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Longitudinal Analyses of Expressive Language Development Reveal Two Distinct Language Profiles among Young Children with Autism Spectrum Disorders

Saime Tek[1], **Laura Mesite**[2], **Deborah Fein**[3], and **Letitia Naigles**[3]

[1]Bilkent University, Psychology Department, Bilkent, Ankara, 06800, Turkey

[2]Brown University, 190 Thayer Street, Providence, 02912, RI

[3]University of Connecticut, 406 Babbidge Road, Unit 1020, Storrs, CT, 06269-1020, USA

Abstract

Although children with ASD show significant variation in language skills, research on what type(s) of language profiles they demonstrate has been limited. Using growth-curve analyses, we investigated how different groups of young children with ASD show increases in the size of their lexicon, morpho-syntactic production as measured by Brown's 14 grammatical morphemes, and wh-question complexity, compared to TD children, across six time points. Children with ASD who had higher verbal skills were comparable to TD children on most language measures, whereas the children with ASD who had low verbal skills had flatter trajectories in most language measures. Thus, two distinct language profiles emerged for children with ASD.

Keywords

Autism spectrum disorders; language acquisition; morphology and syntax

Autism spectrum disorders (ASD) are a group of neurodevelopmental disorders marked by impairments in social interaction, communication, and repetitive and stereotypical behavior, which are generally evident before three years of age (DSM IV-TR, APA, 2000)[1]. Although impairments in aspects of communication are considered one of the core deficits of ASD, and, therefore, have been universally reported among individuals with ASD, there is a dearth

Correspondence should be addressed to the first author: Saime Tek, Bilkent University, Psychology Department, Bilkent, Ankara, 06800, Turkey. Phone: (90 312) 290 1728, saimetek@bilkent.edu.tr.

[2]We did not use t scores of the MSEL Expressive Language Scale to match the groups, as they were not matched in chronological age (Mervis & Klein-Tasman, 2004). We recruited young children with ASD to investigate early language acquisition in this population, as soon as possible after a diagnosis was obtained. However, because the average age of ASD diagnosis is around four in United States (CDC, 2012), the mean age for this group of early-diagnosed children was 32.85 months at visit 1. We recruited TD controls whose expressive language was on par with children with ASD, but they were younger than the ASD group. We also did not use age-equivalency scores of the MSEL, because the age-equivalency scores are on ordinal scale, which can make the analysis using these scores less interpretable or meaningful compared to raw scores, which are on interval scale (Mervis & Klein-Tasman, 2004).

The authors declare that they have no conflicts of interest.

[1]Although the term autism spectrum disorders (ASD) includes a group of disorders that are classified as pervasive developmental disorders in the DSM-IV-TR (APA, 2000), this study reports findings from children with a diagnosis of autistic disorder or pervasive developmental disorder-not otherwise specified (PDD-NOS) according to DSM-IV criteria. Therefore, unless specified otherwise, the term ASD in this paper mostly refers to children with a diagnosis of autism and PDD-NOS.

of literature on the structural aspects of language acquisition in young children with ASD including the lexicon/semantics, morphology, and syntax (Boucher, 2012; Eigsti, Bennetto, & Dadlani, 2007; Park, Yelland, Taffe, & Gray, 2012; Tager-Flusberg, Paul, & Lord, 2005; Williams, Botting, & Boucher, 2008). This can be explained in part by the fact that impairments in formal aspects of language, although an important part of ASD, are not usually considered necessary for a diagnosis. Moreover, there is also considerable variation in language skills among individuals with ASD. For example, some individuals with ASD, such as those with Asperger's syndrome, do not show any language delays, whereas about 25% of all children with ASD may never develop any functional language in their lifetimes (Klinger, Dawson, & Renner, 2002). However, delineating the nature of impairments in language acquisition in autism spectrum disorders is important because, first, impairments in the use of language are one of the earliest symptoms that parents of young children with ASD are concerned about in their children's development, and, second, language functioning early in life strongly correlates with long-term outcomes (Szatmari, et al., 2009; Tager-Flusberg et al., 2005).

Because of the large variation in language outcomes, there is not much consensus among researchers as to which aspects of language are intact or impaired. For example, some studies have shown intact lexical/semantic skills in ASD, where vocabularies increase steadily with age and are composed primarily of nouns, as has been found with typically-developing children (TD; Fein et al., 1996; Swensen, Kelley, Fein, & Naigles, 2007; Tager-Flusberg et al., 1990). On the other hand, it has also been shown that young children with ASD may not rely on similar lexical learning mechanisms as TD children although they can acquire a sizeable vocabulary (Gastgeb, Strauss, & Minshew, 2006; Kelly, Paul, Naigles, & Fein, 2006; Tek, Jaffery, Fein, & Naigles, 2008). Another impairment in lexical skills that has been shown in the literature is that mental state terms are underrepresented in conversations with children with ASD, suggesting that autistic children's vocabulary use can be deficient as compared to TD children (Baron-Cohen et al., 1994).

With respect to morphology and syntax, some research has demonstrated that computational aspects of language (i.e., grammar) are relatively intact in children with ASD. In a longitudinal study of six children with autism between 3 and 7 years of age, Tager-Flusberg et al. (1990) found that children with autism and Down syndrome followed the same developmental pattern as TD children in their increases in mean length of utterance (MLU). More recently, Naigles, Kelty, Jaffery, and Fein (2011) have demonstrated an understanding of some syntax-semantics linkages, such as the mapping of transitive verbs onto causative actions, in preschoolers with ASD at comparable levels to language-matched TD children. On the other hand, other studies have reported atypical morpho-syntax in children with ASD. In one of the earliest accounts, Bartolucci, Pierce, and Streiner (1980) compared school-aged children with autism, children with mental handicap, and TD children, all matched on chronological age, on their acquisition of Brown's 14 grammatical morphemes (Brown, 1973). These morphemes include structures such as articles, prepositions "in" and "on," regular and irregular past tense markers, etc. In this cross-sectional study, Bartolucci et al. (1980) found that children with autism were more likely than children in the other groups to omit certain morphemes, especially articles, auxiliary and copula forms of *be*, past tense, third person singular, and progressives. They also found that these morphemes emerged later in the speech of children with autism. This finding has been replicated by Howlin (1984), using groups matched on MLU, which is a better indicator of language functioning than chronological age. More recently, Eigsti et al. (2007) compared 3-6 year-old children with autism to TD children and children with developmental delay (DD), who were both matched to the autism group on nonverbal IQ. Children's spontaneous speech during free play was analyzed, and Index of Productive Syntax (IPSyn) scores, which measure grammatical complexity on verb phrases, noun phrases, question and negations, and sentence structure, were calculated. Eigsti et al. (2007) found that children with autism produced fewer syntactically complex utterances than both TD children and children with DD on all scales of the IPSyn (see also Park et al., 2012 for similar findings of impaired wh-question production).

Delayed grammatical development need not always be the implicated impairment in the processes of language acquisition, though. In a cross-sectional study, Waterhouse and Fein (1982) found that the order of acquisition of Brown's 14 morphemes in children with autism was similar to the order of acquisition in TD children. Furthermore, in a longitudinal study, Goodwin, Fein, and Naigles (2012) found delayed comprehension of wh-questions in preschoolers with ASD, but also reported that these children demonstrated (typical) earlier comprehension than production of these constructions (see also Swensen et al., 2007). One reason for the different reports of language abilities among individuals with ASD may be that there appear to be different profiles of language development among this population. For example, Tager-Flusberg (2006) has proposed that a subgroup of children with autism have a similar language profile to children with specific language impairment (SLI). SLI is a developmental language disorder that is marked by deficits in language without any hearing loss or cognitive/neurological impairment. Children with SLI show impairments in several aspects of phonology and morpho-syntax, such as frequent omissions of past tense morphology (Joanisse & Seidenberg, 1998). Tager-Flusberg and her colleagues (Kjelgaard & Tager-Flusberg, 2001; Tager-Flusberg, 2006) have demonstrated a heterogeneity in language functioning of a large sample of children with autism using standardized language measures, with some children with autism showing intact language skills (named as autism language-normal group, or ALN), and another subgroup of children with autism showing a language profile that is similar to the language profile of children with SLI (the language-impaired autism group, or ALI). Specifically, children in the ALI subgroup had impairments in phonological processing as evidenced by difficulties on a non-word repetition task, and they also made more errors in tense marking compared to TD children (Roberts, Rice, & Tager-Flusberg, 2004). Although some genetic and neurobiological evidence has suggested an overlap between SLI and autism (Williams et al., 2008), this overlap has also been challenged on the grounds that a generalized learning disability might contribute to the poor performance of lower functioning individuals with ALI on the standardized language measures (Boucher, 2012).

As Tager-Flusberg (2006) has proposed, it is possible that different language profiles may exist among children with ASD because of the wide variation in language skills. One of the aims of this paper is to investigate variation in language performance among children with ASD. For example, it is possible that children with ASD who have better verbal skills will be similar to TD children in many aspects of morpho-syntax, whereas children with ASD with more profound delays may show global impairments in language functioning. Although different language profiles have been proposed in the literature (Tager-Flusberg, 2006), most of these studies have used standardized language measures such as the Mullen Scales of Early Learning (Mullen, 1995) as outcome measures, which provide only a general view of receptive and expressive language. Moreover, young children with ASD may demonstrate poor compliance in a structured test environment due to low motivation or poor attention skills (Condouris, Meyer, & Tager-Flusberg, 2003). Thus, in order to understand different existing language profiles among young children with ASD, there is a need to investigate the development of a wider range of morpho-syntactic elements produced in more naturalistic settings. Moreover, delineating and refining the different language profiles among this population can also provide invaluable information about phenotypic features and genetic subgrouping in this disorder (Kjelgaard & Tager-Flusberg, 2001).

Most studies on structural aspects of language development in ASD have been cross-sectional; however, longitudinal studies are necessary to draw more accurate conclusions as to whether or not children with ASD acquire language in different way(s) than TD children. Furthermore, because autism spectrum disorders are usually diagnosed around four years of age (Centers for Disease Control and Prevention, 2012), most of the studies on language development in ASD have included children who are around or older than this age (Bartolucci et al., 1980; Condouris et al., 2003; Eigsti et al., 2007; Kjelgaard & Tager-Flusberg, 2001; Roberts et al., 2004). However, because language acquisition begins early in life in TD children, it is crucial to study language development in younger children with ASD. The purpose of the present study, therefore, is to assess whether (or which) toddlers with ASD demonstrate the same patterns of acquisition of noun and verb tokens, wh-question complexity, and Brown's (1973) 14 grammatical morphemes, as TD children. To our knowledge, this study will be the first longitudinal analysis of spontaneous speech that will include such an extensive comparison of expressive language skills between TD toddlers and toddlers with ASD across a total of six time points spanning 1.5 years. We hypothesize that, consistent with previous research, TD children and children with ASD will show increases in the size of their lexicon and in the complexity of their morphology and syntax, as measured by Brown's 14 morphemes and wh-question complexity, over time. We also performed growth curve analyses (Singer & Willett, 2003) to examine the patterns of language development in these young children with ASD over time, and we hypothesize that, consistent with previous studies, there will be variations in these patterns in many components of language among these children. Specifically, as Tager-Flusberg (2006) has suggested, it is possible that different language profiles may emerge for different children with ASD, such that higher functioning children with ASD will be comparable to TD children on most language measures, whereas a subgroup of children with ASD with lower verbal skills may show a language profile similar to that of individuals with SLI (Tager-Flusberg, 2006).

Method

Participants

As part of an ongoing longitudinal study investigating language acquisition in young children with ASD, we recruited 18 TD children (mean age = 20.59 months, *SD* = 1.73), and 17 children diagnosed with ASD (mean age = 32.85 months, *SD* = 3.45). In the ASD group, there were 16 boys and one girl. Children in the ASD group had been previously diagnosed with autism or pervasive developmental disorder-not otherwise specified (PDD-NOS) by professionals, and their diagnosis was also confirmed with the Autism Diagnostic Observation Schedule (ADOS; Lord, Rutter, DiLavore, & Rissi, 1999; see Table 1) before the start of the study. The ASD group included one child whose data at visit 3 were missing and another child whose data at visits 4 and 5 were missing. The ASD group was recruited through treatment facilities and schools in the vicinity of our department. The children in the TD group included two girls and 15 boys, and were recruited from a database of children in our lab. There were no missing data points for this group.

Children in the TD group were administered the ADOS, and none had elevated scores (see Table 1). Because this study investigated spontaneous language production in play sessions, we matched the TD and ASD groups at visit 1 on expressive language, which was measured by the raw scores of Expressive Language Scale of Mullen Scales of Early Learning, $t(33) = 0.41$, $p = 0.69$, and the "Total Understands and Says" section of MacArthur Communicative Development Inventory (CDI; Fenson et al., 1993; $t(33) = 0.65$, $p = 0.52$)[1]. We matched the groups on the stringent criterion that a conservative *p*-value of 0.50 should be adopted to determine that the groups did not significantly differ from each other (Mervis & Klein-Tasman, 2004).

Procedure

The participants' data were collected across six home visits, each of which was separated by four months. At visit 1, children were administered the standardized measures, which included the ADOS, CDI, and the MSEL.

At all visits, children engaged in a 30-minute semi-structured parent-child play session. Sessions were video-recorded, and the children's speech measures were derived from this session. The first 15 minutes of the session followed the structure of the Screening Tool for Autism in Two-year-olds (STAT, Stone, Coonrod, & Ousley, 2000), which consists of 12 play-based activities that involve the child in pretend play with dolls, interactive play with a ball or truck, imitative action play, and requests and joint attention (e.g., pointing, reaching, etc.). To ensure that the parents followed this structure, the experimenter handed the parents notecards which stated what they should be doing with their children; fidelity to this structure was thus very high. During the second (free play) part of the session, the parent and the child were instructed to play "however they usually play at home."

Tests and Measures

A. Standardized Test Measures—These measures were collected to confirm the children's placement into diagnostic groups, and to provide general characteristics of their language level at visit 1.

The *Autism Diagnostic Observation Schedule* (Lord et al., 1999) is a structured and play-based assessment for the diagnosis of autism spectrum disorders. It consists of a series of activities designed to interest young children and encourage them to communicate, and systematic probes are used to sample children's behavior in social interaction, communication, stereotypical behavior and repetitive interests. Module 1 was used at visit 1.

The *Mullen Scales of Early Learning* (Mullen, 1995) is a measure of intellectual development, which includes items that measure visual reception, expressive and receptive language, and motor development for children from birth to 5 years, 8 months. The MSEL gives raw scores, standard *t* scores (average standard score is 50 with a standard deviation of 10 on this measure), and age equivalents for each domain of the test.

The *MacArthur Communicative Development Inventory* (Fenson et al., 1993) is a standardized parent reporting instrument used to assess the early language development of children. The CDI consists of two separate versions: the infant version for children 8 to 16 months and the toddler version for children 16 to 30 months. The infant version is composed of two major parts: Part I contains a series of questions followed by a comprehensive vocabulary checklist, including nouns, verbs, adjectives, pronouns, prepositions, quantifiers, and consists of 396 words. Part II focuses on the child's use of actions and gestures in order to provide a more comprehensive evaluation of early communication skills. The infant version was given to all children at visit 1.

B. Spontaneous Language Measures—The language measures were based on children's spontaneous speech produced during parent-child play sessions, and included lexical measures (i.e., tokens of nouns and verbs), morpho-syntactic measures (Brown's 14 grammatical morphemes and wh-questions), and MLU.

Brown's 14 Morphemes: Brown (1973) longitudinally examined the order of acquisition of 14 grammatical morphemes produced by three TD children from when they were two years old. We coded for the correct use of each of these morphemes. The morphemes are presented in Table 2.

Wh-questions: All wh-questions produced by the children were extracted from the transcripts of the mother-child play sessions, and were organized by child and visit. These questions were then subjected to a modified form of the IPSyn (Scarborough, 1990; Tager-Flusberg et al., 1990), in which we coded for the five categories in the IPSyn Q/Neg section that pertained to wh-questions. These were Routines (e.g., "What's that?"), wh-questions with a verb (e.g., "What happened?" "Where is the dolly?"), wh-questions with both a main and auxiliary verb (e.g., "What is she wearing?" "Who is holding the ball?"), wh-questions beginning with why, which, and how (e.g., "Why are you crying?"), and Other, which included additional wh-questions whose forms were not captured by the previous four categories. Few children in the current study received any points in the Other category; however, we awarded one point for children who used the "how about" construction (e.g., "How about we take the green ball away?"), and two TD children also earned points for using wh-questions in the future tense because these involved multiple auxiliaries (e.g., "What am I gonna find for you?").

Mean Length of Utterance (MLU): MLU is a measure of the child's sentence complexity, which was calculated by dividing the total number of morphemes by the number of utterances in each speech sample.

Coding—Children's spontaneous speech uttered during the parent-child play sessions was transcribed and then coded using a computerized language program called CLAN (MacWhinney, 1995), which was developed to analyze language-specific properties in a language corpus. Only the correct uses of the lexical and morpho-syntactic measures were analyzed, and echolalic phrases and repetitions were excluded from the analyses. According to Brown, a morpheme is acquired when it is used correctly in 90% of obligatory contexts (Brown, 1973). Because we were concerned with children's initial usage and developmental trajectory of these morphemes, and not necessarily when they had reached adult-like levels, we coded for number of correctly used morphemes rather than their use in obligatory contexts (Capps, Kehres, & Sigman, 1998; Hale & Tager-Flusberg, 2005). For example, an utterance such as "I goed to the zoo," which is an incorrect usage of the irregular past *went*, was not included in our analysis as a regular past tense marker. CLAN analyses of various aspects of language have 94% reliability (MacWhinney, 1995), and the second author of this paper checked and corrected the coded data for spelling mistakes as well as for morphological assignment errors (e.g., parsing "green" as a verb). The grammatical conventions of Crane & Lillo-Martin (1999) were used, and any uncertain assignments were resolved by discussion with the last author. Children's Wh-IPSyn points (2 possible for each category) were summed across categories to yield a total Wh-IPSyn score.

Analyses—We conducted individual growth curve analyses (IGC) with each spontaneous language measure to examine the differences in the developmental trajectory of these language measures across six visits in all three groups. Individual growth curve analysis is a form of hierarchical modeling that nests time within each individual and has many advantages over models that compare means across time points such as ANOVAs (Singer & Willett, 2003). For example, the IGC allows researchers to model change on the intercept and slope at both intra-individual (within-group-individual differences) and inter-individual levels (i.e., between-group differences), and the IGC has more flexibility especially in handling missing data. Moreover, the model does not have a sample size requirement, and handles small data sets and multiple comparisons very well (Singer & Willett, 2003).

The IGC consists of two levels: Level I and Level II. Level I includes the unconditional means model and the unconditional growth model (UGM). The unconditional means model tests the average change in outcome variables over time without inclusion of predictors at any level. The unconditional growth model indexes each individual's growth over time, and if this is not significant (i.e., if there is no change in individual growth trajectories), then further analyses are rendered unnecessary. At Level II, the predictor Group is included in the model, and the inter-individual differences on growth trajectories are analyzed. The slopes and intercepts at Level I are used as outcome variables at Level II.

We used SPSS software, version 19, and the “mixed” command (“mixed MLU by group with visit”) was entered to conduct the IGCs. We examined the linear, quadratic, and cubic effects of time to control for the possible effects of nonlinearity on some language measures. Of these three models, the linear model provided a better fit for all language measures, with smaller Akaike’s Information Criterion (AIC number, which is a general fit index that compares models; Singer & Willett, 2003), and, therefore, the linear model was chosen for the analyses. Finally, we did not conduct Level II analyses for any given language measure if its unconditional growth model was non-significant at Level I.

In order to account for within person correlations as well as the small amount of variation on some language measures when converted to percentages (see Results section), intercepts were treated as random effects, whereas the time variable “visit” (i.e., slope) was treated as a fixed effect variable. For this model, “variance components” were selected as the covariance type.

Results

The total number of utterances produced was significantly different between TD and ASD children at visit 2 through visit 6, $t(33) = 3.52$, $p = .001$, $d = 1.24$ for visit 2; $t(33) = 2.96$, $p = .01$, $d = 1.03$ for visit 3; $t(33) = 4.34$, $p < .001$, $d = 1.51$ for visit 4; $t(33) = 3.05$, $p = .01$, $d = 1.06$ for visit 5; $t(33) = 2.38$, $p = .02$, $d = 0.82$ for visit 6. Because of these differences in total utterances, for vocabulary (i.e., nouns and verbs) and morpho-syntactic measures (Brown’s 14 morphemes), children’s raw frequency scores were converted into proportions of total number of utterances produced (e.g., Total number of nouns produced/Total number of utterances produced) and then multiplied by 100 for ease of interpretation. Thus, vocabulary measures and Brown’s 14 morphemes represent percentages.

Individual Growth Curves with TD and ASD

Unconditional growth models were first conducted separately for each group to investigate the effect of time, or the rate of increase or decrease (i.e., slopes), on the language measures. The TD group showed significant increases in almost all language measures across six visits; only possessives and nouns for the TD group showed no significant increases. The ASD group, on the other hand, showed flat slopes for nouns, the preposition “in,” plurals, past irregular, and possessives (see Table 3).

The IGC models were conducted with Level I and Level II models to investigate the *group differences* on the rate of change in language measures. The TD group showed significantly steeper increases in MLUs, total number of utterances, verbs, Wh-IPSyn scores, progressive, plurals, third-person irregular present tense marker, uncontractible copula, contractible copula and auxiliary compared to the ASD group (the parameter estimates are presented in Table 3).

In sum, while the TD group showed significant increases in majority of the language measures, the ASD group showed a scattered language profile: the children in the ASD group were on par with TD children in their growth curves on about half of the language measures; however, they showed flatter trajectories compared to the TD group on the remainder of the language measures. It is likely, though, that this scatter could be due to the large variation in expressive language in the ASD group. For example, there were many children in the ASD group who were highly verbal across all six time points, whereas about half of the children in the ASD group consistently did not produce much speech over the entire period of data collection.

To better capture this variation in expressive language, the children in the ASD group were placed in either a High-Verbal subgroup (ASD-HV), or a Low-Verbal subgroup (ASD-LV). To assign placement, we used a median split on the raw scores of the Expressive Language scale of the MSEL at visit 1: children with ASD whose scores were above the median were classified as the ASD-HV group (n = 8, mean age = 30.95 months, SD = 3.38), and children whose scores were below the median were classified as the ASD-LV group (n = 9, mean age = 34.54 months, SD = 2.62). Groups' scores on standardized tests are presented in Table 1.

Individual Growth Curves with TD, ASD-HV, and ASD-LV Groups

Unconditional growth models were conducted separately for each group to investigate the effect of time, or the rate of increase or decrease (i.e., slopes), on the language measures. As shown in Table 4, the ASD-HV group showed significant increases in almost all (12) language measures across six visits; only possessives, nouns, the preposition "in", articles, plurals, third person singular irregular, and contractible copula showed no significant increases. In contrast, the ASD-LV group showed flat slopes for most measures, with significant increases found only for total utterances, the preposition "in," plural marker, articles, the contractible copula, and the contractible auxiliary. All parameter estimates and the t values are presented in Table 4.

Next, the IGC models were conducted with Level I and Level II models to investigate the *group differences* on the rate of change in language measures. Scrutiny of Appendices A and B indicated that at the early visits, the ASD-HV group was actually producing utterances with higher MLUs, as well as higher proportions of many of the grammatical morphemes, compared with the TD group. In fact, exploratory t-test analyses showed significant differences between the two groups in MLUs at visit 2, $t(24) = 2.30$, $p = .03$, $d = 0.94$; in verb tokens at visit 1, $t(24) = 2.73$, $p = .03$, $d = 1.11$, and visit 2, $t(24) = 3.24$, $p = .003$, $d = 1.32$; in the preposition "on" at visit 6, $t(24) = 2.28$, $p = .03$, $d = 0.93$; in plurals at visit 1, $t(24) = 2.74$, $p = .03$, $d = 1.12$, and visit 4, $t(24) = 2.57$, $p = .02$, $d = 1.05$; in articles at visit 3, $t(24) = 2.16$, $p = .04$, $d = 0.88$, and visit 4, $t(24) = 2.89$, $p = .01$, $d = 1.18$; in regular past tense marker at visit 2, $t(24) = 2.32$, $p = .05$, $d = 0.94$, and visit 3, $t(24) = 2.47$, $p = .04$, $d = 1.01$; and in contractible auxiliary at visit 2, $t(24) = 2.78$, $p = .02$, $d = 1.13$. Given that the ASD-HV group was 10 months older than the TD group, these findings may not be surprising; however, they complicated our plans for conducting the IGCs investigating group differences. That is, our initial IGC analyses were conducted across the six visits, and showed significant differences between the TD and ASD-HV groups in MLU, verb tokens, regular plural marker, third-person irregular present tense marker, contractible copula, and uncontractible auxiliary, with the TD group showing higher gains in all measures except the uncontractible auxiliary, and the ASD-HV group showing higher gains in this last measure. However, it is likely that the differences between the TD and ASD-HV groups were due to differences on the intercepts rather than reflecting a genuine difference in the rate of acquisition of expressive language. That is, because the TD group entered our study at visit 1 at a lower level of language, it is perhaps inevitable that their growth would be steeper than that of the ASD-HV group.

Therefore, in our main analyses comparing the ASD-HV and TD groups, we conducted the growth curve analyses comparing TD children at visits 3-6 to ASD-HV children at visits 1-4, when group mean differences were nonsignificant (i.e., the TD children at visit 3 did not differ from the ASD-HV children at visit 1) and when the two groups were matched in age (see Appendices). Across these visits, the ASD-HV group showed significantly greater increases only in articles and uncontractible auxiliary use compared to the TD group. There were no other significant differences between the two groups. The parameter estimates and the t values are presented in Table 5.

Table 5 also presents the parameter estimates and *t*-values for the ASD-LV vs. TD and ASD-LV vs. ASD-HV group comparisons. The TD and the ASD-HV groups showed significantly greater increases over time compared to the ASD-LV group in seven language measures, including MLUs, use of the progressive marker, regular past tense marker, uncontractible auxiliary and copula, contractible auxiliary, and Wh-IPSyn scores. Moreover, there were significant differences between the TD and the ASD-LV groups in the rate of increase in their production of verbs, articles, the irregular past tense, third-person irregular present tense marker, and contractible copula. The ASD-HV group also showed significant increases in their production of the preposition “on” compared to the ASD-LV group. The ASD-HV and the ASD-LV groups did not differ from each other on other measures ($ps > .05$; see Table 5).

In sum, the ASD-HV and the TD groups showed significant increases in their use of most language measures over time, whereas the ASD-LV group showed increases only in total utterances, and in five of the 14 grammatical morphemes. The group comparisons on slopes revealed that the ASD-HV group showed similar growth trajectories compared to the TD group on most language measures, whereas the ASD-LV group was impaired on seven language measures compared to both the TD and the ASD-HV groups, and on five more compared with just the TD group.

Discussion

This study presented a longitudinal investigation of the trajectory as well as the variability of expressive language development in young children with ASD. Specifically, individual growth curve analyses were conducted on a variety of morpho-syntactic measures (e.g., Brown’s 14 morphemes, wh-questions), vocabulary (e.g., nouns and verbs) and sentence complexity (e.g., MLU) using samples of children’s spontaneous speech. TD children and the children in the ASD-HV group showed increases over time on most language measures, whereas the ASD-LV group showed no significant gains on most language measures. Moreover, the IGC analysis for group differences in growth rates revealed that, when all six visits were analyzed, the ASD-HV group showed flatter growth trajectories compared to the TD children in MLU, verb tokens, regular plural marker, third-person person irregular present tense marker, and contractible copula, whereas the ASD-HV group showed significantly steeper gains in uncontractible auxiliary use compared to the TD children. However, when they were matched to TD children in age (i.e., comparing the ASD-HV group at visits 1-4 to the TD children at visits 3-6), the ASD-HV and TD groups showed few significant differences, with the exception of steeper increases in the proportion of articles and uncontractible auxiliaries used in the ASD-HV group compared to the TD group. Overall, then, the growth trajectories of ASD-HV group were more similar than dissimilar to the growth trajectories of TD children. In contrast, children in the ASD-LV group were impaired on many language measures compared to both the TD and the ASD-HV groups.

The growth trajectories of TD and ASD-HV groups showed that children with ASD who had higher verbal abilities at the beginning of the study acquired nouns, verbs, and many morpho-syntactic forms at a similar rate compared to TD children. Because their rate of acquisition was similar to that of TD children, expressive language acquisition was not only unimpaired in this ASD-HV group, but also not delayed at least between two and three years of age. The only difference between the ASD-HV and the TD groups even after they were matched in age was that the former showed steeper increases in their production of articles and the uncontractible auxiliary compared to the TD children. Because these two groups were matched on expressive language as well as on age, it is possible that this can be explained by differences in the language input the groups had received. For example, Gleitman, Newport, and Gleitman (1984; see also Swensen, Fein, and Naigles, 2007 for a recent replication) observed that parents of young typical children who produced more yes-no questions (which include uncontracted auxiliaries in the salient first position) had children who produced more of these auxiliaries. At the beginning of the current study, children in the ASD-HV group were reported to be receiving an average of 14 hours per week of ABA therapy. Responding to yes-no questions is usually targeted in early intervention especially for verbal children (Sundberg & Michael, 2001). Thus, it is possible that the ASD-HV group was exposed to more sentences with uncontractible auxiliaries in the form of yes-no questions, which helped them use more of this form in their discourse compared to TD children. Moreover, labeling objects frequently and consistently is an important component of many different types of intervention models (Goldstein, 2002), and in English, an object name is usually accompanied by an article (e.g., “Look, *a* dog!”). Therefore, children with ASD who have better verbal skills may acquire articles at a faster rate, because they may be hearing and responding to more of them in their daily lives.

Our study has corroborated Bartolucci et al. (1980)’s finding that some children with ASD, here, the ASD-LV group, used morphemes including auxiliary and copula forms of *be*, past tense markers, irregular third person singular, progressives, and articles, consistently less frequently than TD children. These findings underlie a significant impairment in morphology in children with ASD with language delay across many types of morphological forms. However, this difficulty was not only in the area of morphology, as the ASD-LV group had flatter growth trajectories across many areas of expressive language including vocabulary (verbs), morphology (Brown's morphemes), and syntax (wh-questions and MLU). These findings, thus, point to a 'global delay' in expressive language acquisition in this group rather than to impairments specific to the acquisition of certain grammatical structures. Interestingly, only the children in the ASD-LV group showed impairments in the development of wh-questions as measured by the Wh-IPSyn. These findings highlight the importance of distinguishing between growth in wh-question *grammar* (e.g., inverted auxiliaries, moved wh-words), which this study suggests is not impaired in higher-functioning children with ASD, and progress in contextually appropriate wh-question *use* (e.g., asking relevant questions, using *why* and *how*), which this study did not address (see Eigsti et al., 2007; Oi, 2010; Tager-Flusberg, 1994).

Thus, the language profile of the ASD-HV group was highly similar to that of the TD children in grammatical development, whereas the profile of children with ASD who had expressive language delay was suggestive of *a global impairment* in expressive language, coupled with impairments in other areas of development including autism severity in a majority of these children (see Table 1). We did not find evidence in our small sample for a third group of children with ASD whose language profile is similar to the language profile of SLI; that is, who showed specific impairments in past tense morphology and plurals, as suggested by Tager-Flusberg (Kjelgaard & Tager-Flusberg, 2001; Tager-Flusberg & Joseph, 2003). In fact, in some studies conducted by Tager-Flusberg and her colleagues (Kjelgaard & Tager-Flusberg, 2001; Roberts et al., 2004), children who were classified as language impaired (ALI) and whose language profile was similar to SLI included a mixture of children who were impaired in many areas of development as well as children who had average-to-above-average full scale IQ or nonverbal IQ (NVIQ). For example, in Roberts et al. (2004), only 21% children in the ALI group had average to above-average NVIQ scores, whereas 78% of children in the language-normal (ALN) group had NVIQ scores that were within this range. Thus, it is not clear in these earlier studies that the children with ALI, similar to children with SLI, were impaired only in language. For future research, it will be important to include a larger sample of young children with ASD with different levels of functioning to explore the possibility of additional different language profiles among this population. In fact, one of the limitations of this study is the small number of children in the ASD groups; we are currently following the language development of an additional 16 children with ASD, whose data will be added in subsequent reports.

Most studies that have been conducted on language acquisition in young children with ASD have treated children with ASD whose language skills were within the normal range and children with ASD with profound impairments in many areas of functioning as 'one uniform group' (Bartolucci et al., 1980; Eigsti et al., 2007; Tager-Flusberg et al., 1990). However, our study demonstrates that children with ASD vary almost from the beginning of their development of language; thus, the assumption that language acquisition is homogeneous in autism spectrum disorders is misleading at best and can be problematic on many accounts. First, it is clear that not all children with ASD follow the same trajectory in language acquisition. Second, studies on language acquisition that include children with ASD from all levels of functioning may potentially inflate Type I or Type II errors, depending on the question being investigated. Moreover, since phenotypic differences in language acquisition maybe associated with genotypic differences, identifying different profiles of language abilities in autism can help identify genetically meaningful subgroups of autism, and how these subgroups overlap with other developmental disorders including SLI.

One limitation of this study is that we investigated growth trajectories of expressive language from children's spontaneous speech only. It is possible that children with ASD may follow a more similar path to TD children with respect to language comprehension; for example, it has been demonstrated that, children with ASD, like TD children, understand some linguistic constructions (e.g., SVO word order, wh-questions) before they produce them spontaneously (Goodwin et al., 2012; Swensen et al., 2007). However, other studies have shown that young children with ASD may have a more severe receptive language than expressive language delays on standardized measures (Hudry et al., 2010; Weismer, Lord, & Esler, 2010). Therefore, it is necessary to study the growth trajectories of language comprehension in very young children with ASD to determine whether language development in children with ASD who show no delay in receptive language is similar to typical development from very early on or whether these children show delayed onset of language acquisition but catch up with TD children later on.

Another limitation of our study includes the structure of the play sessions. Because the first 15 minutes of the play sessions were semi-structured, and the latter 15 minutes included free play, it is possible that parents used different strategies or engagement styles with their children during each part of the play sessions. For example, it has been reported in literature that parents of children with autism use more direct and controlling styles in play compared to parents of TD children (Siller & Sigman, 2002). The parents of children with ASD in our sample may have, likewise, used more directive styles, especially during the free play, compared to the parents of TD children. Currently, we are in the process of investigating parenting styles (e.g., parental directiveness) during both structured and unstructured play sessions, and their influence on expressive language in both TD children and children with ASD.

Although the children in the ASD-LV group seemed to be delayed in many language measures, it is also possible that at least some of the differences between the ASD-LV group on the one hand and the ASD-HV and the TD groups on the other hand can be attributed to the older age of the former group, since the ASD-LV group (from visits 1 through 4) was significantly older than the ASD-HV (from visits 1 through 4) and the TD groups (from visits 3 through 6). Given the consistently lower scores of the ASD-LV overall, even at the later visits (see Appendix C), we find this unlikely. However, because language acquisition is steeper at younger ages, future studies should compare expressive language development of lower-functioning children with ASD to TD children and children with ASD with high verbal skills who are also on par to one another in age.

Our detailed analyses of growth rates of productive vocabulary and morpho-syntax have shown that the ASD children with and without delay in language production clearly follow different trajectories in language production very early in development. If this is the case, then different treatment modalities that address different aspects of language learning in different groups of young children with ASD may be developed. For example, children with ASD with higher verbal skills seem to need less intensive intervention to foster expressive language, whereas children with delays in expressive language may benefit from a comprehensive treatment that will target both receptive and expressive language abilities as well as nonverbal language skills.

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Appendix A

Spontaneous Language Scores as Percentages of Total Utterances, TD

	Visit 1	**Visit 2**	**Visit 3**	**Visit 4**	**Visit 5**	**Visit 6**
	M (SD)	**M (SD)**	**M (SD)**	**M (SD)**	**M (SD)**	**M (SD)**
MLU[a]	1.40 (0.25)	1.84 (0.63)	2.29 (0.68)	2.80 (0.73)	3.35 (0.60)	3.10 (0.43)
Total utterances[a]	80.56 (74.33)	163.94 (53.94)	219.72 (68.88)	230.44 (82.37)	230.61 (57.38)	234.5 (77.39)
Nouns	39.76 (24.83)	44.69 (20.34)	41.33 (11.31)	39.25 (10.96)	42.83 (11.65)	38.01 (9.92)
Verbs	8.95 (8.57)	27.85 (18.08)	39.73 (16.98)	49.49 (21.43)	63.95 (16.44)	56.58 (13.53)
WhIPSyn[a]	0.13 (0.39)	1.43 (1.28)	1.95 (1.13)	3.10 (1.56)	7.00 (1.53)	6.67 (1.68)
Brown's 14 Morphemes						
Progressive	0.47 (1.56)	0.49 (0.63)	2.05 (1.77)	3.88 (3.35)	5.07 (3.00)	4.21 (2.43)
In	1.36 (3.26)	2.09 (2.17)	2.90 (2.47)	2.63 (2.02)	3.36 (2.65)	2.79 (2.40)
On	0.17 (0.43)	0.75 (1.31)	0.89 (0.92)	1.36 (1.10)	1.37 (1.43)	0.83 (0.76)
Plural	1.62 (2.26)	3.07 (3.39)	4.07 (2.14)	4.81 (1.98)	7.00 (4.06)	4.94 (2.67)
Past irregular	0.21 (0.81)	0.92 (0.95)	2.15 (2.29)	2.15 (1.40)	3.18 (1.78)	2.47 (1.61)
Possessives	0.56 (1.64)	0.34 (0.70)	0.35 (0.40)	0.41 (0.71)	0.51 (0.49)	0.74 (1.81)
Uncontractible copula	0.20 (0.50)	0.70 (1.36)	1.56 (2.01)	2.04 (1.91)	2.93 (2.07)	2.77 (1.25)
Articles	3.45 (7.09)	8.13 (7.19)	10.16 (7.01)	14.29 (6.17)	16.55 (6.59)	13.03 (6.20)
Past regular	0.08 (0.33)	0.06 (0.20)	0.36 (0.46)	0.97 (1.08)	1.50 (1.37)	1.08 (0.79)
3rd person singular (-*s*)	0.52 (1.95)	1.01 (1.56)	1.07 (1.25)	1.33 (1.80)	2.52 (2.61)	1.65 (1.61)
3rd person irregular (-*s*)	0.00 (0.00)	0.14 (0.34)	0.34 (0.42)	1.01 (1.32)	1.41 (0.84)	1.32 (1.21)
Uncontractible auxiliary	0.00 (0.00)	0.11 (0.26)	0.09 (0.31)	0.35 (0.62)	0.34 (0.44)	0.42 (0.62)
Contractible copula	0.74 (1.70)	3.21 (4.29)	5.74 (4.62)	8.22 (4.63)	10.05 (3.43)	7.34 (2.65)
Contractible auxiliary	0.00 (0.00)	0.60 (1.16)	1.16 (1.07)	4.67 (4.22)	6.26 (3.77)	3.98 (2.15)

[a]Represent actual scores

Appendix B

Spontaneous Language Scores as Percentages of Total Utterances, ASD-HV

	Visit 1 M (SD)	Visit 2 M (SD)	Visit 3 M (SD)	Visit 4 M (SD)	Visit 5 M (SD)	Visit 6 M (SD)
MLU[a]	1.91 (0.72)	2.68[*] (1.24)	2.75 (0.86)	3.05 (0.98)	2.96 (0.92)	2.93 (0.65)
Total utterances[a]	159.50[**] (34.46)	157.12 (44.57)	227.75 (79.03)	197.25 (45.53)	222.25 (86.45)	227.62 (61.73)
Nouns	47.08 (15.26)	49.21 (25.61)	43.55 (11.18)	48.15 (16.64)	39.50 (15.20)	37.56 (9.03)
Verbs	36.21[*] (27.61)	58.74[**] (30.48)	52.98 (20.06)	59.98 (27.02)	59.75 (27.75)	58.49 (18.23)
WhIPSyn[a]	1.37 (1.59)	3.37 (2.32)	3.75 (2.81)	5.12 (2.99)	5.12 (3.98)	6.50 (3.29)
Brown's 14 Morphemes						
Progressive	1.96 (2.34)	2.53 (2.49)	3.07 (2.41)	6.00 (6.72)	6.42 (7.17)	5.21 (3.72)
In	1.02 (1.02)	2.76 (2.46)	2.79 (2.43)	2.97 (2.27)	3.21 (1.89)	1.57 (1.91)
On	0.51 (1.04)	0.99 (1.60)	1.65 (2.05)	2.01 (1.55)	1.87 (1.39)	2.01[*] (1.92)
Plural	8.61[**] (7.04)	2.03 (1.72)	6.16 (3.82)	7.01[*] (2.09)	5.09 (3.51)	5.09 (1.23)
Past irregular	0.32 (0.48)	1.32 (1.77)	2.54 (1.84)	1.38 (1.55)	2.29 (2.39)	2.15 (1.53)
Possessives	0.58 (1.14)	0.72 (1.22)	0.31 (0.52)	0.32 (0.90)	0.44 (0.48)	0.45 (0.77)
Uncontractible copula	0.46 (0.84)	1.55 (1.81)	1.72 (1.55)	2.94 (3.10)	2.86 (3.33)	2.46 (1.65)
Articles	5.75 (5.95)	21.41 (19.92)	17.59[*] (10.25)	22.98[**] (8.89)	18.55 (8.93)	15.80 (6.19)
Past regular	0.28 (0.44)	0.53[*] (0.55)	1.55[*] (1.33)	1.03 (1.63)	1.98 (2.62)	1.46 (1.23)
3rd person singular (-*s*)	0.50 (0.77)	0.94 (1.09)	1.30 (1.68)	1.93 (1.99)	2.41 (2.12)	1.70 (2.06)
3rd person irregular (-*s*)	0.15 (0.43)	0.35 (0.65)	0.76 (1.50)	0.70 (1.17)	1.16 (2.02)	0.66 (0.55)
Uncontractible auxiliary	0.00 (0.00)	0.14 (0.27)	0.74 (1.09)	0.59 (0.66)	1.14 (1.74)	0.87 (1.22)
Contractible copula	3.61 (5.25)	5.96 (4.41)	7.44 (4.04)	8.21 (5.19)	7.07 (6.32)	6.37 (3.92)
Contractible auxiliary	0.72 (1.46)	3.46[*] (2.80)	3.90 (3.45)	5.65 (5.52)	4.97 (5.73)	5.25 (4.51)

[a]Represent actual scores

[*]Shows significant differences between TD and ASD-HV groups. All significant differences show where ASD-HV group produced significantly more than the TD group. * <.05,

[**]<.01.

Appendix C

Spontaneous Language Scores as Percentages of Total Utterances, ASD-LV

	Visit 1 M (SD)	Visit 2 M (SD)	Visit 3 M (SD)	Visit 4 M (SD)	Visit 5 M (SD)	Visit 6 M (SD)
MLU[a]	1.06[**] (0.11)	0.98[**] (0.63)	1.04[**] (0.52)	0.90[**] (0.82)	0.93[**] (0.86)	1.18[**] (0.61)
Total utterances[a]	16.55[**] (33.77)	23.22[**] (29.72)	51.00[**] (126.05)	27.00[**] (46.36)	63.00[**] (84.63)	77.22[**] (109.78)
Nouns	16.26[*] (23.26)	14.98[**] (21.47)	9.32[**] (14.59)	11.84[**] (20.81)	24.08[*] (21.87)	30.70 (34.76)
Verbs	3.15 (6.89)	11.52[*] (14.73)	4.39[**] (8.15)	14.13[**] (19.39)	9.86[**] (12.44)	10.62[**] (15.94)
WhIPSyn[a]	0.00 (0.00)	0.00[**] (0.00)	0.62[**] (1.76)	0.75[**] (1.49)	0.25[**] (0.71)	0.66[**] (2.00)
Brown's 14 Morphemes						
Progressive	0.00 (0.00)	0.46 (0.99)	0.10[**] (0.29)	1.14[*] (2.14)	0.57[**] (1.09)	0.33[**] (0.69)
In	0.00 (0.00)	0.00[**] (0.00)	0.03[**] (0.09)	0.22[**] (0.58)	0.15[**] (0.43)	0.26[**] (0.51)

	Visit 1 M (SD)	Visit 2 M (SD)	Visit 3 M (SD)	Visit 4 M (SD)	Visit 5 M (SD)	Visit 6 M (SD)
On	0.00 (0.00)	0.00* (0.00)	0.00** (0.00)	0.33* (0.87)	0.00** (0.00)	0.32 (0.96)
Plural	0.21* (0.64)	0.76 (1.57)	0.79** (1.47)	1.60** (2.98)	1.12** (2.90)	2.69 (3.82)
Past irregular	0.00 (0.00)	3.24 (9.72)	0.90 (2.33)	1.97 (5.58)	0.45** (1.07)	0.21** (0.53)
Possessives	0.00 (0.00)	0.16 (0.47)	0.00** (0.00)	1.06 (2.80)	0.62 (1.76)	0.00 (0.00)
Uncontractible copula	0.00 (0.00)	0.00* (0.00)	0.07** (0.19)	0.75 (1.99)	0.14** (0.27)	0.32** (0.68)
Articles	0.11 (0.32)	1.43* (4.28)	0.59** (1.66)	3.58** (8.02)	3.60** (6.75)	4.45** (7.68)
Past regular	0.00 (0.00)	0.00 (0.00)	0.00** (0.00)	0.00** (0.00)	0.00** (0.00)	0.00** (0.00)
3rd person singular (-*s*)	0.00 (0.00)	0.30 (0.60)	0.00** (0.00)	0.00** (0.00)	0.14** (0.39)	0.42* (0.85)
3rd person irregular (-*s*)	0.00 (0.00)	0.00 (0.00)	0.03** (0.09)	0.00** (0.00)	0.00** (0.00)	0.18** (0.53)
Uncontractible auxiliary	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00* (0.00)	0.00** (0.00)	0.00* (0.00)
Contractible copula	0.00 (0.00)	0.15** (0.47)	0.17** (0.49)	1.09** (2.90)	1.17** (1.91)	1.70** (3.98)
Contractible auxiliary	0.00 (0.00)	0.00* (0.00)	0.00** (0.00)	0.69** (1.24)	0.21** (0.58)	0.39** (0.78)

[a] Represent actual scores

* Shows significant differences between TD and ASD-LV groups. All significant differences show where TD group produced significantly more than the ASD-LV group. * <.05,

** <.01.

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Abbreviations

ASD	autism spectrum disorders
ASD-HV	ASD-High Verbal
ASD-LV	ASD-Low Verbal
TD	Typically Developing

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SLI	Specific Language Impairment
DSM IV-TR	Diagnostic and Statistical Manual IV, Text Revision
ADOS	Autism Diagnostic Observation Schedule
CDI	MacArthur Communicative Development Inventory
MSEL	Mullen Scales of Early Learning
IGC	Individual Growth Curves

Table 1

M and *SD* and range of group scores on standardized tests at Visit 1.

	TD		ASD		ASD-HV		ASD-LV	
N	**18**		**17**		**8**		**9**	
	Mean (SD)	**Range**	**Mean (SD)**	**Range**	**Mean (SD)**	**Range**	**Mean (SD)**	**Range**
Age in months	20.59 (1.73)	18.87-23.90	32.85 (3.45)	26.00-37.46	30.95 (3.39)	26.00-35.80	34.55 (2.62)	29.86-37.46
CDI	118.78 (114.3)	11-317	94.12 (111.4)	0-328	186.50 (94.91)	62-328	12.00 (28.43)	0-86
ADOS[a]	0.11 (0.32)	0-1	13.82 (4.40)	7-20	10.50 (2.62)	7-15	16.78 (3.45)	11-20
MSEL-EL[b]	19.76 (4.38)	15-30	18.53 (8.13)	9-33	26.00 (4.00)	20-33	11.22 (4.26)	9-19

[a] Cut-off score for a diagnosis of autism is 12, and cut-off score for a diagnosis of autism spectrum disorders is 7.

[b] Scores show raw scores.

Table 2

Brown's 14 morphemes

Morpheme	Example
Present Progressive *-ing*	"Baby *sleeping*"
In	"Block *in* bowl"
On	"Ball *on* table"
Regular plural -s	"Balls *fell* down"
Irregular past	"Jar *broke*"
Possessive	"*Daddy's* car"
Uncontractible copula (Verb *to be* as the main verb)	"He *is* a doctor"
Articles	"I see *a* truck"/ "*The* man got lost"
Regular past -ed	"She *walked* to the house"
Regular 3rd person singular present tense	"He *digs* a hole"
Irregular 3rd person singular present tense	"That's what he *does*"
Uncontractible auxiliary (Verb *to be* as auxiliary)	"He *is* sleeping"
Contractible copula	"*It's* a bird"
Contractible auxiliary	"*He's* drinking milk"

Table 3

UGM and group differences in language measures for TD and ASD groups

	TD			ASD			TD vs. ASD		
	β	SE	T	β	SE	t	β	SE	t
MLU	0.38	0.03	13.93**	0.09	0.04	2.35*	0.29	0.04	7.12**
Total utterances	27.64	3.87	7.14**	12.72	3.12	4.08**	14.87	5.01	2.97**
Nouns	-0.85	0.86	-0.99	0.49	0.97	0.50	1.36	1.31	1.04
Verbs	10.14	0.82	12.29**	2.24	0.73	3.05**	7.90	1.11	7.09**
WhIPSyn	1.34	0.11	12.64**	0.50	0.10	4.74**	0.84	0.15	5.56**
Brown's 14 Morphemes									
Progressive	1.02	0.12	8.14**	0.46	0.14	3.19**	0.56	0.19	2.90**
In	0.30	0.13	2.29*	0.09	0.07	1.15	0.22	0.15	1.40
On	0.17	0.05	3.04**	0.17	0.06	2.77**	0.01	0.08	0.02
Plural	0.77	0.16	4.79**	0.11	0.19	0.59	0.66	0.25	2.66**
Past irregular	0.49	0.09	5.31**	0.05	0.20	0.27	0.43	0.22	1.96
Possessives	0.04	0.07	0.66	0.01	0.06	0.21	0.03	0.09	0.32
Uncontractible copula	0.57	0.08	7.22**	0.24	0.08	3.15**	0.32	0.11	2.87**
Articles	2.12	0.32	6.69**	1.09	0.44	2.48*	1.02	0.55	1.88
Past regular	0.27	0.05	5.59**	0.13	0.05	2.44*	0.14	0.07	1.87
3rd person singular (-*s*)	0.28	0.11	2.62*	0.17	0.06	3.11**	0.10	0.12	0.86
3rd person irregular (-*s*)	0.31	0.04	6.85**	0.08	0.04	2.00*	0.23	0.06	3.74**
Uncontractible auxiliary	0.09	0.02	3.58**	0.10	0.03	3.25**	0.01	0.04	0.25
Contractible copula	1.59	0.22	7.29**	0.42	0.16	2.60*	1.16	0.28	4.21**
Contractible auxiliary	1.18	0.15	7.71**	0.44	0.12	3.52**	0.74	0.20	3.70**

** <.01,

* <.05

Table 4

The Rate of Change in Language Measures across 6 Visits (Unconditional Growth Models) for Groups

	ASD-HV			ASD-LV		
	β	SE	t	β	SE	t
MLU	0.18	0.04	4.43**	0.01	0.05	0.21
Total utterances	14.44	4.72	3.06**	11.13	4.09	2.72**
Nouns	-2.06	1.10	-1.87	2.80	1.50	1.87
Verbs	3.47	1.21	2.87**	1.11	0.81	1.37
WhIPSyn	0.92	0.18	5.11**	0.12	0.08	1.50
Brown's 14 Morphemes						
Progressive	0.88	0.27	3.18**	0.08	0.07	1.16
In	0.12	0.15	0.79	0.05	0.02	2.12*
On	0.30	0.12	2.52*	0.05	0.04	1.49
Plural	-0.21	0.34	-0.63	0.39	0.13	2.98**
Past irregular	0.31	0.12	2.56*	-0.18	0.36	-0.48
Possessives	-0.04	0.06	-0.63	0.06	0.10	0.62
Uncontractible copula	0.43	0.14	3.10**	0.07	0.06	1.21
Articles	1.34	0.86	1.55	0.85	0.26	3.27**
Past regular	0.28	0.11	2.55*	No change[a]		
3rd person singular (-*s*)	0.31	0.10	2.98**	0.04	0.03	1.35
3rd person irregular (-*s*)	0.14	0.08	1.76	0.02	0.01	1.45
Uncontractible auxiliary	0.21	0.06	3.55**	No change[a]		
Contractible copula	0.51	0.30	1.68	0.34	0.13	2.52*
Contractible auxiliary	0.83	0.24	3.43**	0.09	0.04	2.16*

** <.01,

* <.05

[a] Mean = 0 across all time points

Table 5

IGC Showing Group Differences on Rate of Change in Language Measures

	TD vs. ASD-HV (4 Visits)			TD vs. ASD-LV			ASD-HV vs. ASD-LV		
	β	SE	T	β	SE	t	β	SE	t
MLU	-0.08	0.10	-0.81	0.37	0.05	7.92**	0.17	0.06	3.00**
Total utterances	-11.98	10.68	-1.12	16.80	5.92	2.84**	3.23	7.03	0.46
Nouns									
Verbs	-1.33	2.62	-0.51	9.06	1.31	6.90**	2.35	1.51	2.05
WhIPSyn	-0.50	0.35	-1.44	1.24	0.17	7.16**	0.80	0.20	3.88**
Brown's 14 morphemes									
Progressive	-0.47	0.47	-1.00	0.89	0.22	4.02**	0.80	0.26	3.03**
In				0.25	0.18	1.35	0.07	0.22	0.31
On				0.10	0.10	1.04	0.24	0.12	2.07*
Plural				0.42	0.29	1.44	0.62	0.35	1.77
Past irregular				0.69	0.26	2.67**	0.49	0.31	1.58
Possessives									
Uncontractible copula	0.40	0.27	1.49	0.49	0.13	3.81**	0.36	0.15	2.31*
Articles[a]	-2.96	1.35	-2.19*	1.35	0.65	2.08*	0.48	0.76	0.63
Past regular	-0.13	0.17	-0.77	0.28	0.08	3.30**	0.28	0.10	2.71**
3rd person singular (-*s*)	-0.23	0.28	-0.82	0.25	0.14	1.72	0.27	0.17	1.55
3rd person irregular (-*s*)	0.09	0.15	0.66	0.29	0.07	4.00**	0.11	0.08	1.33
Uncontractible auxiliary[a]	-0.17	0.08	-2.02*	0.08	0.04	1.96*	0.20	0.05	3.89**
Contractible copula	-0.98	0.65	-1.50	1.25	0.32	3.83**	0.16	0.38	0.42
Contractible auxiliary	-0.64	0.53	-1.21	1.06	0.23	4.57**	0.74	0.27	2.67**

** <.01,

* <.05

[a] Negative signs indicate measures where growth was faster for ASD-HV group compared to TD group Empty cells indicate that unconditional growth model is non-significant