Published in final edited form as:

Autism. 2019 April ; 23(3): 699–712. doi:10.1177/1362361318766241.

Naturalistic Language Sampling to Characterize the Language Abilities of 3 Year Olds with Autism Spectrum Disorder

E. C. Bacon^{1,2}, S. Osuna, E. Courchesne^{1,2}, and K. Pierce^{1,2}

¹Department of Neurosciences, School of Medicine, University of California San Diego, La Jolla, CA

²Autism Center of Excellence, School of Medicine, University of California San Diego, La Jolla, CA

Abstract

Characterization of language in naturalistic settings in Autism Spectrum Disorders (ASD) has been lacking, particularly at young ages, but such information is important for parents, teachers, and clinicians to better support language development in real-world settings. Factors contributing to this lack of clarity include conflicting definitions of language abilities, use of non-naturalistic standardized assessments, and restricted samples. The current study examined one of the largest datasets of naturalistic language samples in toddlers with ASD, and language delay (LD) and typically developing (TD) contrast groups at age three. A range of indices including length of phrase, grammatical markings, and social use of language were assayed during a naturalistic observation of a parent-child play session. In contrast to historical estimates, results indicated only 3.7% of children with ASD used no words, and 34% were minimally verbal. Children with ASD and LD exhibited similar usage of grammatical markings, although both were reduced compared to TD children. The greatest difference between ASD and LD groups was the quantity of social language. Overall, findings highlight a range of language deficits in ASD, but also illustrate that the most severe level of impairments are not as common in naturalistic settings as previously estimated by standardized assessments.

There is a deepening appreciation of the fact that Autism Spectrum Disorder (ASD) is a heterogeneous disorder, not only in terms of clinical profile (Kim et al., 2015; Rice et al., 2012), but also likely etiology (Bill and Geschwind, 2009). This heterogeneity is particularly striking within the domain of language (Pickles et al., 2014) wherein two individuals – both with the same diagnostic label of ASD – can display opposite profiles with one person being nonverbal throughout life while the other verbally fluent and may even obtain a college degree or beyond. Rapidly changing levels of public awareness and enhanced efforts towards earlier identification and treatment of ASD (Pierce et al., 2011; Pierce et al., 2016) provide a difficult landscape for accurately defining language profiles in ASD. Yet, this understanding is essential within a modern cohort as a guide for physicians, clinicians, educators, and parents alike, particularly since language ability prior to treatment has been linked to more

successful outcomes (Anderson et al., 2007; Fossum et al., 2017; Mayo et al., 2013; Moulton et al., 2016; Pickles et al., 2014). Moreover, as we hope for a future that includes precision medicine in ASD (Geschwind and State, 2015), accurately indexing language ability in ASD before and following treatment becomes an essential component for clinical trials.

Studies that index and characterize the speech and language abilities of children with ASD are among the oldest in the literature (Bartak et al., 1975; Hartung, 1970; Rutter, 1967; Sulzbacher and Costello, 1970). One such study, conducted over 40 years ago by one of the founders of the field, Michael Rutter, concluded that “language disability is probably necessary for the behavioral syndrome of autism” (Bartak et al., 1975). This early study reported that 17 out of the 19 ASD children examined had no phrase speech by age 2.5 years (Bartak et al., 1975). Reports that followed continued to suggest that a large percentage, as high as 50%, of children with ASD fail to develop verbal communication (Eigsti et al., 2011; Lord et al., 2004; Prizant, 1996; Tager-Flusberg et al., 2005).

Recently, however, this view of nonverbal and minimally verbal rates in ASD has changed. Awareness of the disorder has grown and the definition of ASD has shifted to include higher ability individuals within the autism spectrum. Moreover, there are now widespread efforts towards earlier identification and treatment to improve outcome. New studies suggest that the rates of nonverbal and minimally verbal children with ASD may be considerably lower than 50%. For example, Anderson et al. (2007) followed a clinic referred sample of 130 children with ASD and 42 children considered non-spectrum from ages two to nine years, and examined changes in expressive language over time. At age nine, only 20% of the ASD sample was considered to have “no-to-few words” based on parent responses during the Autism Diagnostic Interview – Revised. Similarly, Norrelgen and colleagues (2015) indexed the verbal ability of 165 four to six year old children with ASD following intervention based on the Vineland Adaptive Behavior Scales (Sparrow et al., 2005), a parent report measure of child functioning. Fifteen percent of the sample was considered nonverbal (fewer than three words) and an additional 10 percent were minimally verbal (use of at least three words, but limited phrase speech). Rose and colleagues (2016) also examined 246 children with ASD following intervention at age 5 years, but used a more comprehensive battery that included the Vineland Adaptive Behavior Scales, the Autism Diagnostic Observation Schedule (Lord et al., 2012), and the Mullen Scales of Early Learning (Mullen, 1995). There was variation in the proportion of children designated as having limited verbal language depending on which measure was used for classification, ranging from 36–43% demonstrating use of single words only, of which 25–29% demonstrated fewer than a total of five words. However, all children were attending an autism-specific, center-based intervention program, which may have led to sampling bias and an overinclusion of children with more severe symptoms.

Bal and colleagues also examined verbal abilities in a large cohort of 1,470 4–17-year-olds from the Simons Simplex Collection (2016). The proportion of minimally verbal children was determined using five different assessments and definitions including parent estimate of language, scores from standardized parent report measures, and individual items from diagnostic assessments. Definitions across measures ranged from 25 words or fewer and no

use of phrase speech to age equivalents below 18 months on standardized assessments. There was substantial lack of agreement across different definitions ranging from 3–99% classification agreement, resulting in a range of 5–16% of the sample being identified as minimally verbal. Due to these differences, and bias of the sample itself from simplex families only, the authors warn against using results to determine rates of minimally verbal children with ASD. While the aforementioned studies provide important insights into language ability in ASD, a range of issues including use of varied definitions of language ability, reliance on standardized tests and lack of information about language in naturalistic settings, and use of restricted samples that may not result in representative ASD cohorts, continue to contribute to a lack of clarity regarding language ability and disability in ASD.

Differences in definitions of verbal abilities is prevalent throughout research on language use in individuals with ASD. Studies that have focused on nonverbal or minimally verbal individuals have used definitions for inclusion criteria ranging anywhere from no spoken words to fewer than 20 spoken words (Bal et al., 2016; Chenausky et al., 2016; DiStefano et al., 2016; Kasari et al., 2008; Kasari et al., 2014; Koegel et al., 2009; Paul et al., 2013; Ronski et al., 2010; Thurm et al., 2015; Woynaroski et al., 2016; Yoder and Stone, 2006). As exemplified by Bal et al. (2016), depending on what type of measure is used and how stringent the definition is for inclusion, agreement for determining verbal status across participants varies greatly. To combat the inconsistencies within the field, Tager-Flusberg et al. (2009) put forth comprehensive guidelines to better define levels of spoken language. Within these guidelines, the first verbal stage is defined as children using first words that have an age equivalent of 15 months or older on standardized language assessment, using at least 5 word types (number of distinct words used) and 20 word tokens (total number of words used during an observation), producing consonant–vowel syllables, producing at least four consonants, and using at least 2 communicative functions (requesting, commenting, etc.). Therefore, children who are performing at a lower rate than described above, are considered “preverbal”, which is most consistent with individuals that would be considered “minimally verbal” in other studies. These detailed guidelines provide a comprehensive framework to categorize language and allow for easier comparison of results across future studies.

Another issue contributing to the continued lack of clarity regarding rates of nonverbal and minimally verbal children with ASD surrounds the fact that standardized measures are commonly used to measure language level. However, different measures lend themselves to varied definitions of language level due to the nature of the exact questions or skills assessed by the measure, leading back to the issue of inconsistent definitions of language status. Children with ASD also have considerable fluctuations in motivation and attention and standardized test instruments may yield an inaccurate profile of abilities (Koegel et al., 1997).

Moreover, standardized testing often fails to capture more nuanced aspects of language such as a child’s appropriate use morphemes or the quantity that he/she initiates verbally. One method to overcome the shortcomings of standardized assessments is through the fine-grained analysis of language during natural observations. In a rare example of this approach, Tek et al. (2014) performed detailed video coding analyses to study structural language

profiles in 17 children with ASD and 18 TD children longitudinally across 18–60 months of age. A computerized language program was employed to analyze grammatical markings (e.g. plurals, past tense, use of articles) used by the children during a parent-child play session. Overall, differences in mean length of utterance, number of utterances, as well as differences in amount of use of various grammatical markings were observed between diagnostic groups cross-sectionally and over time. However, substantial variability in expressive language was present in the ASD group and those with higher expressive speech skills demonstrated structural language similar to typically developing children, while children with ASD with lower verbal skills showed more widespread impairment. One of the most compelling features of this data analysis was the concrete information regarding actual language skills at a detailed level. Rather than interpreting performance on a standardized measure by comparing scaled scores across groups, scores relating to the actual frequency of use of each skill was compared. Such information is easy to interpret, clinically meaningful, and derived from an example of natural interaction. However, studies utilizing a video coding approach, such as the aforementioned study, often rely on small sample sizes to draw conclusions given the labor-intensive process of quantifying the data. As such, there are few studies on use of grammatical markings in children with ASD due to the difficult analysis process (Eigsti et al., 2011).

Despite newer research, due to inconsistencies of definitions, and limitations inherent in standardized assessments, it remains unclear if the rates of nonverbal or minimally verbal toddlers with ASD in an early detected and early treated contemporary cohort are indeed lower than previously reported. Particularly important, but lacking in the literature, are precision studies of language use in naturalistic social communication settings in toddlers with ASD; how such use varies with language skill level; and how social use and skill levels compare with toddlers without ASD who also have language delay. Further, toddlers with ASD and toddlers with language delay are often confused with each other because early-age standardized language tests may place them at similar levels of delay. Conversely, some toddlers later diagnosed as ASD are misdiagnosed at early ages because they score within the normal range on standardized language tests and are mistaken for typical at early ages because they display good rule-based language (Bacon et al., 2017). Including both ASD and language delay toddlers within the same study would allow for the analysis of language deficits specific to a diagnosis of ASD, rather than general delays in language.

Ideally, fine-grained analysis of language use within large samples of ASD and non-ASD contrast groups should provide a robust approach for determining verbal status in a precise manner, rather than relying on rough estimations based on scores from standardized assessments that lack translation to clinically meaningful information. Additionally, this method would offer the opportunity to analyze details of language use that cannot be assessed using broad standardized assessments, such as the structural use of language, to further our understanding of the acquisition of smaller units of language in children with ASD. Finally, such analyses also offer the advantage of allowing for observation of language use during natural interactions, rather than in response to specific, structured prompts. Overall, detailed coding of language samples offers a way to combat restrictions in determining language level by allowing for fine-grained analysis of vocalizations in a more naturalistic setting.

While most studies examine language in ASD across a relatively wide age range (e.g., 5–7 years), here we aimed to provide a detailed characterization of language abilities of children with ASD (compared to language delayed and typical toddlers) at a very specific point in time -age three - when many children receive their initial diagnosis. Our sample was largely generated by virtue of failure of a broad band screen at a well-baby check-up in pediatric office, and not parent concern. Although this approach is not entirely bias-free, because most referrals were the result of failing a screen at a well-baby check-up within the context of a Level 1 screening program where all children are screened in the general population, the resulting sample may be more representative of ASD in general pediatric community settings than other sample ascertainment strategies used in previous efforts, such as recruiting from special education classrooms or focusing on ASD specialty clinics. Our approach of recruiting from communities throughout San Diego County also mitigates disparities in ASD identification driven by education level, SES, or minority status (Fountain et al., 2011) as well as biases associated with recruiting children who are already receiving community services. Developmental screening is a viable method to reduce these disparities and improve age of detection of ASD for all community members (Herlihy et al., 2014). In the current study, spontaneous language during a naturalistic parent-child play session was examined in one of the largest natural language samples, including over 100 ASD and 100 contrast toddlers, further improving the possibility of a more representative sample. Language was examined in a multifaceted method through analysis of performance on standardized measures and naturalistic language samples using clear definitions of language level (Tager-Flusberg et al., 2009), quantification of usage of grammatical markings, and rate of conversational exchanges between parent and child to provide a comprehensive summary of language ability. Understanding language use of children with ASD in more naturalistic settings at the time of diagnosis may aid clinicians when attempting to disentangle ASD from language delay or global developmental delay and may be useful information for future modifications of diagnostic criteria.

METHODS

Participants

Eligible participants were recruited from a larger ongoing longitudinal study examining ASD detection in the general population using universal broadband screening starting at 12 months (i.e., “The 1-Year Well-Baby Check-Up Approach” see Pierce et al., 2011 for more information) as well as from community referrals. One-hundred and nine toddlers with ASD, 61 typically developing (TD), and 40 with a history of language delay (LD) were included in analyses. Note that 55% of toddlers in the LD group presented with a transient language delay, meaning they showed a delay in language at an early age during intake into our program, but by age three they no longer demonstrated that delay. All toddlers in the ASD and TD groups showed consistent diagnoses from intake until age three. Diagnoses for all toddlers were determined using best practice guidelines, including the combination of standardized testing, observational measures of child behavior, and parent report. Specifically, Ph.D. level psychologists with specialized experience in child development and ASD interviewed the parents about the child’s development, observed the child’s performance on a battery of assessments (described below), and used clinical judgment to

make a final diagnosis. Most toddlers entered the program between 12–24 months and were reassessed every 9–12 months until age 3 years when a final diagnosis was given and participation in the current study measures occurred. See Table 1 for further participant demographics. All procedures were approved by the institutional Human Research Protections Program.

Measures

Autism Diagnostic Observation Schedule (ADOS)—The ADOS (Lord et al., 2012) is a semi-structured assessment used to measure behavioral features of ASD. The appropriate module of the ADOS (i.e., Toddler, 1 or 2) was used as a tool to help inform the clinician's overall diagnostic judgment. All psychologists were research reliable on administering the ADOS.

Mullen Scales of Early Learning (MSEL)—The MSEL (Mullen, 1995) assesses cognitive and motor development through a series of structured tasks and provides standardized scores for visual reception, receptive language, expressive language, and fine motor skills.

Vineland Adaptive Behavior Scales (VABS)—The VABS (Sparrow et al., 2005) is a measure of adaptive behavior through caregiver report and provides standardized scores for communication, daily living skills, socialization, and motor skills.

Parent-Child Interaction (PCI) Task—The PCI task consisted of a 10-minute video recorded, free-play interaction between the child and one parent. The parent-child dyad was given access to a standardized set of age-appropriate toys placed in standardized locations within an observation room. The parent was instructed to play with their child as they normally would at home and the play session was video recorded using two cameras with high definition zoom and frame switching capability to ensure that the child's face could be observed if he/she moved. PCI observations were coded for child and parent language use as described below and results compared between diagnostic groups.

PCI Coding—Videos of the parent-child interaction sessions were transcribed and then coded using a continuous 5-second partial-interval scoring procedure. Using this procedure, the 10-minute observation was broken down into 5-second intervals. For the child, videos were coded at the vocalization/word level, morpheme level, and phrase level. Using this information, and guidelines described below, preverbal status was then determined. Parent phrases were also coded based on their function. See Table 2 for further description and examples.

Child Vocalization and Word Level Coding: Utterances coded at the vocalization/word level included any sound made by the child and ranged from unidentified sounds to fully articulated words. Raters recorded whether any of the 6 possible target behaviors occurred at any point during the interval (see Table 2 for further description). The interval was not marked if the behavior did not occur during the interval, and the interval was only marked once if the behavior occurred multiple times during the interval. If two or more behaviors

occurred in the same interval, both were scored (e.g., babbling and a word approximation). The number of full words used provided a quantification of the number of word tokens used during the observation.

Child Morpheme Coding: Child morpheme coding was modeled after previous research (Tek et al., 2014) and incorporated Brown's 14 morphemes (Brown, 1973) which delineate morphemes first acquired by toddlers and are ordered by acquisition, as well as use of Wh Questions. Similar to vocalization and word coding, the scorer recorded whether any morpheme was used at any point during the interval.

Child Phrase Level Coding: For child and parent phrases, an exclusive category was selected that best fit the function of the phrase (echolalia, initiation, or response) and was recorded in the interval that it started. The length of each phrase spoken by the child was also coded and the mean length of utterance (MLU) was determined by calculating the average across all phrases spoken.

Parent Phrase Coding: Parent phrase production was coded based on its function as either an initiation, response, narration, or feedback. Identical to the phrase level coding for the child participants, all parent phrase production was coded in the interval that it started.

Coding Interpretation: For child vocalization and word, child morpheme, child phrase, and parent phrase coding variables, a percentage of time engaged in each behavior was quantified. The number of intervals the child engaged in the behaviors was divided by the total number of intervals during the observation and multiplied by 100. This method allowed for ease of clinical interpretation of the frequency of the behavior during the short observation.

Preverbal status—Using the guidelines developed by Tager-Flusberg and colleagues (2009), performance during the PCI observation was analyzed to determine how many children met criteria for “preverbal status”. The Tager-Flusberg et al. (2009) guidelines provide several methods for determining preverbal status across different language domains (phonology, vocabulary, pragmatics, and grammar). As we were most interested in actual word use the definitions for determining preverbal status for vocabulary were used. Therefore, the number of word tokens and word types during the PCI were used to determine preverbal status for vocabulary. Word tokens were determined by calculating the frequency of word approximations and full word used from the PCI coding. Frequencies of word type were determined for children with fewer than 20 word types, and was analyzed through transcription analysis. Children with fewer than 20 word tokens or 5 word types were considered “preverbal status”.

Inter-rater Reliability

To assess inter-rater reliability, 33% of the videos were randomly selected and coded independently by two raters. Ratings were compared using partial interval exact scoring where reliability is calculated by determining if the two raters are in agreement for each interval (both rater say the behavior occurred, or both raters say the behavior did not occur)

or are in disagreement (one rater said the behavior did occur while the other said it did not occur). This type of reliability method is a robust, more conservative method of calculating percent agreement as the observers must agree not only exactly when the behavior did occur, but also when it did not occur, and can be susceptible to underestimating reliability due to minor disagreements in the exact timing of the behaviors when used during short intervals, such as 5 seconds intervals as used in the current study (Vollmer et al., 2008). Mean percent agreement for all variables (word, morpheme, and phrase level coding variables) was 96.7% (range, 82.9–99.9% across variables, and 65–100% across individual variables for individual participants).

Data Analysis

Multivariate Analysis of Variance (MANOVA) analyses were conducted for each level of coding including vocalization/word level coding, child morpheme coding, and child and parent phrase level coding, to assess for differences between diagnostic groups. Bonferroni corrections were used to adjust for multiple comparisons. The relationship between language ability and social behavior was of particular interest for the ASD group to understand the relationship between measures of language and social behavior and the potential impact of language skills across domains. Therefore, Pearson's correlations were conducted comparing the relationship between child full word use and child initiations and scores of social skills on the VABS and ADOS.

RESULTS

As expected, differences were seen between diagnostic groups on the battery of standardized assessments – MSEL, VABS, and ADOS within all subdomains (see Table 1). Our naturalistic language sample obtained during the PCI provided more detailed information and revealed that in terms of overall word use, only 3.7% (4 of 109) of the ASD sample and 0% of the LD and 0% of the TD sample used zero words. Results also indicated that 34% (37 of 109) of toddlers with ASD and 7% (3 of 40) toddlers with LD used fewer than 20 word tokens during the PCI observation. Figure 1 shows the distribution of number of word tokens used by those toddlers that used fewer than 20 word tokens in each diagnostic group. Word type was analyzed for toddlers with ASD who presented with 20 or fewer word tokens, and 19 of the 37 toddlers (17% of the entire sample) used fewer than five word types and four used no words (3.7% of the entire sample). No toddlers with LD used fewer than five word types.

MANOVA analyses revealed significant effects between groups for many language features (see table 3 for full results). The largest differentiation between groups was seen for child babbling ($F = 9.85$, $p < .001$, $\eta^2 = .090$) child word approximations ($F = 38.42$, $p < .001$, $\eta^2 = .271$), child full words ($F = 56.17$, $p < .001$, $\eta^2 = .351$), Wh- questions ($F = 27.21$, $p < .001$, $\eta^2 = .208$), child mean length of utterance ($F = 41.29$, $p < .001$, $\eta^2 = .285$), child initiations ($F = 42.775$, $p < .001$, $\eta^2 = .292$), child response ($F = 18.89$, $p < .001$, $\eta^2 = .154$), and parent narration ($F = 8.06$, $p = .001$, $\eta^2 = .072$). The aforementioned variables showed significant differences between ASD and TD toddlers, as well as between ASD and LD. See Figures 2 and 3 for a sample of language features across groups.

Pearson's correlations revealed overall significant positive correlations between child full word use and VABS Socialization Standard Score ($r = .593$, $p < .001$) and child initiations and VABS Socialization Standard Score ($r = .469$, $p < .001$), and significant negative correlations between child full word use and ADOS Total Score ($r = -.564$, $p < .001$) and child initiations and ADOS Total Score ($r = -.585$, $p < .001$). However, these differences were largely driven by diagnostic group status. When correlations were performed separately for each diagnostic group, the ASD group was the only group to show significant correlations between child full word use and VABS Socialization Standard Score ($r = .456$, $p < .001$), child full word use and ADOS Total Score ($r = -.242$, $p = .011$), and child initiations and ADOS Total Score ($r = -.384$, $p < .001$). The ASD and TD groups both showed significant correlations between child initiations and VABS Socialization Standard Scores (ASD: $r = .363$, $p < .001$, TD: $r = -.344$, $p = .007$) although in opposite directions.

DISCUSSION

Leveraging one of the largest natural language sample datasets containing over 200 3-year-old toddlers, the results of the present study overwhelmingly refute the idea that up to 50% of toddlers with ASD are either nonverbal or minimally verbal. No matter how nonverbal or minimally verbal is defined, only a small proportion of toddlers with ASD meet such definitions. Only 3.7% ($n=4$) of the toddlers with ASD used no words or word approximations at all, and 17% ($n=19$) had fewer than five types of words or word approximations. Furthermore, only 34% ($n=37$) had fewer than 20 word tokens during a naturalistic freeplay observation with a parent. These estimates of rates of preverbal or minimally verbal cases of toddlers with ASD in a naturalistic social setting are much lower than previous standardized assessment-based estimates of about 50% of the ASD population. More recent efforts suggest minimally verbal/preverbal rates are anywhere from 5–43% (Anderson et al., 2007; Bal et al., 2016; Norrelgen et al., 2015; Rose et al., 2016). While it is generally agreed that nonverbal rates are now lower than 50% and could be due to a multitude of factors including increased awareness and detection of ASD, changes in diagnostic criteria, and increased access to early intervention (Dawson and Bernier, 2013; Zwaigenbaum et al., 2015), inconsistencies in defining verbal abilities, broad analyses of general performance on standardized measures, and sampling methods have led to a continued lack of clarity of verbal capabilities in children with ASD. In our cohort, there were significant differences between diagnostic groups on standardized assessment of communication (e.g. the MSEL and VABS). These differences were unsurprising as these measures were used by psychologists to determine developmental ability and inform diagnostic impression. Group differences were observed in language and communication scores, providing rough evidence of language deficits in children with ASD. However, further detailed examination of language abilities through video coding of natural language samples in our study provided much more in depth and accurate estimates of verbal abilities. Our study also confirms the assumptions that rates of children with ASD that are preverbal are much lower than documented in early literature.

When examining language abilities across the domains measured, toddlers with ASD showed delays across variables and more impairment than LD and TD groups. For word and phrase level coding, children with ASD performed at a lower level than toddlers with LD,

who performed at a lower level than TD toddlers. The communication impairments seen in toddlers with ASD seem to go beyond the deficits seen in children with a history of non-ASD language delays, especially when examining language use during a social interaction rather than a standardized assessment. The social use of language was markedly different in toddlers with ASD compared to LD and TD, as toddlers with ASD also showed marked reductions in initiations, use of Wh-questions, and responses to parent. However, parents of toddlers with ASD initiated to their children just as frequently as other parents, showing they were creating just as many opportunities for reciprocal communication as other parents. Toddlers with LD also showed reduced word use, however they responded to their parents' initiations, used Wh questions, and initiated interaction in general at a similar rate as TD toddlers. Previous work has highlighted a lack of difference in ratings of autism symptoms (e.g. social communication) for children with ASD with and without co-occurring language impairment (Lindgren et al., 2009; Loucas et al., 2008). This distinction further highlights how toddlers with ASD have a specific impairment related to social communication that cannot be fully accounted for by lower language ability.

Toddlers with ASD and LD did show similar usage of grammatical markings, although both were reduced compared to TD toddlers. This suggests that although behind, toddlers with ASD and LD may show typical progression of grammar rather than atypical development. This lack of difference in language ability between ASD and LD highlights how toddlers with ASD may struggle more with social nuances of language rather than learning routine rules of language. Although reduced, grammatical skills were not significantly different from toddlers with LD, as contrasted with differences seen on several measures of social use of language. This is similar to findings from previous literature showing similar rates of acquisition and composition of word types to normative development, although reduced vocabulary size (Charman et al., 2003; Luyster et al., 2007). Hudry and colleagues (2010) have also demonstrated that children with ASD tend to show more impairment in receptive language relative to deficits in expressive language. The typically developing toddler understands the meaning of words well before using them expressively, leading to a much larger receptive vocabulary than expressively vocabulary as they are learning to talk. Toddlers with ASD often do not follow this profile showing much weaker receptive language than expressive skills relative to expected performance. Hudry and colleagues suggest that this atypical pattern in language development may contribute to difficulties with social communication and understanding social interactions because others may overestimate a child's receptive understanding leading to increased difficulty in participating in social interactions. Therefore, although there may be general delays in expressive language and acquisition of grammar, this may not be the driving force behind difficulties with social communication.

Although toddlers with ASD showed reduced language skills overall, there was considerable variability in performance within the group as well. This variation may be due to differences in brain activation to language as described in a recent fMRI study (Lombardo et al., 2015). In examining language heterogeneity within ASD, infants and toddlers with ASD who had poor later language outcomes defined as demonstrating scores lower than one standard deviation from the mean on the MSEL (which would likely include the nonverbal or minimally verbal ASD toddlers in the present study) had little to no brain activation in

canonical language systems such as superior temporal cortex at the age of first clinical detection. In contrast, ASD infants and toddlers who later had good or optimal language outcomes defined as MSEL scores in the average or above average range (such as the more language able ASD toddlers in the present study) had strong language activation in typical language processing brain regions. Thus, in ASD, distinctly different neurological language activation patterns are strongly associated with and may explain the wide range language and social communication outcomes described in the present study. Furthermore, correlations between language level and social behavior revealed positive correlations between language level and higher ratings of social skills on the VABS and a negative correlation between language level and rating of social impairment on the ADOS (see Figure 4). However, these differences appear to be largely driven by diagnostic classification as the LD and TD groups show a clear difference in performance on standardized measures as compared to the ASD group, and show overlapping ranges, yet different, rates of language use during the PCI observations. It is largely the ASD group that shows a unique relationship between language and social measures, with the toddlers who have more impaired language use, also having more impairment of social skills. Interestingly, the same relationship is not observed in LD cases, who also show language impairment, albeit, not to the same severity as many of the cases of children with ASD. These correlations highlight the wide range of abilities across children and emphasize the impairments in social skills and language faced by children with ASD in particular. Therefore, increasing the vocabulary, language flexibility, and initiation of social communication are goals of utmost importance for toddlers with ASD to improve core symptoms of the disorder, especially for those children demonstrating severe language deficits.

Overall, our study provides a highly reliable estimate of language profiles of ASD at the age three years due to its relatively large sample size, use of typically developing and language delayed contrast groups, measurement through detailed naturalistic language sampling, and the fact that the majority of subjects entered the study as the result of being detected by a routine screening questionnaire in general pediatric community settings, rather than high risk (e.g., baby sibling) referrals, autism services settings, or self-referrals from the community. Although not a completely bias-free sampling method, our sample may have fewer biases than samples obtained from treatment centers or diagnostic evaluation centers that may contain children with more severe phenotypes. Limitations of the current study include that 55% of the toddlers in the LD group did not retain their language delay classification at age three years. Eighty-five percent of toddlers were referred to our center and evaluated prior to the evaluation at age three years, the focus of this paper. Due to the transient nature of language impairments at young ages (Dale et al., 2003; Everitt et al., 2013), a substantial portion of children no longer scored as delayed by age three. Little is known on how to differentially identify persistent and transient cases of language delay at early ages. Moreover, it is still unclear how early delays may affect later outcomes. However, all children were referred for treatment (e.g. speech therapy) once a delay was identified. All children were analyzed in one group due to power limitations and due to similar history. However, this difference may make it more difficult to interpret differences between toddlers with ASD and those with non-ASD language delay.

In sum, our study provides updated estimates for expected language outcomes in a contemporary population of children with ASD who began early intervention prior to age three. The findings highlight that while toddlers with ASD show delays in communication on average, the vast majority demonstrate at least some verbal language, with only 3.7% failing to demonstrate any verbal communication at age three. Additionally, using the language definition guidelines put forth by Tager-Flusberg et al. (2009), only 34% of the ASD sample was considered to have the lowest categorical rating of vocabulary, further supporting that most children go on to use meaningful verbal communication. The findings here also highlight how toddlers with ASD struggle with the social aspects of language over learning rules such as grammatical markings. Although language was reduced as compared to children with LD, grammatical markings were similar, showing that when they did communicate, grammatical use was only slightly impacted as compared to the ability to initiate conversation or respond to questions. In particular, they showed a marked five-fold reduction in asking questions in a natural social situation (Table 3). This difference provides insight into language goals as well. As toddlers with ASD may be better apt to learn rules of language, intervention may be best suited to focusing on conversation exchanges regardless of the sophistication of language. This type of treatment goal lends itself nicely to naturalistic developmental behavioral interventions (Schreibman et al., 2015). These types of interventions incorporate following the child's lead, reinforce and expand communication, and focus on play-based teaching environments, rather than therapist led and drill-based teaching in a structured setting. Support for naturalistic developmental behavioral interventions for young toddlers with ASD has been documented by robust RCTs showing improvements in language, social skills, and adaptive behavior following treatment (Baranek et al., 2015; Dawson et al., 2010; Green et al., 2010; Wetherby et al., 2014). Together with the increased push for early identification, early treatment start and use of progressive intervention strategies, the expectations for communication and language abilities for toddlers with ASD has advanced tremendously.

Acknowledgments

This work was supported by NIH grants ACE P50-MH081755 awarded to E.C. and R01-MH080134 awarded to K.P. We sincerely thank the toddlers and families that participated in this research.

References

- Anderson DK, Lord C, Risi S, et al. 2007; Patterns of growth in verbal abilities among children with autism spectrum disorder. *Journal of Consulting and Clinical Psychology*. 75:594–604. [PubMed: 17663613]
- Bacon EC, Courchesne E, Barnes CC, et al. 2017 Rethinking the idea of late autism spectrum disorder onset. *Development and Psychopathology*. :1–17.
- Bal VH, Katz T, Bishop SL, et al. 2016; Understanding definitions of minimally verbal across instruments: evidence for subgroups within minimally verbal children and adolescents with autism spectrum disorder. *Journal of Child Psychology and Psychiatry*. 57:1424–1433. [PubMed: 27473432]
- Baranek GT, Watson LR, Turner-Brown L, et al. 2015; Preliminary efficacy of adapted responsive teaching for infants at risk of autism spectrum disorder in a community sample. *Autism Research and Treatment*. 2015:386951. [PubMed: 25648749]

- Bartak L, Rutter M, Cox A. 1975; A comparative study of infantile autism and specific developmental receptive language disorder. I. The Children. *British Journal of Psychiatry*. 126:127–145. [PubMed: 1131465]
- Bill BR, Geschwind DH. 2009; Genetic advances in autism: heterogeneity and convergence on shared pathways. *Current Opinion in Genetics and Development*. 19:271–278. [PubMed: 19477629]
- Brown, R. A first language: The early stages. Cambridge, MA: Harvard University Press; 1973.
- Charman T, Drew A, Baird C, et al. 2003; Measuring early language development in preschool children with autism spectrum disorder using the MacArthur Communicative Development Inventory (Infant Form). *Journal of Child Language*. 30:213–236. [PubMed: 12718299]
- Chenauksy K, Norton A, Tager-Flusberg H, et al. 2016; Auditory-Motor Mapping Training: Comparing the Effects of a Novel Speech Treatment to a Control Treatment for Minimally Verbal Children with Autism. *PLoS One*. 11:e0164930. [PubMed: 27829034]
- Dale PS, Price TS, Bishop DVM, et al. 2003; Outcomes of early language delay: I. Predicting persistent and transient language difficulties at 3 and 4 years. *Journal of Speech, Language, and Hearing Research*. 46:544–560.
- Dawson G, Bernier R. 2013; A quarter century of progress on the early detection and treatment of autism spectrum disorder. *Development and Psychopathology*. 25:1455–1472. [PubMed: 24342850]
- Dawson G, Rogers S, Munson J, et al. 2010; Randomized, controlled trial of an intervention for toddlers with autism: the Early Start Denver Model. *Pediatrics*. 125:e17–23. [PubMed: 19948568]
- DiStefano C, Shih W, Kaiser A, et al. 2016; Communication growth in minimally verbal children with ASD: The importance of interaction. *Autism Research*. 9:1093–1102. [PubMed: 26824676]
- Eigsti I-M, de Marchena AB, Schuh JM, et al. 2011; Language acquisition in autism spectrum disorders: A developmental review. *Research in Autism Spectrum Disorders*. 5:681–691.
- Everitt A, Hannaford P, Conti-Ramsden G. 2013; Markers for persistent specific expressive language delay in 3–4-year-olds. *International Journal of Language and Communication Disorders*. 48:534–553. [PubMed: 24033652]
- Fossum KL, Williams L, Garon N, et al. 2017; Pivotal response treatment for preschoolers with autism spectrum disorder: Defining a predictor profile. *Autism Research*.
- Fountain C, King MD, Bearman PS. 2011; Age of diagnosis for autism: individual and community factors across 10 birth cohorts. *Journal of Epidemiology and Community Health*. 65:503–510. [PubMed: 20974836]
- Geschwind DH, State MW. 2015; Gene hunting in autism spectrum disorder: on the path to precision medicine. *Lancet Neurology*. 14:1109–1120. [PubMed: 25891009]
- Green J, Charman T, McConachie H, et al. 2010; Parent-mediated communication-focused treatment in children with autism (PACT): a randomised controlled trial. *Lancet*. 375:2152–2160. [PubMed: 20494434]
- Hartung JR. 1970; A review of procedures to increase verbal imitation skills and functional speech in autistic children. *Journal of Speech and Hearing Disorders*. 35:203–217. [PubMed: 5449497]
- Herlihy LE, Brooks B, Dumont-Mathieu T, et al. 2014; Standardized screening facilitates timely diagnosis of autism spectrum disorders in a diverse sample of low-risk toddlers. *Journal of Developmental Behavioral Pediatrics*. 35:85–92. [PubMed: 24509053]
- Hudry K, Leadbitter K, Temple K, et al. 2010; Preschoolers with autism show greater impairment in receptive compared with expressive language abilities. *International Journal of Language and Communication Disorders*. 45:681–690. [PubMed: 20102259]
- Kasari C, Kaiser A, Goods K, et al. 2014; Communication interventions for minimally verbal children with autism: a sequential multiple assignment randomized trial. *Journal of American Academy of Child and Adolescent Psychiatry*. 53:635–646.
- Kasari C, Paparella T, Freeman S, et al. 2008; Language outcome in autism: randomized comparison of joint attention and play interventions. *Journal of Consulting and Clinical Psychology*. 76:125–137. [PubMed: 18229990]
- Kim SH, Macari S, Koller J, et al. 2015; Examining the phenotypic heterogeneity of early Autism Spectrum Disorder: subtypes and short-term outcomes. *Journal of Child Psychology and Psychiatry*.

- Koegel LK, Koegel RL, Smith A. 1997; Variables related to differences in standardized test outcomes for children with autism. *Journal of Autism and Developmental Disorders*. 27:233–243. [PubMed: 9229256]
- Koegel RL, Shirotova L, Koegel LK. 2009; Brief report: using individualized orienting cues to facilitate first-word acquisition in non-responders with autism. *Journal of Autism and Developmental Disorders*. 39:1587–1592. [PubMed: 19488847]
- Lindgren KA, Folstein SE, Tomblin JB, et al. 2009; Language and reading abilities of children with autism spectrum disorders and specific language impairment and their first-degree relatives. *Autism Research*. 2:22–38. [PubMed: 19358305]
- Lombardo MV, Pierce K, Eyler LT, et al. 2015; Different functional neural substrates for good and poor language outcome in autism. *Neuron*. 86:567–577. [PubMed: 25864635]
- Lord, C, Risi, S, Pickles, A. *Developmental language disorders: From phenotypes to etiologies*. Mahwah, NJ: Lawrence Erlbaum Associates Publishers; 2004. Trajectory of language development in autistic spectrum disorders.
- Lord, C, Rutter, M, DiLavore, P., et al. *Autism Diagnostic Observation Schedule—2nd edition (ADOS-2)*. Los Angeles, CA: Western Psychological Corporation; 2012.
- Loucas T, Charman T, Pickles A, et al. 2008; Autistic symptomatology and language ability in autism spectrum disorder and specific language impairment. *Journal of Child Psychology and Psychiatry*. 49:1184–1192. [PubMed: 19017030]
- Luyster R, Lopez K, Lord C. 2007; Characterizing communicative development in children referred for Autism Spectrum Disorders using the MacArthur-Bates Communicative Development Inventory (CDI). *Journal of Child Language*. 34:623. [PubMed: 17822142]
- Mayo J, Chlebowski C, Fein DA, et al. 2013; Age of first words predicts cognitive ability and adaptive skills in children with ASD. *Journal of Autism Developmental Disorders*. 43:253–264. [PubMed: 22673858]
- Moulton E, Barton M, Robins DL, et al. 2016; Early Characteristics of Children with ASD Who Demonstrate Optimal Progress Between Age Two and Four. *Journal of Autism Developmental Disorders*. 46:2160–2173. [PubMed: 26895327]
- Mullen, EM. *Mullen Scales of Early Learning*. MN: American Guidance Service Inc.; 1995.
- Norrelgen F, Fernell E, Eriksson M, et al. 2015; Children with autism spectrum disorders who do not develop phrase speech in the preschool years. *Autism*. 19:934–943. [PubMed: 25488002]
- Paul R, Campbell D, Gilbert K, et al. 2013 *Comparing Spoken Language Treatments for Minimally Verbal Preschoolers with Autism Spectrum Disorders*. Speech-Language Pathology Faculty Publications.
- Pickles A, Anderson DK, Lord C. 2014; Heterogeneity and plasticity in the development of language: a 17-year follow-up of children referred early for possible autism. *Journal of Child Psychology Psychiatry*. 55:1354–1362. [PubMed: 24889883]
- Pierce K, Carter C, Weinfeld M, et al. 2011; Detecting, studying, and treating autism early: the one-year well-baby check-up approach. *Journal of Pediatrics*. 159:458–465. e451–456. [PubMed: 21524759]
- Pierce K, Courchesne E, Bacon E. 2016; To Screen or Not to Screen Universally for Autism is not the Question: Why the Task Force Got It Wrong. *Journal of Pediatrics*. 176:182–194. [PubMed: 27421956]
- Prizant B. 1996; Brief Report: Communication, Language, Social, and Emotional Development. *Journal of Autism and Developmental Disorders*. 26:173–178. [PubMed: 8744480]
- Rice K, Moriuchi JM, Jones W, et al. 2012; Parsing heterogeneity in autism spectrum disorders: visual scanning of dynamic social scenes in school-aged children. *Journal of American Academy of Child and Adolescent Psychiatry*. 51:238–248.
- Romski M, Sevcik RA, Adamson LB, et al. 2010; Randomized comparison of augmented and nonaugmented language interventions for toddlers with developmental delays and their parents. *Journal of Speech, Language, and Hearing Research*. 53:350–364.
- Rose V, Trembath D, Keen D, et al. 2016; The proportion of minimally verbal children with autism spectrum disorder in a community-based early intervention programme. *Journal of Intellectual Disability Research*. 60:464–477. [PubMed: 27120989]

- Rutter M. 1967; The autistic child. Royal Institute of Public Health and Hygiene Journal. 30:130–132. [PubMed: 5588915]
- Schreibman L, Dawson G, Stahmer AC, et al. 2015; Naturalistic Developmental Behavioral Interventions: Empirically Validated Treatments for Autism Spectrum Disorder. Journal of Autism and Developmental Disorders. 45:2411–2428. [PubMed: 25737021]
- Sparrow, S, Cicchetti, D, Balla, D. Vineland-II scales of adaptive behavior: survey form manual. Circle Pines, MN: American Guidance Service; 2005.
- Sulzbacher SI, Costello JM. 1970; A behavioral strategy for language training of a child with autistic behaviors. Journal of Speech and Hearing Disorders. 35:256–276. [PubMed: 5449503]
- Tager-Flusberg, H, Paul, R, Lord, C. Language and Communication in Autism. In: Volkmar, FRPR, Klin, A, Cohen, D, editors. Handbook of Autism and Pervasive Developmental Disorders. 3. 2005. 335–364.
- Tager-Flusberg H, Rogers S, Cooper J, et al. 2009; Defining Spoken Language Benchmarks and Selecting Measures of Expressive Language Development for Young Children with Autism Spectrum Disorders. Journal of Speech, Language, and Hearing Research. 52:643–656.
- Tek S, Mesite L, Fein D, et al. 2014; Longitudinal analyses of expressive language development reveal two distinct language profiles among young children with autism spectrum disorders. Journal of Autism and Developmental Disorders. 44:75–89. [PubMed: 23719855]
- Thurm A, Manwaring SS, Swineford L, et al. 2015; Longitudinal study of symptom severity and language in minimally verbal children with autism. Journal of Child Psychology and Psychiatry. 56:97–104. [PubMed: 24961159]
- Vollmer TR, Sloman KN, St Peter Pipkin C. 2008; Practical implications of data reliability and treatment integrity monitoring. Behavior Analysis in Practice. 1:4–11. [PubMed: 22477682]
- Wetherby AM, Guthrie W, Woods J, et al. 2014; Parent-implemented social intervention for toddlers with autism: an RCT. Pediatrics. 134:1084–1093. [PubMed: 25367544]
- Woynaroski T, Yoder P, Watson LR. 2016; Atypical Cross-Modal Profiles and Longitudinal Associations Between Vocabulary Scores in Initially Minimally Verbal Children With ASD. Autism Research. 9:301–310. [PubMed: 26180010]
- Yoder P, Stone WL. 2006; Randomized comparison of two communication interventions for preschoolers with autism spectrum disorders. Journal of Consulting and Clinical Psychology. 74:426–435. [PubMed: 16822100]
- Zwaigenbaum L, Bauman ML, Choueiri R, et al. 2015; Early Intervention for Children With Autism Spectrum Disorder Under 3 Years of Age: Recommendations for Practice and Research. Pediatrics. 136(Suppl 1):S60–81. [PubMed: 26430170]

Figure 1. Distribution of word tokens for participants who used fewer than 20 word tokens during the PCI. Note, all TD children used over 20 word tokens and are not depicted.

Figure 2.

Average percentage of intervals child and parent language behaviors occurred by diagnostic group. Significant differences between groups are represented by asterisks (* p < .05, ** p < .01, *** p < .001).

Figure 3.

Mean length of utterance spoken during the PCI observation by diagnostic group. Significant differences between groups are represented by asterisks (* $p < .05$, ** $p < .01$, *** $p < .001$).

Figure 4.

Correlations between child language use during the PCI and standardized scores of social skills. Panels A and B represent correlations between VABS Socialization Standard Scores and percentage of full word used by the child and child initiations during the PCI. Panels C and D depict correlations between ADOS Total Scores and percentage of full word used by the child and child initiations during the PCI.

Table 1

Participant demographics. For assessment scores (Mullen, Vineland, ADOS) means are listed with standard deviations in parentheses. Test scores are based on assessments conducted at age 3 years. Children included in the LD group showed a history of language delay, with 45% of the sample continuing to show a language delay at age 3 years. (Mean initial age detected = 21.1 months; Mullen Receptive Language T Score = 42.1, Mullen Expressive Language T Score = 33.8).

	ASD (n=109)	LD (n=40)	TD (n=61)	F	Sig	Partial Eta Squared	ASD vs LD	ASD vs TD	LD vs TD
Age in months	35.3 (3.4)	34.5 (3.2)	34.6 (3.1)						
Sex									
Male	87	27	32						
Female	22	13	29						
Ethnicity									
Hispanic or Latino	31	11	10						
Not Hispanic or Latino	71	28	49						
Not Reported	7	1	2						
Race									
American Indian/Alaska Native	1	1	0						
Asian	9	4	1						
Black/African American	2	1	1						
Caucasian	75	25	48						
Pacific Islander/Native Hawaiian	1	0	0						
Multiple Races Reported	9	3	6						
Not Reported	12	6	5						
Mullen T Scores									
Visual Reception	39.0 (14.8)	51.9 (11.2)	61.0 (11.3)	42.5	***	0.32	***	***	**
Fine Motor	35.1 (11.4)	49.7 (10.3)	52.2 (10.3)	43.4	***	0.33	***	***	N.S.
Receptive Language	31.6 (13.5)	46.4 (10.2)	55.1 (9.2)	61.9	***	0.41	***	***	**

	ASD (n=109)	LD (n=40)	TD (n=61)	F	Sig	Partial Eta Squared	ASD vs LD	ASD vs TD	LD vs TD
Expressive Language	30.9 (15.6)	45.6 (11.1)	55.4 (8.8)	54.3	***	0.38	***	***	**
Vineland Standard Scores									
Communication	80.1 (15.3)	98.8 (11.5)	107.0 (11.3)	84.4	***	0.45	***	***	**
Daily Living Skills	80.9 (12.1)	96.5 (11.3)	101.5 (8.3)	73.0	***	0.41	***	***	N.S.
Socialization	80.9 (12.4)	98.4 (9.9)	105.1 (9.8)	100.6	***	0.49	***	***	*
Motor Skills	87.1 (11.8)	94.5 (12.8)	97.0 (7.7)	21.2	***	0.17	***	***	N.S.
ADOS Algorithm Scores									
Social Communication	13.6 (3.7)	2.5 (2.3)	2.0 (1.9)	361.2	***	0.78	***	***	N.S.
RRB	3.6 (1.5)	0.5 (0.5)	0.2 (0.4)	235.1	***	0.69	***	***	N.S.

Significant differences between groups are represented by asterisks (* p .05, ** p .01, *** p .001).

Table 2

Vocalization/word, phrase, and grammatical coding variables and definitions. Grammatical morphemes based on Brown's 14 grammatical morphemes that are acquired prior to age three (adapted from Brown, 1973 and Tek et al., 2013).

Child Vocalization/Word Level Coding		
Code	Function	Examples
Unidentified Sounds	Non-word sounds/vocalizations	"Bah," "tuh"
Self-Stimulatory Speech	Repetitive, non-communicative sounds	"Aa-ee aa-ee"
Babbling	Sound reduplications	"bababa"
Sound Effects	Sounds used to accompany play scenarios	"Vroom," "Moo"
Word Approximation	An imperfect or unclear attempt at a word	"Ba" (ball)
Fully Articulated Word	Clearly articulated word	"Yes"
Child Morpheme Scoring		
Order of Acquisition	Morpheme	Example
1	Present progressive - <i>ing</i> (no auxiliary verb)	Mommy singing.
2	<i>In</i>	Dog in house.
3	<i>On</i>	Hat on head.
4	Regular plural - <i>s</i>	Boys fell down.
5	Irregular past	I ate ice cream
6	Possessive - 's	Daddy's keys.
7	Uncontractible copula (Verb to be as main verb)	This is yours
8	Articles	I see a kite.
9	Regular past - <i>ed</i>	He talked ed on the phone.
10	Regular third person -s	Johnny swings.
11	Irregular third person	She has crayons
12	Uncontractible auxiliary (Verb to be as auxiliary)	She was dancing.
13	Contractible copula	Dog's big.
14	Contractible auxiliary	Mommy's eating cake.
-	Wh- questions	What is it?
Child and Parent Phrase Level		
Code	Function	Examples
Child Echolalia	Use of an idiosyncratic phrase, or repeating word/phrase said by the caregiver	Parent: Look it's a train! Child: Look it's a train!
Child Initiation	Child makes statement or asks a question	Child: Let's play with baby!
Child Response	Child responds to statement or question asked by caregiver	Parent: "Do you want the ball?" Child: "No"
Child Mean Length of Utterance	Mean number of words in phrases spoken by child during assessment	Ex: 2.5
Parent Initiation	Question, command, or attempt to capture child's attention	"Pass the doll," "What is that?"
Parent Response	Repeating the child's words or answering a question	Child: "Can we play?"

Child Vocalization/Word Level Coding		
Code	Function	Examples
Parent Narration	Descriptions of the environment or use of non-directive speech (e.g. sound effects, singing)	Parent: "Yes!" "Baby is sleeping"
Parent Feedback	Used to regulate or encourage the child	"Good job!"

Table 3

Results of MANOVA analyses. Bonferroni corrections used for multiple comparisons.

Percent Child Vocalizations							
Code	ASD	LD	TD	F	Sig	Partial Eta Squared	ASD vs LD ASD vs TD LD vs TD
Unidentified Sounds	13.87 (10.37)	11.40 (7.59)	9.94 (5.68)	4.21	*	0.04	N.S. * N.S.
Self-Stimulatory Speech	0.61 (1.81)	0.04 (0.26)	0.10 (0.41)	4.31	*	0.04	N.S. * N.S.
Babbling	1.75 (2.82)	0.81 (1.12)	0.30 (0.55)	9.85	***	0.09	* *** N.S.
Sound Effects	2.98 (4.23)	4.02 (3.76)	3.25 (3.52)	1.01	N.S.	0.01	N.S. N.S.
Word Approximation	20.36 (14.78)	34.62 (14.96)	39.37 (13.27)	38.42	***	0.27	*** *** N.S.
Fully Articulated Word	12.20 (13.35)	23.50 (13.48)	35.07 (14.10)	56.17	***	0.35	*** ***
Percent Child Morpheme Use							
Morpheme	ASD	LD	TD	F	Sig	Partial Eta Squared	ASD vs LD ASD vs TD LD vs TD
Present progressive - <i>ing</i>	0.29 (0.66)	0.52 (0.79)	0.83 (1.07)	8.63	***	0.08	N.S. *** N.S.
In	0.22 (0.57)	0.31 (0.49)	1.11 (1.66)	16.10	***	0.14	N.S. ***
On	0.23 (0.56)	0.41 (0.82)	0.97 (1.17)	15.77	***	0.13	N.S. ***
Regular plural - <i>s</i>	0.94 (1.55)	1.46 (1.96)	2.02 (2.11)	7.11	***	0.06	N.S. *** N.S.
Irregular past	0.38 (0.80)	0.69 (1.11)	0.89 (1.21)	5.28	**	0.05	N.S. *** N.S.
Possessive - <i>'s</i>	0.12 (0.46)	0.23 (0.68)	0.33 (0.61)	2.91	N.S.	0.03	N.S. N.S.
Uncontractible copula	0.20 (0.79)	0.33 (0.73)	0.83 (1.34)	8.47	***	0.08	N.S. *** *
Articles	2.37 (4.70)	3.15 (2.95)	5.11 (4.08)	8.23	***	0.07	N.S. *** N.S.
Regular past - <i>ed</i>	0.10 (0.46)	0.13 (0.55)	0.27 (0.74)	1.88	N.S.	0.02	N.S. N.S.
Regular third person - <i>s</i>	0.13 (0.53)	0.17 (0.43)	0.78 (1.65)	9.46	***	0.08	N.S. ***
Irregular third person	0.05 (0.35)	0.14 (0.68)	0.20 (0.66)	1.68	N.S.	0.02	N.S. N.S.
Uncontractible auxiliary	0.04 (0.18)	0.02 (0.13)	0.07 (0.32)	0.59	N.S.	0.01	N.S. N.S.
Contractible copula	0.70 (1.24)	1.58 (1.92)	3.21 (2.98)	30.31	***	0.23	N.S. ***
Contractible auxiliary	0.12 (0.41)	0.23 (0.63)	0.52 (1.00)	6.96	***	0.06	N.S. ***
Wh- questions	0.62 (1.17)	2.15 (2.17)	3.17 (3.38)	27.21	***	0.21	*** N.S.
Percent Child and Parent Phrase Use							

Percent Child Vocalizations										
Code	ASD	LD	TD	F	Sig	Partial Eta Squared		ASD vs LD	ASD vs TD	LD vs TD
						Partial Eta Squared	Partial Eta Squared			
Child Echolalia	3.88 (3.82)	4.86 (3.75)	3.30 (2.94)	2.27	N.S.	0.02		N.S.	N.S.	N.S.
Child Initiation	17.72 (13.42)	30.35 (14.19)	36.36 (11.81)	42.78	***	0.30		***	***	N.S.
Child Response	9.03 (8.08)	14.79 (7.20)	16.46 (8.63)	18.89	***	0.15		***	***	N.S.
Child Mean Length of Utterance	1.46 (0.62)	1.80 (0.57)	2.40 (0.73)	41.29	***	0.29		*	***	***
Parent Initiation	49.76 (15.58)	48.72 (13.46)	46.08 (13.75)	1.24	N.S.	0.01		N.S.	N.S.	N.S.
Parent Response	6.45 (5.78)	9.13 (5.48)	11.98 (6.75)	16.65	***	0.14		N.S.	***	N.S.
Parent Narration	41.03 (12.96)	34.32 (11.58)	34.19 (11.35)	8.06	***	0.07		**	**	N.S.
Parent Feedback	5.17 (4.43)	5.15 (4.22)	3.45 (3.24)	3.84	*	0.04		N.S.	*	N.S.

Note: *p .05,

** p .01,

*** p .001.