J Autism Dev Disord (2007) 37:1007–1023
DOI 10.1007/s10803-006-0239-2

ORIGINAL PAPER

Beyond Pragmatics: Morphosyntactic Development in Autism

Inge-Marie Eigsti · Loisa Bennetto · Mamta B. Dadlani

Published online: 7 November 2006

Abstract Language acquisition research in autism has traditionally focused on high-level pragmatic deficits. Few studies have examined grammatical abilities in autism, with mixed findings. The present study addresses this gap in the literature by providing a detailed investigation of syntactic and higher-level discourse abilities in verbal children with autism, age 5 years. Findings indicate clear language difficulties that go beyond what would be expected based on developmental level; specifically, syntactic delays, impairments in discourse management and increased production of non-meaningful words (jargon). The present study indicates a highly specific pattern of language impairments, and importantly, syntactic delays, in a group of children with autism carefully matched on lexical level and non-verbal mental age with children with developmental delays and typical development.

Keywords Autism · Language acquisition · Syntax · Vocabulary · Pragmatics

Autism is a neurodevelopmental disability involving severe and persistent deficits in multiple areas of functioning. One of the hallmarks of autism is a qualitative impairment in communication (American Psychiatric Association, 1994). Communicative deficits can range from mutism to adequate speech with poor conversational skills, with this variability at its greatest when all disorders on the autism spectrum are included (Fombonne, 1999). Many children with autism are initially referred for evaluation because of parents' concerns about delayed language milestones (Dahlgren & Gillberg, 1989), and the attainment of these milestones appears to be strongly related to long-term prognosis (Rutter, 1970; Stone & Yoder, 2001; Szatmari, Bryson, Boyle, Streiner, & Duku, 2003).

Current descriptions of language in autism have primarily focused on four areas: (a) Absence of verbal abilities (e.g., the failure to acquire spoken language during the lifespan), which is the outcome for between 50–75% of affected individuals (Rapin, 1991); (b) Early language delays, with words first produced at an average age of 38 months (Howlin, 2003), rather than the typical time of 12–18 months. The presence of such delays is one of the diagnostic criteria for autism; (c) Atypical features of language production, including echolalia and jargon (Tager-Flusberg & Calkins, 1990); and (d) High-level discourse and pragmatic abilities (Bartak, Rutter, & Cox, 1975; Bartolucci, 1982; Lord & Paul, 1997). The latter two categories are considered in more detail below.

Echolalia, the immediate or delayed echoing or repetition of whole, unanalyzed utterances or interactions, is observed in typically-developing children. In autism, however, echolalia is present to a greater degree and for a longer period of time. Indeed, with many children with autism, a large proportion of their early speech productions are echolalic (Prizant & Duchan,

I.-M. Eigsti · L. Bennetto
Department of Clinical and Social Sciences in Psychology, University of Rochester, Rochester, NY, USA

M. B. Dadlani
Department of Psychology, University of Massachusetts, Amherst, MA, USA

Present Address:
I.-M. Eigsti (✉)
Department of Psychology, University of Connecticut, 406 Babbidge Road, Unit 1020, Storrs, CT 06269, USA
e-mail: inge-marie.eigsti@uconn.edu

1981). While the function of these echolalic utterances is not well understood, it might serve several purposes, communicative and otherwise. For example, children might use echoing in conversation when unsure of their response; as a familiar verbal ritual; or as a way of holding information in memory.

The use of jargon, or nonsense words, has frequently been reported in autism. Children with autism are more likely to come up with idiosyncratic labels, to invent nonsense terms with consistent meanings, and to link phrases with atypical meanings (Lord & Paul, 1997). The production of jargon, like that of echolalia, likely serves several functions. For example, jargon could signal the presence of poor referential abilities; it might signal a difficulty in updating representations (e.g., if a child interprets a phrase incorrectly, he may have difficulty encoding the more correct interpretation); or, as in echoing, it could serve as a communicative ''bridge'' when a child is unsure of how to respond.

In addition to jargon and echolalia, verbal individuals with autism spectrum disorders frequently have a unique speech style, marked by suprasegmental speech qualities such as inappropriately soft, or, more frequently, loud, speech volume; flat or singsong intonation; hoarseness; hyper-nasality; and unusually fast or slow speech rates (Shriberg et al., 2001). Speech is also marked by overly formal or precise words, neologisms, and odd phrasings (Rutter, Mawhood, & Howlin, 1992).

Pragmatic language use—that is, employing language as a social system to communicate—is a domain of significant impairment in ASD. High-level discourse aspects of language in autism include difficulty with turn-taking behaviors; interpreting statements in an overly literal fashion (e.g., responding to the literal meaning of metaphors or not catching the underlying meaning of irony or sarcasm); responding in conversation without regard for the Gricean maxims of quality, quantity, relevance, and manner (Grice, 1975); and difficulty in structuring narratives (Capps, Losh, & Thurber, 2000; Diehl et al., 2006). Individuals with autism of all ages are likely to use words with an inappropriate level of conversational formality (i.e., register), leading to somewhat pedantic, precise speech (Lord & Pickles, 1996).

Learning the grammatical structure of a language involves learning to combine words into phrases; learning grammatical categories (e.g., noun, verb, object, agent, Bloom, Rocissano, & Hood, 1980); and learning to use the grammatical elements of language (e.g., morphemes such as –ing, –ed, or cat, which are words or parts of words that carry grammatical meaning; Brown, 1973; de Villiers & de Villiers, 1973). While an extensive literature examines the relationship between social impairments in autism and impairments in pragmatic and discourse aspects of language (Baltaxe & D'Angiola, 1997; Ozonoff & Miller, 1996; Shriberg et al., 2001; Tager-Flusberg & Anderson, 1991), there has not been a similarly in-depth exploration of syntactic development in autism, nor how it may relate to underlying cognitive impairments.

Several studies have examined the acquisition of grammatical morphemes in children with autism and found no differences between children with autism and typical control children matched on nonverbal mental age (Fein & Waterhouse, 1979, October; Howlin, 1984a, 1984b). Similarly, one longitudinal study found few differences between children with autism and mental age-matched Down syndrome and normal controls in grammatical complexity in productive language (Tager-Flusberg et al., 1990) using the Index of Productive Syntax (Scarborough, 1990). In contrast, however, Bartolucci and colleagues found that children with autism were less likely than mentally retarded and normal control participants to produce grammatical morphemes, especially verb tense and articles (Bartolucci, 1982; Bartolucci & Albers, 1974; Bartolucci, Pierce, & Streiner, 1980). Dalgleish (1975) has suggested that syntactic deficits in autism are related to deficits in the ability to sequence stimuli, or to learn rules for ordering stimuli. One study found that children with autism differed from verbal mental age-matched children with typical development and Down syndrome in their comprehension of transitive (*the man put the glass on the table)*, but not intransitive (*the man arrived)*, sentences (Prior & Hall, 1979); the latter typically emerge later in development. Several recent publications suggest the presence of more substantive syntactic impairments in autism (Condouris, Meyer, & Tager-Flusberg, 2003; Rapin & Dunn, 2003), or in a subgroup of individuals with autism (Kjelgaard & Tager-Flusberg, 2001). Thus, while many researchers have concluded that syntactic development, contrasted with pragmatics or discourse aspects of language acquisition in autism, is concomitant with general developmental progress, the findings to date are equivocal and could be consistent with a specific deficit.

One consideration with respect to the diversity of findings to date is that deficits in autism may be masked by matching procedures (Lord & Paul, 1997). Relatively heterogeneous groups of children with autism are often compared with more homogenous groups of children with mental retardation. Because nonverbal ability is often a strength in autism, and since groups are typically matched on verbal ability, the autism group may contain children who are not delayed on tests of nonverbal ability. The matching process may then obscure the greater language deficits of participants in the autism group, relative to other cognitive domains.

In addition, most studies examining syntactic development in autism occurred prior to the advent of rigorous, reliable diagnostic measures such as the Autism Diagnostic Interview-Revised (Cox et al., 1999; Lord, Rutter, & LeCouteur, 1994) and the Autism Diagnostic Observation Schedule (Lord et al., 1989; Lord, Rutter, & DiLavore, 1998) in the late 80's and early 90's. A comprehensive investigation of language in a well-controlled sample of children with autism, compared with both typically developing and developmentally delayed groups, is needed.

The present study was designed to address the conflicting and sparse literature on syntactic development in young children with autism, investigating whether children with autism exhibit syntactic abilities commensurate with their developmental age. In addition to morphosyntactic or grammatical functioning, we assessed a broad spectrum of communicative abilities, including lexical knowledge; discourse or turn-taking abilities; the occurrence of errors; the occurrence of jargon and echolalic speech; and discourse characteristics of adult interlocutors.

Methods

Participants

Participants in this study included children in three groups: (a) children with autism ages 3–6 years; (b) children with non-specific developmental delays (DD), matched on nonverbal IQ, gender, and chronological age; and (c) typically developing (TD) children matched on non-verbal IQ and gender. Participant information is presented in Table 1. Both the DD and autism groups were verbal and relatively high-functioning, with mean non-verbal IQ scores in the low average range.

Autism Group

Interviews to confirm the diagnosis of autism were conducted by the principle investigator using the ADI-R and the ADOS (module 2) with all children in the autism group. Both the ADOS and the ADI-R were scored according to DSM-IV and ICD-10 criteria for autism disorder. Only subjects whose early development and current level of functioning met strict criteria for a diagnosis of autism on both the ADOS and the ADI-R were included (see Table 2). To be included, participants had to be producing at least 2-word phrases; all but one of the ASD participants had been talking for at least 12 months at the time of the study, and could be described as currently verbal.[1] However, all children in this group had significant early language impairments, and none could be described as meeting criteria for Asperger syndrome or Pervasive Developmental Disorder/Not Otherwise Specified.

Developmentally Delayed Comparison Group

Participants in the DD group were recruited from a local school providing special education services. Inclusion criteria were that children be receiving special education through Early Intervention or the Board of Cooperative Educational Services. Parents of all participants completed the Child Behavior Checklist (CBCL; Achenbach, 1991) to assess for comorbid diagnoses. Where there was any reason to suspect difficulties in social development, the ADI-R and ADOS were administered ($n = 2$). None of the children in this group had a history or current symptoms consistent with ASD.

Typically Developing Comparison Group

Children were recruited for the TD group from the community, and parents completed the CBCL. All parents gave informed consent for their children to participate in research.

Matching Procedures

Intellectual functioning was assessed with a short form of the Stanford-Binet Intelligence Scale: Fourth Edition (SB-IV, Thorndike, Hagen, & Sattler, 1986). The nonverbal reasoning factor includes four subtests (Bead Memory, Copying, Quantitative, and Pattern Analysis; Sattler, 1992) appropriate for assessing intellectual functioning in young children with developmental disabilities (Carpentieri & Morgan, 1994; Lawson & Evans, 1996).

As stated above, participants were included only if they were already combining words into at least 2-word phrases. Many previous studies have matched

[1] When analyses were repeated, excluding the child who had been talking for only 4 months, results were identical.

Table 1 Demographic data for autism, developmentally delayed (DD), and typically developing (TD) groups

	Autism *M* (*SD*) Range	DD *M* (*SD*) Range	TD *M* (*SD*) Range	Group differences
N	16	16	16	
Gender (M: F)	11:5	14:2	12:4	
Chronological Age*** (mos)	57.7 (11.9) 39–78	56.9 (9.7) 38–79	42.6 (5.7) 33–50	TD < Aut, DD
Stanford-Binet Nonverbal IQ*** (Scaled Score)	80 (15) 49–111	82 (13) 52–106	100 (9) 85–121	TD > Aut, DD
Stanford-Binet Nonverbal IQ (Age equivalent score, months)	44 (11) 30–64	42 (7) 31–53	45 (6) 35–58	
Peabody Picture Vocabulary Test (Age equivalent score, months)	43.4 (14.0) 22–69	47.7 (14.5) 22–72	50.8 (6.9) 36–62	
SES** (Hollingshead 4-Factor Index. Larger numbers indicate higher SES; Range: 8–66)	51 (10) 32–66	39 (15) 16–57	53 (13) 27–66	Aut, TD > DD
Ethnicity* (White: African-American: Hispanic)	14:1:1	9:5:2	16:0:0	TD ~ = DD

‡ $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 2 Autism diagnostic measures (Autism group only)

	ADI-R *M* (*SD*) Range	Cut-Off[a]	ADOS *M* (*SD*) Range	Cut-Off[a]
Communication	15.3 (4.3) 8–24	8	6.8 (1.5) 5–9	5
Social reciprocity	18.3 (4.9) 10–26	10	10.6 (2.7) 6–14	6
Repetitive behaviors/ interests	7.8 (2.4) 3–12	3	1.8 (1.3) 0–5	N/A [b]
Differences apparent (mos) [c]	22.2 (8.7) 14–42			
Age at which at least 5 words used meaningfully (mos)	28.6 (11.4) 10–48			
Time between age of first words and age at assessment (mos)	27.4 (12.2) 4–44			

[a] For an autism spectrum diagnosis

[b] No cut-off score is used as it is possible to meet criteria for an autism spectrum diagnosis on the ADOS without exhibiting repetitive behaviors or stereotyped interests

[c] Average age at which parents became aware that development was proceeding differently. For an autism diagnosis, differences must be apparent prior to age three

participants on receptive vocabulary level (e.g., Mottron, 2004), using it as a stand-in for overall language abilities. To maintain consistency with this literature, and to ensure that children were similar on a non-syntactic verbal measure, participants were matched on receptive vocabulary using the Peabody Picture Vocabulary Test – Third Edition (PPVT-III; Dunn & Dunn, 1997). Only children with a verbal mental age of 21 months or older on the PPVT-III were included. There were no significant differences in age equivalence scores across groups; mean group scores were in the three and a half to 4-year-old range; see Table 1. Using these matching criteria, children across groups should have equivalent levels of receptive vocabulary, although they may have reached this level at different ages (e.g., groups were matched by receptive vocabulary but differed in chronological age).

Socioeconomic status (SES) was calculated from a four-factor index, in which parental educational attainment and occupation are used to calculate a weighted index, ranging from 8 to 66 (Hollingshead, 1975). Scores are reported in Table 1. There was a main effect of Group for socioeconomic status (SES), $F(2,45) = 5.08$, $p < .01$, and post hoc analyses indicated that the DD group had a lower SES than the autism group, $t\ (30) = 11.31$, $p = .02$, and the TD group, $t\ (30) = 13.38$, $p = .005$. There was a main effect of Group for Ethnicity distributions, $\chi^2\ (4, n = 48) = 11.0$, $p < .05$, such that the DD group had a greater proportion of African-American participants than the TD group, $\chi^2\ (2, n = 32) = 8.96$, $p = .01$. SES could potentially exert a significant influence on the measures of interest (Hoff-Ginsberg, 1991), though this pattern of group differences in SES would be predicted to lead to lower scores for the DD group. When analyses were repeated with SES entered as a covariate, results were identical. The present results are based on analyses without covarying SES or ethnicity.

Procedure

Children participated in a 30-minute free play session, which took place during a second visit to the lab (standardized and diagnostic testing took place during the first session). The testing room contained a standard set of toys and books, and the children and a researcher played together with those toys. The caregiver was outside the room for all free play sessions (with the exception of one child from the TD group who was unable to separate from his mother). The free play sessions were typically fun for the children. All interactions were videotaped through a one-way mirror.

The child played together with the first author or a trained research assistant. Although children may have been more comfortable with their mothers and fathers, the presence of a play partner that engaged with children across groups in a standardized fashion was important for maintaining the consistency of the play sessions.

The play partner made an effort to engage the child in play. Although initially the play partner followed the child's lead, if the child did not initiate interaction or if the play ceased and the child became engaged in solitary play, the play partner used a set of standardized prompts to engage the child. Initially, play partners commented on the child's actions: e.g., ''that looks like a big dog.'' This strategy was repeated up to five times. If the child did not respond, the play partner then asked a direct question (e.g., ''where are you driving the truck?''). Comments and direct questions then were alternated to stimulate conversation. The exception to this protocol was if the child began to engage in inappropriate/potentially harmful actions (attempting to open a closed cupboard, climbing up a bookshelf, throwing hard objects). In order to include one verbally-based interaction that was consistent across children, the play partner encouraged the child to look through and describe a wordless picture book, *Goodnight, Gorilla*, during the play session. All the children engaged in this activity for at least several minutes.

Transcription of Free Play Session

To code data for analysis of language measures, all free play sessions were transcribed from videotape (Brown, 1973; Demuth, 1996) in the format of the Child Language Data Exchange System (CHILDES; MacWhinney, 1991) using CLAN software, which automates a variety of language analyses including frequency counts, word searches, and co-occurrence analyses (MacWhinney, 2000). Analyses were based on a uniform number of utterances (100) across all children. An utterance was jointly defined by intonation contour and by the presence of a discernible pause between it and surrounding utterances. For partially unintelligible or semantically uninterpretable utterances, phonetic representations were transcribed and supplemented by the transcriber's gloss. Compounds, proper names, and ritualized reduplications were counted as single words (*birthday*, *Sally Smith*, *night-night*); fillers (*mm)* and single-word routines (*yeah*, *hi*) were not included. Repetitions, within five utterances, of self or interlocutor were not included.

A small number of children ($n = 8$) did not produce 100 qualifying utterances (see Table 3); analyses were pro-rated for these children where appropriate. The proportion of children producing less than 100 qualifying utterances did not differ by group.

Mean Length of Utterance (MLU)

MLU assesses the length, and thus the relative grammatical complexity, of a child's utterances, by counting individual morphemes. MLU is frequently used to describe individual differences and developmental changes in grammatical development, particularly for early stages of language acquisition. MLU was calculated on the set of 100 utterances using the MLU and FREQ routines within CLAN[2] (MacWhinney, 1991).

Index of Productive Syntax (IPSyn)

The IPSyn has been used with typically developing children and those with developmental disabilities as a means of evaluating syntactic development (Fowler, 1980; Scarborough, 1990; Scarborough, Rescorla, Tager-Flusberg, Fowler, & Sudhalter, 1991). IPSyn scores are likely a more sensitive measure of language level than MLU, particularly for children at this developmental level, as they yield a fine-grained analysis of disparate domains of syntax (Scarborough et al., 1991).

[2] The MLU routine alone calculates only the number of words per utterance, rather than the number of morphemes, which is the variable of interest. Thus, after running MLU on each transcript to find the number of utterances spoken by the child, FREQ was used to find the complete frequency listing, assessed word by word to determine whether each word consisted of one or more morphemes. Additional morphemes were then incorporated into the measurement of utterance length.

Table 3 Quantitative assessments of language ability

	Autism *M* (*SD*)	DD *M* (*SD*)	TD *M* (*SD*)	Group Differences
No. Utterances[b]	94.63 (10.40)	97.38 (10.50)	92.81 (16.34)	
Range	69–100	58–100	50–100	
Mean length of utterance (MLU)	2.97 (1.15)	4.07 (1.17)	3.61 (1.10)	Aut < DD**Aut < TD‡
Range	0.78–5.02	2.13–6.26	1.71–5.39	
Index of Productive Syntax (IPSyn)[a]	55.28 (17.99)	70.94 (14.05)	76.81 (15.30)	Aut < TD*** Aut < DD**
Range	11–77	36–84	40–100	
IPSyn age equivalent	28 months	35 months	41 months	
Infit Mean Sq: IPSyn				
Verb phrases	1.02 (.34)	1.06 (.38)	.90 (.29)	
Sentence structures	1.14 (.70)	1.0 (.48)	.89 (.40)	
Questions, negations	1.23 (.78)	.81 (.49)	.76 (.55)	Aut > TD* Aut > DD‡
Noun Phrases	1.15 (1.14)	.62 (.93)	.21 (.29)	Aut > TD*

[a] Scores could range from 1 to 118

[b] Number of utterances on the IPSyn (100 = maximum). The median in all groups was 100

‡ $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

The transcripts were scored for the presence of 56 different syntactic and morphological forms of progressively greater complexity, ranging from one-word utterances to fluent speech; see Appendix Table 7. Each utterance was scored in turn and one point was scored for each occurrence of a morphosyntactic structure (maximum of two points per structure). For example, the utterance "*an iron*?" would give credit for the following: (a) intonational question; (b) use of a noun; and (c) two-word combination of article plus noun. A grammatical structure could be given credit even if it was used inaccurately, i.e., the past tense morpheme in "**It maked it a twirl thing*." Morphosyntactic structures were divided into four subscales (Verb Phrases, Noun Phrases, Questions and Negations, and Sentence Structures), and summed for an overall score.

Other Measures

In addition to the syntactic assessments, the transcriptions were assessed on a variety of dimensions: (a) Developmental scatter of grammatical structures; (b) Grammatical errors; (c) Type-token ratio for lexical items; (d) Jargon production; (e) Present/absent topic use; and (f) Turn-taking as a measure of pragmatic discourse ability. These analyses are described in detail in the results.

Reliability

The free play sessions were transcribed by the first author or one of two research assistants, and the first author reviewed all transcriptions in full. Because the experimenter had interviewed parents and worked with the participants, she was not necessarily naïve to participants' developmental status during transcription. Thus, maintaining high standards for reliability across naïve and non-naïve coders was particularly important. Following (Demuth, 1996), 8% ($n = 6$) of the videotapes were independently transcribed for reliability by two coders. Word for word reliability (product-moment correlation; Cohen, 1960) was $r = .90$, χ^2 (1) = 8.96, $p = .01$. Reliability for coding of other measures is described in the results.

Results

Prior to all inferential statistics, dependent variables were examined for deviations from the assumptions of normality and sphericity and were found to be normally distributed. In addition, analyses reported below were repeated, with PPVT-III scores entered as a covariate, to control for lexical differences. This additional analysis did not lead to changes in any findings, with one exception in MLU findings, described below.

Mean Length of Utterance (MLU). Participants' language was assessed with respect to MLU; see Table 3. A one-way ANOVA revealed a significant group difference in total MLU, $F(2,45) = 3.78$, $p = .03$. Post hoc analyses indicated that the autism group mean was significantly lower than the DD group, t (30) = .91, $p = .008$. The autism vs. TD group comparison approached significance, t (30) = .56, $p = .09$, and the TD and DD groups did not differ. When MANCOVA analyses were performed with PPVT-III Age Equivalent score as the covariate, the significant main effect of group was unchanged, $F(2,43) = 3.12$, $p = .05$. Similarly, the autism group mean was lower than the DD group mean, $F(1,29) = 6.23$, $p = .02$. The ASD-TD and TD-DD contrasts did not differ, $F(1,29) = 1.45$, $p = n.s.$, and $F(1,29) = 2.07$, $p = n.s.$, respectively.

IPSyn. A one-way ANOVA on IPSyn scores revealed a significant group difference in the total IPSyn score, $F(2,45) = 7.88$, $p < .001$. Post hoc analysis revealed that the mean for the autism group was significantly lower than both the DD group, $t\,(30) = 15.66$, $p = .008$, and TD group, $t\,(30) = 21.54$, $p < .001$. The algorithm estimating age equivalents for these scores indicated that the autism group's utterances were at the developmental level of a 28-month-old, as compared to 35 and 41 months for the DD and TD groups, respectively.

As described above, the grammatical analyses were based on the first 100 scorable utterances. Most participants produced 100 utterances (13/16 in the autism group, 15/16 in the DD group, and 12/16 in the TD group). The remaining participants had utterance totals ranging from 50 to 90. Total IPSyn scores for these participants were calculated by using a conversion metric provided in (Scarborough et al., 1991). Analyses of IPSyn and MLU results were recalculated using only data from children with 100 utterances, and results did not differ. The number of scorable utterances did not differ by group, and thus, interestingly, suggested no group differences in overall talkativeness.

A further analysis of syntactic complexity was conducted on the four subscales of the IPSyn (Verb Phrases, Sentence Structures, Questions and Negations, and Noun Phrases).[3] A 3 (Group) × 4 (Subscale) mixed-model MANOVA revealed a significant main effect of Group, $F(2,37) = 88.19$, $p = .001$, a significant main effect of Subscale, $F(3,37) = 81.31$, $p < .001$, and a trend towards a significant Group × Subscale interaction, $F(2,37) = 2.85$, $p = .07$. Follow-up ANOVAs yielded significant group differences for the Verb Phrases, $F(2,39) = 4.17$, $p = .02$, Sentence Structures, $F(2,39) = 4.77$, $p = .01$, Questions and Negations, $F(2,39) = 8.40$, $p < .001$, and Noun Phrases subscales, $F(2,39) = 4.17$, $p = .02$. These data are presented in Fig. 1.

Post hoc analyses revealed that the autism group mean was significantly lower than the TD group mean across all subscales: Verb Phrases, $t\,(23) = 2.32$, $p = .007$; Sentence Structures, $t\,(23) = 6.22$, $p = .004$; Questions-Negations, $t\,(23) = 4.99$, $p < .001$; and Noun Phrases, $t\,(23) = 2.32$, $p = .007$. The autism group used significantly fewer Question and Negation structures than the DD group, $t\,(25) = 3.50$, $p = .006$. There was a trend towards a significant group difference for the other three subscales: Verb Phrases, $t\,(25) = 1.50$, $p = .06$; Sentence Structures, $t\,(25) = 3.37$, $p = .09$; and Noun Phrases, $t\,(25) = 1.50$, $p = .06$, with the autism group consistently scoring lower than the DD group. The DD and TD groups' subscale scores did not differ.

The results reported thus far indicate that children in the autism group, despite being matched on both nonverbal IQ and lexical knowledge, produced syntactically less complex utterances than children in the TD and DD groups.

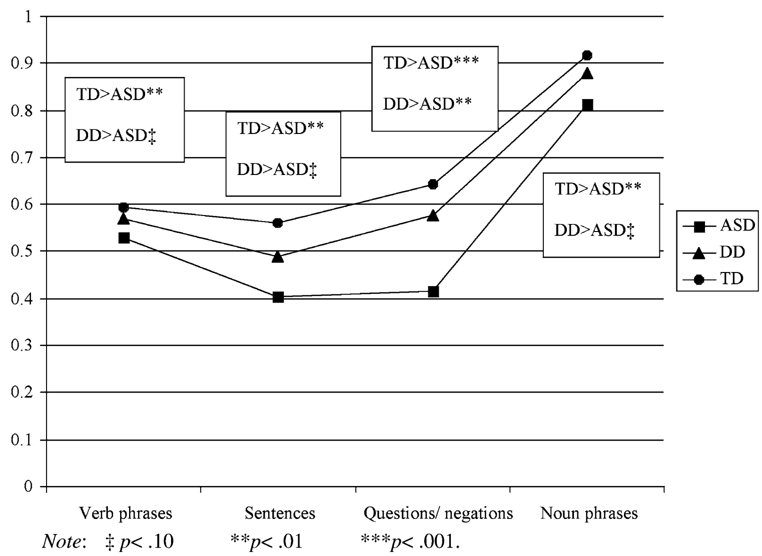
Developmental Scatter. While this analysis of grammatical structures is informative, it does not take into account the pattern of responses (Kaplan, Fein, Morris, & Delis, 1991). The order of items on the IPSyn replicates the typical order of acquisition of those items, so that a typical pattern of responses of a given individual at a single timepoint reflects a progression from higher to lower scores on within-scale items. In other words, children typically learn simpler items before they learn items of greater complexity, and thus are likely to produce the initial items in the scales before producing later items. Group differences in total IPSyn scores might reflect simple delays in grammatical knowledge or learning, but could also reflect a different developmental progression for children in the autism group.

To address this question, we employed analytic procedures assessing "intrasubtest scatter," (based on item response theory) for detecting unusual response *sequences*. The most sensitive of these is an index of inconsistent responding, calculated using the partial-credit model of Rasch analysis (Adams & Khoo, 1993; Godber, Anderson, & Bell, 2000); one advantage of this index is that it is not confounded with total subscale scores. Conceptually, the procedure estimates an individual's overall ability from the total score, then observes the interaction between this ability level and the difficulty of the items observed. This interaction between a particular subject's observed and expected patterns of responding, given his overall ability, is calculated as the infit mean square. Individuals with response patterns that fit well (e.g., predictably) with their overall score are represented by an infit mean square score of zero; response patterns that fit poorly (because of inconsistent responding) are represented by larger values.

The infit mean square scores were calculated separately for each IPSyn subscale for the autism, DD, and TD groups; see Table 3. Results were subjected to a 3 (Group) × 4 (Subscale) mixed-model MANOVA,

[3] For participants who produced fewer than 100 utterances, subscale scores were not computed (because of potential differences across groups on subscales). Thus, the subscale analyses are likely more conservative since they were based on a smaller group of participants.

Fig. 1 Index of Productive Syntax (IPSyn) Subscale Scores Index of Productive Syntax scores by group. Only scores for participants who made the full 100 utterances were included. Sample sizes for this analysis were: Autism $n = 12$, DD $n = 15$, TD $n = 13$



which revealed a significant main effect of Group, $F(2,35) = 5.71$, $p = .007$ and a significant main effect of Subscale, $F(3,105) = 2.80$, $p < .05$. The Group × Subscale interaction was not significant. Post hocs indicated that the pattern of responses for the autism group was significantly different from the DD and TD groups, $p = .05$ and $p = .002$, respectively, and the latter two groups did not differ.

Follow-up ANOVAs on the individual subscales yielded a significant group difference for the Noun Phrases, $F(2,35) = 3.59$, $p = .04$, and a trend for a difference within the Questions and Negations subscale, $F(2,38) = 3.11$, $p = .06$. The Verb Phrases and Sentence Structures subscales did not differ across groups. The children with autism had response patterns that were significantly different than in the TD group for both the Questions-Negations, $t\ (24) = 2.08$, $p < .05$, and Noun Phrases subscales, $t\ (23) = 2.76$, $p = .01$. There was a trend for a group difference between the autism and DD groups for the Questions-Negations subscale, $t\ (26) = 1.91$, $p = .07$. The DD and TD groups did not differ. In summary, the developmental scatter analysis indicates that the children with autism had response patterns for the IPSyn which differed significantly from responses in the comparison groups.

Types and Tokens in Word Production. Receptive vocabulary (language comprehension) was assessed with the PPVT-III, on which all groups were similar. In the spoken language domain, one common measure of spontaneous language use is the contrast between the sheer number of words, or *tokens*, spoken during a specified period, and the number of different words, or *types*, produced in that same period. This is a way of quantifying the variety of different words used by a talker, while equating for talkativeness. The Type to Token ratio was estimated using the FREQ routine within CLAN. Results indicated that children in all three groups produced similar numbers of Word Types, $F(2, 45) = .093$, $p = .91$, with means (SD) of 178 (58) , 186 (47), and 186 (62), for the autism, DD, and TD groups, respectively. Children also produced similar total Tokens: 459 (181), 550 (183), and 532 (224), $F(2, 45) = .96$, $p = .39$. This supported the finding (described in the IPSyn section) that children across groups were equally talkative. The effect of Group on the ratios of Types to Tokens did not reach significance, $F(2, 45) = 2.47$, $p = .096$. Because there was a trend for a group difference in the Type-Token ratio, post hoc analyses were conducted and indicated that the autism group ratio was higher than in the DD group, $t\ (30) = 2.22$, $p = .04$, which suggests that the children with autism tended to produce a greater variety of different words than children in the DD group.

Error Analysis

Although groups differed with respect to the relative complexity of syntactic constructions, these differences might be masking differences in utterances that are produced with errors. The IPSyn assigns credit for producing a particular structure even if it is ungrammatical (e.g., credit for past tense is assigned if a child says, "*they wented outside*"). When errors are produced, they may reflect an incomplete or tentative grasp of the particular linguistic structure. To assess whether group differences in syntactic complexity may have been influenced by ungrammatical speech, we examined the frequency of grammatical errors and the types of errors produced. Because the focus was not on exhaustively identifying every possible error, but rather on establishing possible links between error rates and syntactic deficits, inclusion criteria were strict. Thus, transcripts were examined, utterance by utterance, and only clear, unambiguous errors of omission and errors of commission (Bates, 1997) were included. Results and examples are presented in Table 4.

Findings indicated that the DD group exhibited significantly more errors of omission than both the ASD and TD groups (p's = .06 and .003, respectively), whereas there were no differences in errors of commission (all p's > .5). To summarize, children in the DD group were more likely to omit required grammatical structures than children in the autism and TD groups.

Nonsense Words (jargon)

Play session transcripts were analyzed for the presence of jargon, defined as intelligible but uninterpretable words or phrases. Any words or phrases that the transcriber was able to hear, but was not able to supply a gloss or meaning for, were included, such as, "*the serpice [sic] is flying*." This definition was designed to distinguish utterances in which a child mispronounces an item (as in, "*goin' to make a lelivery*," when context and previous utterances indicate that the child's target was '*delivery*'), from utterances where the child seems to be producing a novel wordform.[4] Results indicated that the incidence of jargon was as follows: Autism group, Mean (SD) = 4.9 (5.3), range = 0–17; DD group, Mean (SD) = 1.3 (1.6), range = 0–5; TD group, Mean (SD) = .3 (.6), range = 0–2. Groups differed significantly, $F(2, 45) = 9.005$, $p < .001$, and post hocs indicated that children with autism produced more jargon than children in the DD group, $p < .009$, and TD group, $p < .001$.

Topic Analysis

One challenge for the present findings is that children in the autism group may have produced less complex grammatical structures because the topics they discussed were less complex. For example, to describe people or events that are not present, specific grammatical structures (e.g., subjunctive or past tense) are required. Talk about non-present events or people will entail relatively more complex structures, and differences in such talk may be ascribed to conceptual referential grounds rather than morphosyntactic knowledge. Thus, syntactic delays in autism may reflect conceptual rather than grammatical delays. In general, evidence from typical development indicates that children are more likely to use here-and-now (vs. displacement) language than are adults (Wanska & Bedrosian, 1986).

The transcripts were examined for references to items, events, or people not physically or temporally present (Foster, 1986). This referential domain was chosen because children at this developmental stage were likely to be able have this conceptual ability. Specifically, transcripts were assessed, utterance by utterance, for the presence of an antecedent which was identifiable as physically present. For example, in this dialogue, a child is pulling toys from a toybox and remarking on them to the experimenter (EXPTR). All references were to the here-and-now:

CHILD: *what's dis* [: this]?
EXPTR: *I don't know, what do you think?*
CHILD: *a dum(p) t(r)uck.*
EXPTR: *yeah*!
CHILD: *a big dump tuck [e.g., truck] wif [e.g., with] that big ting [thing].*
CHILD: *got big things on it.*

In contrast, in the following dialogue, the child (age three) refers to two events that may transpire in future (turning five years old, and riding a bus):

CHILD: *I'm gonna be five like Sally, too!*
EXPTR: *five*?
CHILD: *yeah. Sally 's five more. She's, she's still five.*
EXPTR: *yeah? well it's fun to be little sometimes, too, dontcha think?*
CHILD: *[chuckling].*
EXPTR: *so what other things are you gonna do when you're five?*
CHILD: *um, I'm gonna go on the bus.*
EXPTR: *on the bus? wow.*
CHILD: *that's when I'm five*

While this rather coarse conflation of many syntactic categories and types of utterances obscures finer issues about the development of these categories, and may in fact not reflect accurately the complexity demanded by

[4] In this scheme, some utterances are likely to be erroneously labeled as jargon, when the experimenter fails to recognize a target utterance even though it is a known word. Utterances from children with poor articulation will be over-included, making comparisons between the autism and DD group more conservative, as the latter are likely to have misarticulations.

discussion of present-tense events in the here and now, we depend on this analysis simply to highlight a conceptual question presented by these data: Do children with autism in this sample use less complex syntax because their syntactic knowledge is more limited? Or, do the children in this sample think about a more simplified/limited set of concepts, and thus, is their language more grammatically simple because of these conceptual limitations?

Children were scored in a dichotomous fashion, as either making this type of non-present reference, or failing to produce a single identifiable example. Because it can be difficult to reliably determine whether a given phrase refers to a distal or here-and-now event, our criteria were as conservative as possible. Specifically, we used a simple dichotomous analysis; rather than making subtle distinctions about the quality or quantity of such references, we scored whether or not a child produced at least one clear example of a non-present reference. Results indicated that the children with autism were the least likely to refer to things not physically present ($n = 2$ children), followed by children in the DD group ($n = 5$) and the TD group ($n = 9$), a main effect that was significant, X^2 (2) = 6.94, $p = .03$.

Discourse Analysis

An important component of language development is learning to use language as a tool for social communication; as discussed previously, this is typically an area of difficulty in autism. One conventional method for assessing discourse abilities is to examine the conversational "turns" that typically make up an interaction (Bloom, Rocissano, & Hood, 1976). Utterances in each transcript were coded line by line for discourse function, as follows: *Interactive categories*: (a) new topic initiations; (b) direct reply to interlocutor, including nonverbal responses such as a head shake; and (c) expansion of one's own (previous) utterance. *Discourse-interrupting categories* included: (d) direct echo (with identical prosody) of self or other within five utterances; (e) Failure to respond to direct query of interlocutor (ignore); (f) Uninterpretable (though intelligible) comments, the discourse function of which we (and presumably, also the play partner) were unable to categorize.

Results are presented in Table 5, on the "Child" lines. A repeated measures MANOVA revealed a significant main effect of Discourse Category, $F(1,44) = 141$, $p < .001$ and a Group × Category interaction, $F(2, 44) = 3.73$, $p = .03$. Follow-up analyses indicated that the children with autism differed from children in both comparison groups in the three Discourse Interrupting categories (echo, $F(2, 44) = 6.43$, $p = .004$; ignore, $F(2, 44) = 9.89$, $p < .001$; and uninterpretable, $F(2, 44) = 5.62$, $p = .007$), but had no specific group deficits in the three Interactive categories (see Table 4 for groupwise comparisons). The DD group produced more expansions and

Table 4 Error types and error rates by group

		Autism	DD	TD
	Mean (SD) errors of omission (includes failure to invert phrases) *[a]	2.2 (1.5)	3.3 (1.9)	1.5 (1.6)
	Proportion errors of total utterances* [b]	.023	.036	.016
Possessives	*I go over [your] house*	0	2	0
Verbal auxiliary	*what she plays?*	5	6	7
Determiners	*get this up in sky*	5	2	1
Main verb	*it a toys*	3	3	0
Verb marking	*he bite your finger*	4	7	3
Prepositions	*you crashed me*	1	6	0
Negation marking	*He likes yucky things but she likes not yucky things*	0	1	1
	Mean (SD) errors of commission	1.1 (1.2)	1.4 (1.7)	1.2 (1.0)
	Proportion errors of total utterances	.011	.015	.012
Possessives	*mine snake is breaking*	0	0	1
Pronouns	*she* (referring to child's father)	2	0	4
Verbal auxiliary	*he's took his keys*	0	2	5
Determiners	*I got a Joey in my class*	4	1	1
Noun plurals	*that's a little people* (for a single toy)	3	0	1
Overextension	*he's upping it, they're unlocking them out*	2	2	1
Verb marking	*remembers I saw that*	2	2	3
Adjective/ adverb	*well, it pretty hurt*	0	2	1
Prepositions	*the bigger one was full with books*	1	2	0
Other	*who's under here the boots* (sees feet under door)	2	1	1

* $p < .05$

[a] DD > TD, $p < .01$; DD > A, $p < .05$

[b] DD > TD, $p < .05$; DD > A, $p < .10$

initiations, and the TD group produced more replies. The results indicated that the autism group was more likely to produce atypical utterances that do not further the flow of conversation, although they are not less likely to engage in more typical ways as well.

Another important element of the discourse analysis is to ask whether the adults across the three groups responded to or initiated conversations differently. This could both affect children's responses, and be the result of group differences in how children talk to the adults. Adult utterances were categorized into the same categories as child utterances (see Table 5). Results showed a main effect of Category, and a Category × Group interaction. Follow-up analyses indicated a trend for a significant group effects in Expansions, $F(2, 44) = 2.63$, $p = .08$, and Replies, $F(2, 44) = 2.72$, $p = .08$. Post hoc analyses showed that the adults interacting with children in the autism group produced more expansions of their own utterances than for the DD group, $t(29) = 2.18$, $p = .04$, and fewer replies to the children's utterances, $t(29) = 2.11$, $p = .04$.

Previous work on discourse differences in autism (Curcio & Paccia, 1987) has shown that particular situational contexts as well as conversational partners can influence communicative skills in children with autism. Although an in-depth analysis of the moment-to-moment discourse context is beyond the scope of the present study, an assessment of a subset of five randomly-selected participants in each group demonstrated that most children spent the bulk of their time in playing directly with toys [Autism group, Mean (*SD*) = .66 (.28); DD group, Mean (*SD*) = .85 (.14); TD group, Mean (*SD*) = .72 (.15)]. Groups did not differ on these measures, all *p*'s > .12.

Coding of discourse categories was done by two independent raters (IME and MD), and 8% (n = 6) of the transcripts were coded by both raters. Inter-rater consistency was calculated at $r = .923$, with a net agreement of .887; χ^2 (1) = 375.7, $p < .001$.

Correlational Analyses

To determine the relationships between non-verbal IQ, IPSyn scores, and interrelationships among variables, the data were subjected to a planned series of correlational analyses, focusing on within-group correlations for the ASD participants to reduce Type I errors; see Table 6.

Syntactic ability (IPSyn score) was correlated with other language measures across the entire sample, including lexical abilities (PPVT-III, Type-token ratio), and pragmatic abilities (Ignoring; Expansions). Although correlational data cannot determine causality, this finding is consistent with the suggestion that having stronger syntactic abilities facilitates one's acquisition of new words, as well as one's ability to participate more effectively in interactions.

Interestingly, the production of jargon was negatively correlated with NVIQ, with IPSyn score, with lexical measures (PPVT-III and Type-Token Ratio), and with discourse functioning (Ignore), suggesting that jargon is linked both to language ability as a whole as well as to cognitive functioning.

The conceptual ability to discuss non-present objects, people, or events, seemed to be a language-specific ability. It was not correlated with non-verbal IQ, $r(48) = .15$, $p > .3$, but was correlated with IPSyn, $r(48) = .29$, $p < .05$, and with the production of jargon, $r(48) = -.39$, $p < .01$, computed across all subjects.

Table 5 Discourse characteristics

	Autism *M* (*SD*)	DD *M* (*SD*)	TD *M* (*SD*)	Group differences
Interactive				
Child initiation**	.068 (.036)	.14 (.075)	.083 (.058)	DD > TD**, Aut**
Adult initiation	.074 (.037)	.062 (.037)	.062 (.033)	
Child reply**	.60 (.18)	.570 (.15)	.74 (.13)	TD > DD**, Aut*
Adult reply‡	.46 (.16)	.59 (.16)	.51 (.17)	Aut < DD*
Child expansion*	.15 (.097)	.23 (.13)	.14 (.10)	DD > TD*, Aut*
Adult expansion‡	.44 (.14)	.33 (.16)	.41 (.13)	Aut > DD*
Discourse interrupting				
Child echo***	.06 (.036)	.026 (.026)	.019 (.02)	Aut > TD**, DD**
Adult echo	.027 (.025)	.02 (.016)	.014 (.013)	
Child ignore***	.046 (.032)	.014 (.015)	.013 (.013)	Aut > TD***, DD***
Adult ignore	.0021 (.0043)	.0028 (.0048)	.0008 (.002)	
Child uninterpretable**	.058 (.078)	.014 (.012)	.007 (.013)	Aut > DD**, TD**
Adult uninterpretable	.0003 (.0013)	.0001 (.0005)	.0004 (.0011)	

Note: Figures represent rates of occurrences of the given discourse type per total number of turns (e.g., possible occurrences)

‡ $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 6 Relationships among language and other measures for the ASD group

	ASD Group
IPSyn – PPVT	.475‡
IPSyn – Type–Token ratio	**–.904*****
IPSyn – Ignore (Child)	–.364
IPSyn – Expand (Child)	.398
Jargon – NVIQ	**–.594***
Jargon – IPSyn	–.338
Jargon – PPVT	**–.554***
Jargon – Type–Token ratio	.282
Jargon – Scatter (NP)	**.577***
Jargon – Ignore (Child)	.155

Note: Correlations are reported as *r* (16)

‡ $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

More generally, given previous findings of specific language subtypes within a large sample of children with autism (Kjelgaard & Tager-Flusberg, 2001), participants in the autism group were divided into two language groups, based on PPVT-III scaled scores: those below 85, $n = 5$, vs. those above 85, $n = 10$ (the one child whose PPVT-III scaled score of 65 was below 70 was excluded from this analysis). For each subgroup, we subjected the pattern of scores on the IPSyn, non-verbal IQ, and topic, discourse, and error analyses to a one-way ANOVA with subgroup as the between-subjects variable. Findings indicated no subgroup differences (all *p*'s > .29), with four exceptions: (a) Nonverbal IQ, $F(1,13) = 29.9$, $p < .001$; Borderline group, *M* (*SD*) = 63.8 (9.0); normal group, *M* (*SD*) = 89.9 (8.6); (b) Jargon production, $F(1,13) = 14.75$, $p = .002$; Borderline group, *M* (*SD*) = 8.4 (5.3); normal group, *M* (*SD*) = 1.9 (1.2); (c) Uninterpretable utterances in the discourse, $F(1,13) = 4.8$, $p < .05$; Borderline group, *M* (*SD*) = .114 (.115); normal group, *M* (*SD*) = .027 (.033); (d) Errors of omission and commission (combined), $F(1,13) = 4.58$, $p = .05$; Borderline group, *M* (*SD*) = 1.8 (1.3); normal group, *M* (*SD*) = 3.9 (2.0). Consistent with some previous reports (e.g., Jarrold, Boucher, & Russell, 1997), these data do not suggest specific language-impaired and language-typical subgroups within a relatively small but homogenous group of children with autism; rather, these data are consistent with other results in indicating that morphosyntactic abilities were specifically lower in the autism group.

Discussion

To investigate morphosyntactic development in autism, 5-year-old children with autism and general developmental delays, and 3-year-old children with typical development, all matched on non-verbal mental age, participated in a free play session that was transcribed and analyzed. Receptive vocabulary was assessed with the PPVT-III.

The most striking finding from the present study was the clear presence of syntactic deficits in the autism group. Controlling for lexical knowledge and nonverbal IQ, and overall talkativeness, the children with autism produced language that was significantly less complex than might be expected for their developmental level. This result expands upon the 1982 finding by Bartolucci and colleagues that children with autism produced fewer grammatical morphemes than controls. Even a relatively gross measure of syntactic ability, MLU, supported the finding of autism-specific syntactic delays, showing shorter MLUs in the autism group compared with the DD group, and a trend for a shorter MLU than the TD group. While the Autism/TD difference was only marginally significant, post hoc power analyses indicated that the present finding may not have had sufficient power to detect an effect ($1\text{-}\beta = .47$), whereas a more sensitive tool such as the IPSyn was able to demonstrate a group difference.

The results indicated that the autism group likely reached their syntactic abilities via an atypical developmental pathway. Individual IPSyn items in the autism group followed a pattern that was marked by significant inter-item inconsistency. Although the data are cross-sectional in nature and do not directly examine development, they suggest that children in the autism group were not progressing in the typical pathway from simpler forms to increasingly complex ones.

In contrast to syntactic development, the present study demonstrated that lexical knowledge was an area of relative strength for the young children with autism. In addition to group matching for receptive language, an analysis of the free play sessions indicated that the autism group produced as many different word types as peers, and potentially an even richer set of words (higher Type-Token ratio) than their mental-age-matched peers without autism. Consistent with previous studies, the children with autism seemed to comprehend and produce as many words as their peers. While some aspects of lexical knowledge in autism are atypical, including the use of idiosyncratic meanings for words and of neologisms (Rumsey et al., 1985; Rutter, 1970; Volden & Lord, 1991), adults with autism often have larger vocabularies than would be predicted from their other language abilities (Lord & Paul, 1997). Studies of individual and developmental differences indicate that word learning is highly correlated with short-term phonological memory capacity. It is possible that the strong lexical skills seen in the autism group in the present study may be tied to the relative strengths in short-term memory ability characteristic of the disorder (Bennetto, Pennington, & Rogers, 1996; Eigsti & Bennetto, 2001; Hermelin & O'Connor, 1975).

In the course of learning to talk, children are likely to omit required grammatical elements and to make grammatical errors. Sometimes these errors are seen as evidence of underlying syntactic knowledge (e.g., the presence of past tense overregularization errors like ''wented'' suggests that a child has learned the general form of the past tense). Children in the autism group were not more likely to make errors, while children in the DD group made significantly more errors of omission (not included or scored in the IPSyn). Interestingly, this conflicts with a previous report, that children with autism were *more* likely to omit such morphemes (Bartolucci et al., 1980), a discrepancy that may lie in the disparate ages of children studied. Errors (which were similar in frequency to those observed in studies of typical language acquisition; e.g., Marcus et al., 1992; Rubino & Pine, 1998) are thus not the source of group differences in morphosyntactic abilities. Clearly, then, the syntactic deficits found here were not due to language that was more error-prone, as children with autism were no more likely to omit required particles, to fail to invert phrase orders, or to produce incorrect structures or orders.

One possible explanation for syntactically less complex language is that children with autism could be producing many more neologisms or ''jargon words,'' as has been described in the literature. For example, children could be saying nonsense words in place of a variety of morphosyntactic elements, and in this way achieving lower scores on the IPSyn. Results indicated that children with autism did produce significantly more jargon than children in the DD and TD groups (a mean of 5 compared to a mean of 1.3 and 0.3, respectively) and that the amount of jargon was negatively correlated with syntactic abilities (IPSyn score). However, jargon production was also correlated with cognitive abilities (non-verbal IQ). While the presence of jargon or neologisms in the speech of children with autism confirms previous findings, it alone cannot account for syntactic deficits.

There is a second explanation that could partially account for the present syntactic impairments. Children are increasingly likely to talk about things that are spatially and temporally removed as they grow in language skill and cognitive skill; more complex referential discourse entails more complex syntax. While this cross-sectional dataset can not determine causality in this chicken-and-egg problem, the children with autism as a group made significantly fewer mentions of non-present events and objects, and furthermore, those mentions were correlated with IPSyn score and jargon productions (i.e., language measures) but not with non-verbal IQ. The fact that children across groups were matched on non-verbal cognitive ability argues against the hypothesis that syntactic complexity was limited by cognitive processing of events. However, the data raise the possibility that the children with autism scored lower on the IPSyn because they were talking about less complex events, or (conversely) that their syntactic limitations prevented the discussion of such topics.

Pragmatics and discourse aspects of language provide the most frequently-discussed aspect of language deficits in autism (Baltaxe & D'Angiola, 1997; Kelley et al., 2006; Ozonoff & Miller, 1996; Shriberg et al., 2001; Tager-Flusberg & Anderson, 1991). Interestingly, the present results indicated that children with autism produced as many of the conversation-supporting turns as children in comparison groups, suggesting that there were no specific impairments in the ability to initiate new topics, to reply to an interlocutor's comments or questions, or to expand upon one's own utterances, for children at this verbal level. However, as expected, children with autism were significantly more likely to produce utterances that did not contribute to the discourse—they were less able to participate in the ''to and fro'' of conversation. Specifically, they were more likely to echo their own or their interlocutor's utterances; they were more likely to ignore or fail to respond to a direct query; and they were more likely to produce utterances whose discourse features were uncategorizable. This latter category included intelligible but uninterpretable utterances (e.g., jargon). Thus, the conversation of children in the autism group was typical in many respects, but contained additional atypical elements. This finding is consistent with previous research on discourse structure in children with autism at roughly the same developmental level (Tager-Flusberg & Anderson, 1991). While addressing the question goes beyond the scope of the present paper, this finding raises an interesting issue for future research, of whether these ''discourse-interrupting'' utterances occurred more frequently in particular discourse contexts.

An important counterpart to the analysis of children's discourse is to ask whether the adults across the three groups interacted differently with children across groups. As discussed in the Methods, play partners consisted of the first author or one of several trained research assistants, all of whom followed a relatively standard set of guidelines on how to respond and initiate interactions. Marginally significant group differences suggested that adults interacting with children in the autism group produced more expansions of their own utterances, and fewer replies to the children's utterances. Adults may have been less likely to reply to children who produced more uninterpretable utterances, jargon, and echolalia. Overall, the adult discourse analysis suggests that adults interacted similarly with children across groups, to the extent that we were able to measure differences.

One limitation of the present findings draws on the dichotomy between *competence* and *performance*. An individual's speech at any given moment (performance) may not be an accurate index of underlying knowledge (competence) of the syntax of the language (Chomsky, 1957). The presence of speech errors in everyday speech (e.g., ''a five pile car up'') does not suggest that people have not mastered their syntax, but rather that there is ''slippage'' or noise in the process of producing an utterance. This raises the possibility that children with autism may have a greater underlying competence, or knowledge of the syntactic structures of English, but that they are less able or less willing (e.g., because of deficits in social reciprocity) to access this knowledge in some contexts. For example, they could be less comfortable with a relatively unfamiliar experimenter, and thus be less likely to produce syntactically complex structures. In support of this hypothesis, children with autism performed as well as controls on a measure (the PPVT-III) that required non-verbal rather than spoken responses. By including other standardized measures of syntactic skills, it would have been possible to directly address this concern; however, to our knowledge, no standardized measures are appropriate for assessing syntax at this very early stage of language acquisition. The CELF-Preschool, for example, which targets children ages 3–6, is often too difficult for children with autism of this age (e.g., Kjelgaard & Targer-Flusberg, 2001).

There are, however, several sources of evidence against the ''performance deficit'' as the sole explanation for syntactic delays in the autism group. First, children performed another non-verbal language task (not described here, Eigsti & Bennetto, 2001), and the autism group exhibited specific syntactic impairments on that task. Second, the children with autism were equally as talkative as their peers, and talked about similar topics. A third argument comes from the broader language acquisition literature. Seidenberg and MacDonald (1999) have suggested a performance-based alternative to Chomsky's generative approach. In their probabilistic framework, language production and acquisition emerge as learners and talkers exploit multiple probabilistic constraints drawn from both linguistic and nonlinguistic information. Under this framework, production data observed in the course of language acquisition are informative about how children extract the underlying regularities of the language system. This approach suggests that the less complex syntax observed in language of children with autism may reflect actual delays in their knowledge, rather than ''performance factors.''

The present data, which were collected from a single play session, present a further limitation. The children with autism were somewhat acclimated to the examiner and the physical environment of the play-room, because the play session was recorded during their second visit to the lab. Nonetheless, children with autism may have greater difficulty adjusting to this still relatively novel situation. This play session may have thus elicited somewhat less complex or typical spontaneous language from this group of children. Future studies may address this concern by performing a more extended familiarization procedure or, alternatively, by documenting children's speech and language in the home setting, where they are likely to be most comfortable.

One issue that must be raised in considering how generalizable the study's findings may be is whether the participants are characteristic of the autism population. The ASD group was comprised solely of high-functioning children with autism, not other diagnoses such as PDD/NOS or Asperger syndrome. The children all had a history of language delay, as is characteristic of autism, but were all verbal at the time of the study; inclusion criteria required that participants have at least 2-word phrases in their speech at home. Certainly, given the wide spectrum of abilities in autism, it may be the case that the syntactic deficits identified here may be less apparent in a sample of children with diagnoses other than classic autism, or in a sample of children with a wider range of developmental abilities. In addition, some research suggests the presence of several distinct subtypes of children with ASD, where one subgroup has deficits that parallel those observed in children with specific language impairment (SLI), whereas other subgroups exhibit few morphosyntactic delays (Kjelgaard & Tager-Flusberg, 2001). Analyses examining the possibility that participants in the autism group could be best characterized by normal and language-impaired subgroups were not consistent with these previous findings. Instead, the data indicated a rather consistent morphosyntactic deficit across participants with autism, independent of functional level, consistent with least one large study of language profiles in autism (Jarrold et al., 1997). Furthermore, the focus in this study was on identifying deficits that characterized children with autism as a group, and, due to the labor-intensive language analyses employed, numbers of participants were insufficient to conclusively determine the presence of coherent subgroups. Further study is needed to address these issues.

Finally, the present study shares a limitation with much of the research on language in autism: the challenge of choosing appropriate matching criteria. Matching on the PPVT-III raises a concern that the identification of objects in a PPVT-style task may be a peak of ability in high functioning individuals on the autism spectrum, that serves to over-estimate IQ (Mottron, 2004). In this study, non-verbal IQ served as the primary matching criterion, and groups were also matched on PPVT-III receptive vocabulary to maintain consistency with the large literature also matching on that basis. In addition, only participants who were combining words into 2-word phrases were included, in order to insure that all participants had at least begun to communicate verbally. To address this limitation in the matching procedure, analyses were performed both with and without the PPVT-III results covaried , with no change in results.

The major finding of the present study is that children with autism, compared with chronological age- (DD group) and non-verbal mental age- (DD and TD groups) matched peers exhibited clear delays in syntactic knowledge. In contrast to these syntactic impairments, the autism group's lexical knowledge was unimpaired. We have discussed some possible factors underlying these syntactic impairments, including the production of jargon, the discussion of less complex events in the world, and the atypical sequence of learning of syntactic structures. One important implication is that receptive vocabulary abilities, such as those measured by the PPVT-III, are likely an inadequate marker of "language ability," and studies that match groups based only on lexical measures are likely to overestimate the comprehension of children in the autism group.

Acknowledgement This research was supported by the NIMH (R03 grant # MH61032-01), a Young Investigator award from the Journal of Language Learning, and a Dissertation Award from the Society for Science of Clinical Psychology, to IME. We are especially grateful to the parents and children that participated in the study.

Appendix Index of Productive Syntax (IPSyn) Items

Table 7

Verb phrases subscale	Sentence structures subscale
Verb	Two-word combination
Particle or preposition	Subject-verb sequence
Prepositional phrase (Preposition + NP)	Verb-object sequence
Copula linking two nominals	Subject-verb-object sequence
Catenative (pseudo-auxiliary) preceding a verb	Conjunction (any)
Auxiliary *be*, *do*, *have* in VP	Sentence with two VPs
Progressive Suffix	Conjoined phrases
Adverb	Infinitive marked with *to*
Modal preceding verb	*Let/Make/Help/Watch* introducer
Third person singular present tense suffix	Adverbial conjunction
Past tense modal	Propositional complement
Regular past tense suffix	Conjoined sentences
Past tense auxiliary	*Wh-* clause
Medial adverb	Bitransitive predicate
Copula, modal, or auxiliary for emphasis or ellipsis (non-contractible context)	Sentence with 3 or more VP's
Past tense copula	Relative clause, marked or unmarked
Bound morpheme on verb or on adjective	Infinitive clause with new subject
	Gerund
	Fronted, center-embedded subord. clause
	Passive construction
Question-Negation Subscale	*Noun Phrases Subscale*
Intonationally marked question	Proper, mass, or count noun
Routine *do/go*, existence question, *wh-* pronoun	Pronoun or prolocative (not modifier)
Negation (*no(t)*, *can't*, *don't*) + X (NP, VP, PP)	Modifier (adjective, possessive, quantifier
Initial *wh-* pronoun followed by verb	2-word NP: Article/ modifier + nominal
Negative morpheme between subject and verb	Article, used before a noun
Wh- question- inverted modal, copula, auxiliary	Two-word NP after verb or preposition
Negation of copula, modal, or auxiliary	Plural suffix
Yes/no question- inverted modal, copula, auxiliary	2-word NP (as N4) before verb
Why, When, Which, Whose	3-word NP (Determiner + Modifier + Noun)
Tag question	Adverb modifying adjective or nominal
Questions with negation + inverted copula, modal	Any bound morpheme on noun, adjective

Note: NP = noun phrase, VP = verb phrase, PP = prepositional phrase

References

Achenbach, T. M. (1991). *Manual for the child behavior checklist/ 4–18 and 1991 profile*. Burlington: University of Vermont, Department of Psychiatry.

Adams, R., & Khoo, S. (1993). *Quest, the interactive test analysis system*. Melbourne: ACER.

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: American Psychiatric Association.

Baltaxe, C., & D'Angiola, N. (1997). Cohesion in the discourse interaction of autistic, specifically language-impaired, and normal children. *Journal of Autism and Developmental Disorders, 22*(1), 1–21.

Bartak, L., Rutter, M., & Cox, A. (1975). A comparative study of infantile autism and specific developmental language disorder: I. The children. *British Journal of Psychiatry, 126*, 127–145.

Bartolucci, G. (1982). Formal aspects of language in childhood autism. In Advances in child behavior analysis and therapy (Vol. 2, pp. 159–18). Lexington, MA: Lexington Books.

Bartolucci, G., & Albers, R. J. (1974). Deictic categories in the language of autistic children. *Journal of Autism and Childhood Schizophrenia, 19*, 131–141.

Bartolucci, G., Pierce, S. J., & Streiner, D. (1980). Cross-sectional studies of grammatical morphemes in autistic and mentally retarded children. *Journal of Autism and Developmental Disorders, 10*(1), 39–50.

Bates, E. (1997). Origins of language disorders: A comparative approach. *Developmental Neuropsychology, 13*(3), 447–476.

Bennetto, L., Pennington, B. F., & Rogers, S. J. (1996). Intact and impaired memory functions in autism. *Child Development, 67*, 1816–1835.

Bloom, L., Lahey, J., Hood, L., Lifter, K., & Fiess, K. (1980). Complex sentences: Acquisition of syntactic connectives and the semantic relations they encode. *Journal of Child Language, 7*, 235–261.

Bloom, L., Rocissano, L., & Hood, L. (1976). Adult–child discourse: Developmental interaction between information processing and linguistic knowledge. *Cognitive Psychology, 8*, 521–552.

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

Capps, L., Losh, M., & Thurber, C. (2000). The frog ate the bug and made his mouth sad'': Narrative competence in children with autism. *Journal of Abnormal Child Psychology, 28*(2), 193–204.

Carpentieri, S. C., & Morgan, S. B. (1994). Brief report: A comparison of patterns of cognitive functioning of autistic and nonautistic retarded children on the Stanford-Binet – Fourth Edition. *Journal of Autism and Developmental Disorders, 24*(2), 215–223.

Chomsky, N. (1957). Syntactic structures. In. The Hague: Mouton.

Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement, 20*, 37–46.

Condouris, K., Meyer, E., & Tager-Flusberg, H. (2003). The relationship between standardized measures of language and measures of spontaneous speech in children with autism. *American Journal of Speech–Language Pathology, 12*(3), 349–358.

Cox, A., Charman, T., Baron-Cohen, S., Drew, A., Klein, K., Baird, G., et al. (1999). Autism spectrum disorders at 20 and 42 months of age: Stability of clinical and ADI-R diagnosis. *Journal of Child Psychology and Psychiatry, 40*(5), 719–732.

Curcio, F., & Paccia, J. (1987). Conversations with autistic children: contingent relationships between features of adult input and children's response adequacy. *Journal of Autism and Developmental Disorders, 17*(1), 81–93.

Dahlgren, S. O., & Gillberg, C. (1989). Symptoms in the first two years of life: A preliminary population study of infantile autism. *European Archives of Psychiatric and Neurological Science, 283*, 169–174.

Dalgleish, B. (1975). Cognitive processing and linguistic reference in autistic children. *Journal of Autism and Developmental Disorders, 5*(4), 353–361.

de Villiers, J. G., & de Villiers, P. A. (1973). A cross-sectional study of the acquisition of grammatical morphemes in child speech. *Journal of Psycholinguistic Research, 2*, 267–278.

Demuth, K. (1996). Collecting spontaneous production data. In D. McDaniel, C. McKee, & H. Smith Cairns (Eds.), *Methods for assessing children's syntax* (pp. 3–22). Cambridge, MA: MIT Press.

Diehl, J. D., Bennetto, L., & Young, E. C. (2006). Story recall and narrative coherence of high-functioning children with autism spectrum disorders. *Journal of Abnormal Child Psychology, 34*, 87–102.

Dunn, L. M., & Dunn, L. M. (1997). *Peabody picture vocabulary test-3*. Circle Pines, MN: American Guidance Service.

Eigsti, I. M., & Bennetto, L. (2001). Syntactic and memory functions in young children with autism. San Diego, CA: Paper presented at the International Society for Developmental Psychobiology.

Fein, D., & Waterhouse, L. (1979). Autism is not a disorder of language. Boston, MA: Paper presented at the New England Child Language Association.

Fombonne, E. (1999). The epidemiology of autism: A review. *Psychological Medicine, 29*(4), 769–786.

Foster (1986). Learning discourse topic management in the preschool years. *Journal of Child Language, 13*, 231–250.

Fowler, A. E. (1980). A comparison of normal and retardate language equated on MLU. Boston, MA: Paper presented at the Boston University Conference on Child Language Development.

Godber, T., Anderson, V., & Bell, R. (2000). The measurement and diagnostic utility of intrasubtest scatter in pediatric neuropsychology. *Journal of Clinical Psychology, 56*(1), 101–112.

Grice, H. P. (1975). Logic and conversation. In P. Cole & J. Morgan (Eds.), Syntax and semantics (Vol. 3, pp. 41–58). NY: Academic Press.

Hermelin, B., & O'Connor, N. (1975). The recall of digits by normal deaf and autistic children. *British Journal of Psychology, 66*, 203–209.

Hoff-Ginsberg, E. (1991). Mother–child conversation in different social classes and communicative settings. *Child Development, 62*(4), 782–796.

Hollingshead, A. B. (1975). *Four factor index of social status*. New Haven, CT: Yale University Department of Sociology.

Howlin, P. (1984a). The acquisition of grammatical morphemes in autistic children: A critique and replication of the findings of Bartolucci, Pierce, and Streiner, 1980. *Journal of Autism and Developmental Disorders, 14*, 127–136.

Howlin, P. (1984b). The acquisition of grammatical morphemes in autistic children: a critique and replication of the findings of Bartolucci, Pierce, and Streiner, 1980. *Journal of Autism and Developmental Disorders, 14*(2), 127–136.

Howlin, P. (2003). Outcome in high-functioning adults with autism with and without early language delays: implications for the differentiation between autism and Asperger syndrome. *Autism and Development Disorders, 33*(1), 3–13.

Jarrold, C., Boucher, J., & Russell, J. (1997). Language profiles in children with autism: Theoretical and methodological implications. *Autism, 1*, 57–76.

Kaplan, E., Fein, D., Morris, R., & Delis, D. (1991). *WAIS as a neuropsychological instrument (Manual)*. New York: Psychological Corporation.

Kelley, E., Paul, J., Fein, D., & Naigles, L. R. (2006). Residual language deficits in optimal outcome children with a history of autism. *Journal of Autism and Developmental Disorders, 34*(1), 87–102.

Kjelgaard, M. M., & Tager-Flusberg, H. (2001). An investigation of language impairment in autism: Implications for genetic subgroups. *Language and Cognitive Processes, 16*(2/3), 287–308.

Lawson, T. T., & Evans, L. D. (1996). Stanford-Binet: Fourth edition short forms with underachieving and learning disabled students. *Psychological Reports, 79*(1), 47–50.

Lord, C., Goode, S., Heemsbergen, J., Jordan, H., Mawhood, L., & Rutter, M. (1989). Autism diagnostic observation schedule: A standardized observation of communicative and social behavior. *Journal of Autism and Developmental Disorders, 19*, 185–212.

Lord, C., & Paul, R. (1997). Language and communication in autism. In D. J. Cohen & F. R. Volkmar (Eds.), *Handbook of autism and pervasive developmental disorders* (2nd ed., pp. 195–225). New York: Wiley.

Lord, C., & Pickles, A. (1996). Language level and nonverbal social-communicative behaviors in autistic and language-delayed children. *Journal of the Academy of Child and Adolescent Psychiatry, 35*(11), 1542–1550.

Lord, C., Rutter, M., & DiLavore, P. C. (1998). *Autism diagnostic observation schedule-generic*. Chicago, IL: University of Chicago.

Lord, C., Rutter, M., & LeCouteur, A. (1994). Autism diagnostic interview-revised: A revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism and Developmental Disorders, 24*, 659–685.

MacWhinney, B. (1991). *The CHILDES Database*. Dublin, OH: Discovery Systems.

MacWhinney, B. (2000). *The CHILDES project: Tools for analyzing talk* (3rd ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

Marcus, G., Pinker, S., Ullman, M., Hollander, M., Rosen, T., & Xu, F. (1992). Over-regularization in language acquisition. *Monographs of the Society for Research in Child Development, 57*(4), 1–182.

Mottron, L. (2004). Matching strategies in cognitive research with individuals with high-functioning autism: Current practices, instrument biases, and recommendations. *Journal of Autism and Developmental Disorders, 34*(1), 19–27.

Ozonoff, S., & Miller, J. (1996). An exploration of right-hemisphere contributions to the pragmatic impairments of autism. *Brain and Language, 52*(3), 411–434.

Prior, M. R., & Hall, L. C. (1979). Comprehension of transitive and intransitive phrases by autistic, retarded, and normal children. *Journal of Communication Disorders, 12*, 103–111.

Prizant, B., & Duchan, J. (1981). The functions of immediate echolalia in autistic children. *Journal of Speech and Hearing Disorder, 46*, 241–249.

Rapin, I. (1991). Autistic children: Diagnosis and clinical features. *Pediatrics, 87*(5), 751–760.

Rapin, I., & Dunn, M. (2003). Update on the language disorders of individuals on the autistic spectrum. *Brain and Development, 25*(3), 166–172.

Rubino, R. B., & Pine, J. M. (1998). Subject-verb agreement in Brazilian Portuguese: What low error rates hide. *Journal of Child Language, 25*(1), 35–59.

Rumsey, J. M., Duara, R., Grady, C., Rapoport, J. L., Margolin, R. A., Rapoport, S. I., et al. (1985). Brain metabolism in autism: Resting cerebral glucose utilization rates as measured with positron emission tomography. *Archives of General Psychiatry, 42*(5), 448–455.

Rutter, M. (1970). Autistic children: Infancy to adulthood. *Seminars in Psychiatry, 2*, 435–450.

Rutter, M., Mawhood, L., & Howlin, P. (1992). Language delay and social development. In P. Fletcher & D. Hall (Eds.), *Specific speech and language disorders in children: Correlates, characteristics, and outcomes* (pp. 63–78). London: Whurr.

Sattler, J. M. (1992). *Assessment of children: Revised and updated third edition*. San Diego, CA: Jerome M. Sattler, Inc.

Scarborough, H. (1990). Index of productive syntax. *Applied Psycholinguistics, 11*, 1–22.

Scarborough, H., Rescorla, L., Tager-Flusberg, H., Fowler, A., & Sudhalter, V. (1991). Relation of utterance length to grammatical complexity in normal or language-disordered groups. *Applied Psycholinguistics, 12*, 23–45.

Seidenberg, M. S., & MacDonald, M. C. (1999). A probabilistic constraints approach to language acquisition and processing. *Cognitive Science, 23*(4), 569–588.

Shriberg, L. D., Paul, R., McSweeny, J. L., Klin, A. M., Cohen, D. J., & Volkmar, F. R. (2001). Speech and prosody characteristics of adolescents and adults with high-functioning autism and Asperger syndrome. *Journal of Speech and Language Hearing Research, 44*(5), 1097–1115.

Stone, W., & Yoder, P. (2001). Predicting spoken language level in children with autism spectrum disorders. *Autism, 5*(4), 341–361.

Szatmari, P., Bryson, S., Boyle, M., Streiner, D., & Duku, E. (2003). Predictors of outcome among high functioning children with autism and Asperger syndrome. *Journal of Child Psychology and Psychiatry, 44*(4), 520–528.

Tager-Flusberg, H., & Anderson, M. (1991). The development of contingent discourse ability in autistic children. *Journal of Child Psychology and Psychiatry, 32*(7), 1123–1134.

Tager-Flusberg, H., & Calkins, S. (1990). Does imitation facilitate acquisition of grammar? Evidence from the study of autistic, Down's syndrome and normal children. *Journal of Child Language, 17*, 591–606.

Tager-Flusberg, H., Calkins, S., Nolin, T., Baumberger, T., Anderson, M., & Chadwick-Dias, A. (1990). A longitudinal study of language acquisition in autistic and Down syndrome children. *Journal of Autism and Developmental Disorders, 20*(1), 1–21.

Thorndike, R. L., Hagen, E. P., & Sattler, J. M. (1986). *The Stanford-Binet Intelligence Scale: Fourth Edition*. Chicago, IL: Riverside Publishing.

Volden, J., & Lord, C. (1991). Neologisms and idiosyncratic language in autistic speakers. *Journal of Autism and Developmental Disorders, 21*, 109–130.

Wanska, S. K., & Bedrosian, J. L. (1986). Topic and communicative intent in mother–child discourse. *Journal of Child Language, 13*(3), 523–535.