____ Date: ________________

Signature of Patient/Legal Guardian

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Telephone 850.488.5780 Fax 850.644.3644

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BIOGRAPHICAL SKETCH

Allison M. Plumb received her Bachelor and Master of Arts degrees in Communication Disorders from the University of Central Florida and her Ph.D. from Florida State University with Dr. Amy M. Wetherby as her major professor. She has several years of clinical experience working with preschool and school-age children with communication disorders. Her research interests include improving early identification and intervention for children with delays, particularly children with autism spectrum disorders. She has presented her research at national and international levels.