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Shared attention and grammatical development in typical children and children with autism*

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ABSTRACT

The two studies presented here explore the relationship between children's pragmatic skills and their growth in grammar. In study 1, thirty normally developing children were videotaped interacting with their parents at 1;2 and again at 2;7. Using correlational and regression techniques, we found that pragmatic accomplishments of MUTUAL ATTENTION, as well as mother's conversational style, explained 45% of the variance in grammar at 2;7. The second study investigated pragmatic–grammatical relationships with data from 6 high-functioning children with autism. To control for individual variation in skill level at the start of the study, within-individual growth rates for grammar were estimated as our outcome. The results substantiated those of study 1, in that pragmatic accomplishments within mutual attention predicted the per month growth rate in grammar. We interpret these findings as consistent with the position that the infant's social-pragmatic skills contribute to the acquisition of grammar.

INTRODUCTION

Children's earliest linguistic accomplishments have been described as purely communicative, without conventional lexical or grammatical structure.

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These early communications include requests for help, pointing and showing accompanied with vocalizations (Bates, Camaioni & Volterra, 1975), as well as the production of routine social markings (e.g. *bye-bye*), responses to questions, moves in games, and mimicking animal noises (Ninio & Snow, 1996). Though children universally begin language acquisition expressing these interpersonal intents, these early social-pragmatic skills have generally been assumed to be irrelevant to grammatical acquisition, which is the focus of attention in somewhat older children.

Of course, since pragmatic skills emerge early and grammar only many months later, it seems logical that they have little relation with one another. The assumption of their separate development is further strengthened by the dissociation between these two domains in children with autism, who show limited pragmatic skill but can have excellent grammar.

A cross-species perspective, though, would suggest that certain pragmatic capabilities co-occur with true language. Tomasello (1997), for example, has claimed that chimpanzees use gestures to direct each others' actions and in ritualized exchanges, which fall short of true communication, but do not intentionally manipulate others' attention (see also Tomasello, Kruger & Ratner, 1993). In other words, grammar does not emerge in the absence of joint attention regulation. Furthermore, it has been suggested that the early pragmatic capabilities of the child are a potential source of growth in grammar (Ninio & Snow, 1988). In this paper we pursue the question of whether there is any relation between children's pragmatic accomplishments during the earliest stages of language development and their growth in morphological and syntactic domains, looking at both normally developing children and at children with autism, whose pragmatic skills are limited.

We focus on those pragmatic accomplishments which constitute the primary uses of language during the early stages of development, as derived from both observations (Bates *et al.*, 1975; Snow, Pan, Imbens-Bailey & Herman, 1996) and parent reports (Ninio & Goren, 1993). Children's early pragmatic achievements involve producing interpretable expressions of three general types of communicative intents: (a) negotiating an ongoing activity (e.g. requesting help, requesting an object, directing another's action), (b) participating in social routines and well practiced formats (e.g. saying bye-bye, playing peek-a-boo, answering questions like 'what do cows say?'), and (c) regulating mutual attention (e.g. vocalizing to attract attention to oneself, pointing at something while vocalizing, asking 'what's that?').

It is not immediately clear whether these three types of intent can be ordered in complexity. Negotiations of activity, the instrumental uses of language, are within the capacities of nonhuman primates (Tomasello, 1997), suggesting they are simpler to accomplish than the other two classes of communicative intent, which are not produced by nonhuman primates. Children with autism can develop quite extensive instrumental uses of

language, without any skill in either social participation or attention regulation (Rollins, 1994). While negotiations emerge early in typically developing children (as proto-imperatives; see Bates *et al.*, 1975 or demand vocalizations, see Carter, 1979), social participation acts are more frequent, at least during the early stages of development (Snow *et al.*, 1996). Social participation acts typically emerge earlier than attention regulation acts (Ninio & Snow, 1996), and demand a less sophisticated level of intersubjectivity. Thus, we argue that negotiations are the least sophisticated and attention regulation, the most sophisticated of these communicative intents. However, the specific speech acts that occur within negotiations and within mutual attention regulation become more varied and more complex with age, while social participation declines in frequency and remains restricted to a limited number of different speech acts. Data from nonhuman primates would suggest that they express intents specific to activity negotiation in the absence of grammar.

Why would any pragmatic accomplishment be expected to relate to grammar? First, among normally developing children at least, we find correlations across the various domains of language skill, rather than any strong dissociation of grammatical from lexical or pragmatic skills (Bates & Goodman, in press). Snow *et al.* (1996), for example, reported within-age correlations ranging from 0·37 to 0·59 between pragmatic and lexical indices at 1;2 and from 0·32 to 0·44 between pragmatic and grammatical indices at 1;8. Second, accomplishment of the pragmatic capacities to negotiate activity, participate in social routines, and regulate mutual attention creates the conditions under which children can interact with adults and benefit from adult language. Control over negotiation acts enables the child to enter into conversations about ongoing activities, contexts in which objects the child is attending to and impending actions are labelled by the adult; these are precisely the contexts that have been identified as helpful in supporting lexical development (Tomasello & Todd, 1983; Tomasello & Kruger, 1992; Tomasello, Strosberg & Akhtar, 1996). The embedding of the adult talk, which infants hear in social routines, ensures nonlinguistic scaffolding for language learning by alerting the child to information that should be attended to, and defining what can be presupposed (Bruner, 1995). With time, typically developing children learn to go beyond routines to participate socially in contexts even without well-rehearsed or practised routines to carry the interaction; they begin to converse about a shared focus of attention (Ninio & Goren, 1993; Snow *et al.*, 1996). For early language learning to take place, it is important that children to be able to coordinate attention to the caregiver with attention to the object or event of interest (Tomasello *et al.*, 1996; Baron-Cohen, Baldwin & Crowson, 1997). The value of contexts of shared attention in promoting lexical acquisition has been substantiated in both naturalistic and experimental studies of early word learning (Goldfield, 1990; Tomasello & Kruger, 1992; Tomasello *et al.*, 1996; Baron-Cohen *et*

al., 1997); effects on early grammars, though less widely attested, have also been claimed (Ninio & Snow, 1988).

But, of course, it is overly simplistic to think that the emergence of grammar might depend solely on the child's capacities in the socio-pragmatic domain. Even if pragmatic accomplishments are important prerequisites to grammatical development, one might also expect a contribution from the nature of the language interactions the child engages in – the quantity of maternal language heard (as shown by Huttenlocher, Haight, Bryk, Seltzer & Lyons, 1991, for example), and/or the usefulness of that language as a source of information about the grammar (as mediated by parental maintenance of semantic contingency and use of a conversation-eliciting style; see Snow, 1989, for a review). Accordingly, in exploring the relation between children's early accomplishments in each of these three communicative domains and later grammar, we also included indicators of the children's language environments to reflect quantity of maternal speech directed to them and the conversational style of their mothers.

In our exploration of the plausibility of a relationship between children's pragmatic capacities and their syntactic development, we have selected two groups of children for study. One relatively large group of normally developing children observed at ages 1;2, and 2;7 provides considerable statistical power in seeking the relationship, but the robustness and speed of both pragmatic and syntactic acquisition in normally developing children reduces the chances that syntactic dependence on pragmatic prerequisites can be isolated. Thus, we have chosen also to pursue the relationship in a group of six children with autism. The choice of this group may seem odd, given that children with autism are precisely the group used to support the claim of dissociation between grammar and pragmatics. However, there is considerable individual variation within groups of children with autism in both grammatical and pragmatic skill. For example, Baron-Cohen (1989) reported that 10% of children with autism comprehended points designed to regulate joint attention, and 29% of the children with autism in another study used speaker's gaze direction as a cue to word meaning (Baron-Cohen *et al*., 1997). Within the domain of grammar, many children with autism never acquire productive syntax, while others show fairly high achievement (see for example Tager-Flusberg, Calkins, Nolan, Bamberger, Anderson & Chandwick-Dias, 1990). Many studies cited in support of the claim that children with autism have advanced in the face of poor pragmatics have: (a) not assessed grammar and pragmatics in the same children and/or (b) have not used a truly longitudinal perspective. The study by Mundy, Sigman & Kasari (1990) demonstrates the value of a longitudinal analysis. These authors found that children with autism in the prelinguistic to early one-word stage displayed marked, and often persistent, deficits in producing gestures to regulate joint attention. Nonetheless, their skills in pointing,

showing, and using eye gaze to direct another person's attention were predictive of language development a year later. Thus, children with autism can make visible a relationship between pragmatics and grammar that is easily obscured in typically developing children whose robust language acquisition capacities may establish such a low threshold for effects that every child has adequate access. While the group of children with autism available for study was small, it is appropriate to study fewer cases when the anticipated effect size is large (Light, Singer & Willett, 1990).

STUDY 1

METHODS

Subjects

The subjects whose language development is reported here were drawn from the New England sample (Pan, Imbens-Bailey, Winner & Snow, 1996; Snow *et al*., 1996). The 52 children for the New England sample was chosen form a larger sample of 100 children on whom videotapes were available through the MacArthur Individual Differences Project (see Dale, Bates, Resnick & Morisett, 1989 for description of subject recruitment and background information on the original sample). The New England sample were chosen using the following criteria: English-speaking families; no evidence by age three of any hearing impairment or developmental delay; equal proportions of girls and boys; representation of the full range of socioeconomic status available in the original sample; and children whose families could be contacted for data collected at age 5. An additional criterion for the current study was that the children's Mean Length of Utterance was less than or equal to 1·2 at 1;2, and that they were brought again to the laboratory between 2;6 and 2;8 (referred to here as 2;7). These last two criteria constrained the current sample to 30 children, 13 girls and 17 boys. Mean Hollingshead score (a measure of socioeconomic status, see Hollingshead (1965) was 54 with a standard deviation of 10·9 (see Snow *et al*., 1996 for other analyses on the full NE sample).[1] Because we were interested in prediction of morphosyntactic accomplishments from pragmatic capacities before the emergence of syntax, we chose to include in the analysis presented here only those 30 children whose MLU at 1;2 was under 1·2; such children were still producing essentially one-word speech, with a few unanalysed phrases and morphological markers.

Data collection

Parent–child dyads were brought to the laboratory at age 1;2, and again at 2;7. With the exception of three children who were videotaped with their

[1] The transcripts from the entire New England sample have been donated to the CHILDES data base.

fathers for one session, all dyads were mother–child pairs. Parents and children were videotaped using a camera located either at ceiling level in one corner of the room and operated by remote control, or located behind a one-way mirror.

At 1;2, transcripts analysed for this study consist of spontaneous language collected during a variety of dyadic activities. During the warm-up period, the parent and child were left alone in a small room with a set of toys, and the parent was instructed to take a few minutes to let the child become accustomed to the setting. During the remaining semi-structured free play period, the parent was asked to play with the child using the contents of four boxes. The boxes contained, in order, a ball, a cloth for peekaboo, paper and crayons, and a book. Parents were not instructed how long should be spent on each box, but were asked to have only one box open at a time, and to try to get to all four boxes in about 10 minutes. In reality, the sessions were terminated only when the parent had tried to engage the child in all four activities. This led to some variation in the duration of the videotaped session (see Table 1).

TABLE 1. *Univariate statistics in normally developing children* (n = *30*)

Variable	Mean	Standard deviation	Min	Max	Skewness
Negotiations	1·27	2·47	0	11	2·47
Social participation	3·23	4·45	0	20	2·15
Mutual attention	7·5	6·26	0	26	0·90
Total no. of acts	12	9·86	0	47	1·59
Maternal talkativeness	325	119·4	184	720	1·41
Maternal conversational style	1·17	0·71	0·32	3·68	1·76
Vocabulary comprehension	103·2	43·0	35	180	0·44
Vocabulary production	20·4	36·5	0	178	3·68
Minutes at 1;2	26·3	4·43	20	37	0·998
IPSyn at 2;6–2;8	48·6	15·24	11	78	−0·122

The protocol for parent–child interaction at ages 2;7 also involved the four boxes. There was no warm-up period, however, and two substitutions were made in order to render the activities age-appropriate; the ball and peekaboo cloth were replace by hand puppets and a toy house.

Transcription

Videotaped parent–child interactions were transcribed into computer files using the transcription conventions of the Child Language Data Exchange System (MacWhinney, 1991). Transcripts were verified by a second tran-

scriber for content and checked for adherence to transcription conventions using the automatic checking facilities of the CHILDES system. Utterance boundaries were based primarily on intonation contour, and secondarily on pause duration. No attempt was made to distinguish the number of unintelligible words in a string. Discrepancies in the transcription were resolved by consensus.

Assessing morphosyntax

The Index of Productive Syntax (IPSyn) (Scarborough, 1990) was used to assess morphosyntactic skill achieved by each child at 2;7. The IPSyn score is a composite score, based on 100 utterances, which reflects the child's use of 56 syntactic and morphological forms, including elaborations within noun and verb phrases, questions, negations, and various sentence structures.

Assessing the frequency of communicative acts at three levels of pragmatic demand

The Inventory of Communicative Acts-Abridged (INCA-A) (Ninio, Snow, Pan & Rollins, 1994) was used to code children's communicative intents. This system is a shortened and modified version of the system developed by Ninio & Wheeler (1984; see Ninio & Snow, 1996). Ninio & Wheeler's system was based both on speech act theory (Austin, 1962; Searle, 1976) and on studies of face-to-face interaction (Goffman 1974; Streeck, 1980) which emphasize the importance of socially constructed communicative interchanges. Thus, the system identifies and codes communicative intent at two different levels – the level of the social interchange and the level of the utterance, thus acknowledging the existence of an organization of talk at a level higher than the single utterance (cf. Streeck, 1980; Dore & McDermott, 1982). An interchange is defined as one or more rounds of talk, all of which serve a unitary interactive function implicitly agreed upon by the interlocutors. Within this social interchange, speakers express specific intents at the utterance level. The INCA-A, then, actually consists of two subsystems, each of which codes for a different component of communicative intent. Since the system was designed to provide exhaustive coding of the communicative attempts expressed by children of varying ages (as well as their mothers), it can reflect development and continuity across a wide age range. In addition to its theoretical grounding, the ecological validity of the system was assured by distinguishing categories based on mothers' interpretations of their own and their children's intents. Finally, it is important to note that the type of analysis employed is communicative rather than functional. On the level of the utterance, the intended, rather than the achieved, illocutionary act is coded. On the level of the interchange, it is the speaker's overt (though

not necessarily explicit) framing of the immediate social situation that is coded. The INCA-A differs from Ninio & Wheeler's system in that it included nonverbal and semi-gestural communicative acts, as well as purely verbal ones.

Reliability was assessed on 20% of the more than 50000 communicative acts coded in the larger study. Expressed as a simple per cent agreement between two coders, it ranged from 0·79 to 0·90 on the interchange level, and 0·81 to 0·89 on the speech act level. Cohen's kappa, which takes account of chance agreement between coders, was calculated for the interchange level using five transcripts. The values for kappa ranged from 0·74 to 0·88 (substantial to almost perfect agreement according to guidelines in Landis & Koch, 1977).

For purposes of the current analysis, we assessed frequency of use of three categories of communicative intent:

(a) interchanges in which the child is using language instrumentally to negotiate which actions will be carried out and by whom were classified as Negotiation. These were coded in INCA-A as Negotiate Immediate Activity (NIA).

(b) interchanges in which the child is using language to participate in social exchanges were classified as Social Participation. These included utterances coded INCA-A as Perform a Verbal Move in a Game (PRO), Mark an Event (MRK) and responses to questions in practised formats.[2]

(c) interchanges in which the child initiates shared attention to an object or a topic or participates in a discussion of a joint attention were classified as Mutual Attention. These utterances were coded in INCA-A Direct Hearer's Attention (DHA) and Discuss a Joint Focus of attention (DJF).

A child was credited within each category only with initiatory communicative intents and with communicative intents used at least twice, in order to be sure that the intents included were being used productively.

Maternal conversational style

To investigate variation in maternal conversational style we looked at the ratio of child-centred communicative acts to directive communicative acts that the mother addressed to her child at 1;2 (Pan *et al.*, 1996). Thus, mothers whose ratio scores are 1 were addressing an equal number of child-centred and directive speech acts to their children, while mothers with ratios above 1 used comparatively more child-centred acts and those with ratios below 1 used comparatively more directive acts. Child-centred acts included only interchange-speech act combinations which were judged to be unambiguously 'child-centred', that is, communicative acts that followed the

[2] Responses to well practised questions were coded in INCA-A on the speech act level not on the interchange level.

child's lead. This category included a variety of speech acts (statements, questions, acknowledgments) which occurred within the context of parent–child joint focus, as well as parental attempts to clarify children's verbal or nonverbal communicative acts, and discussions of the child's thoughts and feelings. Directive communicative acts included only those acts that were unambiguous 'directives', i.e. attempts either to direct the child's attention to new focus or to prohibit a child behaviour. Pan *et al*. acknowledge that adopting this approach perhaps somewhat underestimates the number of acts in both categories, a strategy we prefer to that of including in either category parental utterances that were somewhat mixed in function (see Pan *et al*. for a complete list of interchange speech-act combinations for both categories).

Maternal talkativeness

The total number of maternal utterances was used to measure maternal talkativeness.

Initial language status

Vocabulary comprehension and vocabulary production at 1;2, derived from an early version of the McArthur Communicative Development Inventories (Fenson, Dale, Resnick, Thal, Bates, Hartung, Pethick & Reilly, 1993) were used as indicators of the child's initial language status.

Statistical analyses

Correlation and regression techniques were used to explore the relationship between the IPSyn score at 2;7 with the three pragmatic measures: negotiations at 1;2; social participation at 1;2; and mutual attention at 1;2, the two language environment measures, maternal conversational style and maternal talkativeness, as well as the children's initial language status. Because the observation sessions varied in length from 20 to 37 minutes, and clearly longer sessions provide children more opportunity to produce any given communicative intention, we used partial correlations (partialling out number of minutes) and controlled for number of minutes in our regression analyses.

RESULTS

Univariate statistics for each of our measures, as well as for total number of communicative acts produced at 1;2, are presented in Table 1. Clearly children at age 1;2 vary considerably in their pragmatic skills. Three out of the 30 children did not produce any communicative acts at 1;2 whereas one child produced 47 communicative acts. This child's communicative precocity positively skewed the total number of communicative acts, negotiation and social participation measures. Without her, the ranges for these measures were 0–28, 0–6, and 0–10 respectively. Mutual attention were also skewed

because of one child. When she as removed the frequency of mutual attention ranged from 0 to 17.

The children's language environment also varied considerably. Maternal conversational style was positively skewed (skewness = 1·76) due to two very child-centred mothers with ratios of 3·68 and 2·52. Without these two observations, the maternal style measure was symmetrical (skewness = 0·435) around a mean of 1·04 with a standard deviation of 0·467. Mothers ranged from being very directive (ratio of 0·319) to very child-centred (ratio of 2·1).

Partialling out the number of minutes in each sample, there were moderate positive correlations between IPSyn at 2;7 and the frequency of communicative acts at each of the three levels (for negotiations partial $r = 0{\cdot}41$, $p < 0{\cdot}02$; for social participation partial $r = 0{\cdot}45$, $p < 0{\cdot}01$; for mutual attention, partial $r = 0{\cdot}49$, $p < 0{\cdot}006$). Maternal conversational style also showed a significant correlation with IPSyn at 2;7 (partial $r = 0{\cdot}58$, $p < 0{\cdot}003$). On the other hand, the child's initial language status and maternal talkativeness did not correlate significantly, and thus were omitted from the regression analyses. Controlling for number of minutes, negotiations, social participation and mutual attention were mutually uncorrelated, indicating all three measures could contribute to the variation in IPSyn at 2;7, individually and in combination.

Results of the regression analyses are reported in Table 2. The first four models include minutes and then either negotiations at 1;2 (M1), social participation at 1;2 (M2), mutual attention at 1;2 (M3), or maternal conversational style at 1;2 (M4). As would be expected from the correlations reported above, all these models were related to the variation in IPSyn at 2;7, explaining 22, 25, 18 and 26% of the variation respectively. However, when we regressed IPSyn at 2;7 on the main effects of both negotiation and mutual attention (M5, Table 2), negotiation was not significantly related to the outcome. When social participation and mutual attention were included as predictors in a single model (M6, Table 2), the variance in syntactic outcomes explained was 36% (significant at $p < 0{\cdot}007$). Adding maternal conversational style to this model increased overall variance explained to 48% but suppressed the contribution of social participation. Thus, the most parsimonious model (M8) is one which includes only mutual attention and maternal conversational style; this model explains 45% of the variance in IPSyn ($F = 7{\cdot}12$, $p = 0{\cdot}002$).

DISCUSSION

We have found in this group of normally developing children that those who, at the onset of combinatorial speech, produced more communicative acts in contexts of joint attention and whose mothers were more child-centred, had more fully developed syntactic skills 20 months later. On the other hand, children who were communicating more within contexts of negotiated

TABLE 2. *Regression models explaining variance in IPSyn at 2;7 controlling for number of minutes* (n = 30)[a]

	Negotiations		Social participation		Mutual attention		Child-centred			
Model	$\hat{\beta}_1$	S.E.($\hat{\beta}_1$)	$\hat{\beta}_1$	S.E.($\hat{\beta}_1$)	$\hat{\beta}_1$	S.E.($\hat{\beta}_1$)	$\hat{\beta}_1$	S.E.($\hat{\beta}_1$)	D.F.	R^2
M1	2·67*	(1·12)							2, 27	0·18
M2			1·92*	(0·723)					2, 27	0·22
M3					1·19*	(0·104)			2, 27	0·25
M4							11·08*	(3·62)	2, 27	0·26
M5	1·97*	(1·07)			0·988*	(1·97)			3, 26	0·33
M6			1·48*	(0·688)	0·964*	(0·395)			3, 26	0·36
M7			0·807	(0·699)	0·957*	(0·365)	8·211*	(0·622)	4, 25	0·48
M8					1·04**	(0·357)	9·89**	(3·22)	3, 26	0·45

*$p <= 0{\cdot}05$, **$p <= 0{\cdot}01$.

[a] The abbreviations 'S.E.' and 'D.F.' refer to standard error and degrees of freedom error respectively. Please note that M5 includes negotiations and mutual attention, M6 includes social participation and mutual attention, M7 includes social participation, mutual attention and child-centred and finally M8, includes only mutual attention and child-centred.

activity were not more accomplished in syntax at the later age. These findings are particularly striking because the coding of children's communicative acts at 1;2 included nonverbal and semiverbal acts (48% of all communicative acts produced by the entire sample of children aged 1;2 were nonverbal; Snow *et al.*, 1996), and because we eliminated from the sample children aged 1;2 who had productive word combinations; in other words, it was not the case that these relationships simply reflect the impact of precocious language learners who stay linguistically ahead of their agemates.

This study suggests that children's pragmatic capacities and their mothers' conversationstyle both contribute in unique ways to their grammatical development. This can perhaps best be illustrated by considering two pairs of children with roughly equivalent IPSyn scores at 2;7 (see Table 3). Huck

TABLE 3. *Standard scores (SS) for four typically developing children and their mothers*

Name	Child grammatical score at 2;7 (SS IPSyn)	Child pragmatic style at 1;2 (SS mutual attention)	Maternal conversational style at 1;2 (SS conversational style)
Huck	−1·48	−1·20	−0·183
Tom	−1·48	−0·559	−1·12
Dick	1·01	2·95	−0·504
Jane	1·08	0·719	0·716

and Tom both scored more than one standard deviation below the mean on IPSyn, but Huck's production of mutual attention acts at 1;2 was much lower than Tom's, while Tom's mother showed a considerably less child-centred style when he was 1;2 than did Huck's mother. Two relatively high achieving children at 2;7, Dick and Jane, differed in that Dick scored extraordinarily high on production of mutual attention acts at 1;2, though his mother was somewhat below average in child-centredness, while Jane scored within one standard deviation above the mean on both these measures when she was 1;2.

We should note that a limitation of this study is that the normally developing children were associated with a relatively low frequency of negotiations. The truncated variation on frequency of negotiations may well have reduced its predictive power and led to underestimation of the relation between negotiation acts and grammatical development. Children with autism, who tend not to produce many acts within contexts of either social participation or mutual attention regulation, do produce many negotiations, and thus may well help us uncover the role of negotiations in promoting grammatical growth. We now turn to a replication of this study with a group

of children whose pragmatic and syntactic development overall are considerably less robust.

STUDY 2

In study 2, we move away from large samples to an analysis of more intensively collected longitudinal data from six children with autism. In study 2 we used growth modeling of IPSyn scores, which were calculated on 8 or more time points as the outcome variable. Calculation of predictor variables was done the same way as in Study 1.

METHODS

Subjects

The subjects whose language development is reported here were six children with autism who participated in an earlier study on grammatical and word acquisition conducted by Helen Tager-Flusberg (see Tager-Flusberg *et al.*, 1990). The children with autism were all boys who had been located through their school or intervention programs. All met the DSM III (APA, 1980) criteria for the diagnosis of autism and had acquired at least some productive language prior to the beginning of the study, as evidenced by their MLU. Nonverbal cognitive functioning for five of the six children was within the normal to low-normal range as assessed by the Leiter International Performance Scale (Leiter, 1969). The sixth child performed in the mildly retarded range (refer to Table 4).

TABLE 4. *Individual characteristics of the children with autism*

Child	MLU[a]	IQ[a]	Age[a]	Months observed	Number of observations
Rick	1·73	94	4;7	22	11
Brett	3·74	108	5;8	22	10
Roger	2·31	105	3;9	22	10
Mark	1·68	75	7;9	26	13
Jack	3·30	91	6;11	25	12
Stu	1·20	61	3;6	15	8

[a] At first observation.

Data collection

Unstructured parent–child interaction previously videotaped and transcribed by Tager-Flusberg and her colleagues provided the basis for the analyses (see Tager-Flusberg *et al.*, 1990). Each child had been videotaped interacting individually with his mother in a free play situation during bi-monthly visits in their homes. The dyadic play interactions lasted approximately 60 minutes, ranging from a minimum of 40 minutes to a maximum of 70

minutes. To provide some comparability across visits and across sessions, Tager-Flusberg gave each child a small gift during each of the recording sessions.

Assessing morphosyntax

As in study 1, the Index of Productive Syntax (IPSyn) (Scarborough, 1990) was used to assess morphosyntax for the children with autism. These scores have been reported in Tager-Flusberg *et al.*, (1990). For the outcome measure, we used each child's individual rate of change on IPSyn over the course of the study to control for individual variation in skill level at the start of the study (see Snow, 1994 for a discussion). The procedure for obtaining each child's rate of change on IPSyn is described below.

Assessing the frequency of communicative acts at three levels of pragmatic demands

A sample of 20 minutes of on-task parent–child interaction was analysed at each time point under investigation and was used to assess social-pragmatic skills. The following were always excluded from the total number of usable minutes: (a) intervals where the parent or child was out of the room; (b) intervals where a sibling or the examiner talked with the parent or the target child; (c) intervals longer than 30 seconds where the mother attempted to engage the target child in an activity but where the target child refused to cooperate; (d) intervals longer than 30 seconds where the target child actively avoided an activity or interactions with the parent; (e) time intervals longer than 60 seconds where the parent and target child negotiated the next activity.

As with study 1, the INCA-A (Ninio *et al.*, 1994) was used to code children's communicative intentions (see study 1 for a complete description). For study 2 we calculated for each child, the frequency of child initiations at three early observations, for negotiations, social participation, and mutual attention. A second rater independently coded twenty per cent of the total corpus from which each measure was calculated. Interrater reliability estimates ranged from 84 to 88 per cent for interchange and speech act codes.

Language environment

As with study 1, maternal conversational style and maternal talkative measures were calculated for each child at three early observations (see study 1 for a complete description of these measures).

Statistical analyses

We used a statistical approach that builds on recent methodological advances in longitudinal analysis of growth (Bryk & Raudenbush, 1991). The approach was chosen because taking snapshots of children's observed status before and

after is not the best way to reveal the intricacies of their progress. Changes may be occurring over time with some complex and substantively interesting trajectory. Crude pre/post-measurements can never reveal the details of that trajectory.[3] To do a good job of describing individual change over time, a truly longitudinal perspective must be adopted. This requires following children carefully over time and collecting multiple waves of data on their status at sensibly spaced intervals. The investigator must assemble an observed growth record for each child in the data set. If the attribute of interest – IPSyn, for instance – is changing steadily and smoothly over a long period of time, perhaps only three widely-spaced measurements ('waves of data') on each child will be sufficient to capture the shape and direction of the change. But, if the trajectory of individual change is complex, then many more closely-spaced measurements may be required.

Using a Hierarchical Linear Modelling (HLM) technique, the growth plots may be summarized by fitting a suitable individual growth model to the data for each child through regression. In our study, inspection of within-child plots suggested that a straight-line could be used to represent within-child change in IPSyn. Consequently, we used ordinary least-squares regression analysis and a linear model to summarize change over time in IPSyn. The estimated slopes from the fitted trajectories were then used in follow-up analyses to represent per month rates of change, for each child on IPSyn. The p-values on the parameter estimate indicate whether or not the change in IPSyn score is statistically significant. Thus, the within-child analysis provides evidence as to whether and how the IPSyn scores for each child change during the course of the study.

Finally, between-child analyses enabled us to explore whether or not change in IPSyn could be attributed to social-pragmatic influences, using standard correlational and regression methods. By using information about within-child and between-child performance variability, it is possible to compensate for the influences of measurement error in the analysis and thereby increase the chances of detecting true differences in IPSyn that are related to social-pragmatic skills (see Willett, 1989 for a discussion).

[3] In study 1, we used the IPSyn scores at 2;7 as the outcome measure rather than the per month rate of change in IPSyn, at 1;2 many of the typical children did not produce enough utterances to calculate a meaningful IPSyn score. However, it is reasonable to assume local linearity in IPSyn for the children in this study (see Scarborough, 1990). The IPSyn score at 2;7, then, is theoretically meaningful because all of the children start the study with a score of 0 (although it is not as reliable from a statistical standpoint based on three or more time points.

RESULTS

Frequency of pragmatic and language environment measures

Frequency of negotiations, mutual attention, maternal conversational style, and maternal talkativeness are presented in Table 5. It is noteworthy that social participation is not included in Table 5 or in subsequent analyses because the children with autism produced essentially no communicative intentions in the relevant categories.

Within-child changes in IPSyn

Table 5 also presents the predicted IPSyn scores at the first observation, the last observation and the estimated monthly rate of change in grammatical development for each of the six children with autism. The individual growth rates were precisely estimated, as measured by the standard error of the parameter statistics (column 9). The predicted scores of IPSyn at the first and last observation (columns 6 & 7 respectively) were used rather than the child's observed scores because they are more reliable estimates of the child's true score at these observations (Willett, 1989). So, for example, Mark had an estimated IPSyn score of 35 at the start of the study. On average, he acquired approximately one new morphosyntactic form every two months over the 26 months he was observed (parameter estimate = 0·447 points/month change in IPSyn, on average as noted in column 8). Thus, at the end of the study Mark had an estimated IPSyn score of 46·6 (column 7). Although Mark's growth in syntax was considered statistically significant ($p < 0{\cdot}01$), we must question whether or not his rate of development was significant from a practical standpoint. Rick, Brett, and Roger also exhibited statistically significant growth rates in IPSysn (see column 8, Table 5) achieving end of study IPSyn estimates of 61·5, 76·8, 60·8. Finally, Jack and Stu did not exhibit significant growth rates (column 8). Their end of study IPSyn estimates were 72 and 27·2 respectively.

Between-child variability in monthly rate of change in IPSyn

Standard correlation and regression analyses were used to explore the relationship between monthly rate of change in IPSyn with the pragmatic measures, language environment measures and IQ. We found a high, positive relationship ($r = 0{\cdot}94$, $p < 0{\cdot}005$) between per month change in IPSyn and the frequency of communicative acts in mutual attention. A correlation was not found between per month change in IPSyn and negotiations. When we regressed the per month rates of change of IPSyn on the main effect mutual attention, we found that approximately 89% of the variation in the monthly rate of change in IPSyn was attributable to the effects of the frequency of

TABLE 5. *Pragmatic, language environment and morphosyntactic variables for six children with autism*[a]

	Pragmatics		Language environment		Morphosyntactic measures			
							Monthly change	
Child	Mutual attention	Negotiation	Maternal conversational style	Maternal talkativeness	Predicted IPSyn scores first observation	Predicted IPSYN scores last observation	$\hat{\beta}_1$	S.E.($\hat{\beta}_1$)
Rick	75	99	0·91	2323	30·0	61·5	1·430**	0·217
Brett	45	150	1·15	1934	56·0	76·8	0·944*	0·307
Roger	40	130	0·8	860	42·0	60·8	0·856**	0·197
Mark	26	42	3·31	3018	35·0	46·6	0·447**	0·107
Jack	3	65	1·39	2130	66·0	72·0	0·240	0·216
Stu	8	61	0·88	1707	18·0	27·2	0·614	0·383

** $p < 0·01$, * $p < 0·05$.

[a] S.E.($\hat{\beta}_1$) is the standard error of the parameter estimate.

mutual attention. The monthly rate of change in IPSyn was not related to IQ at the start of the study ($r = 0{\cdot}04$, $p < 0{\cdot}38$), number of maternal utterances ($r = -0{\cdot}16$, $p < 0{\cdot}76$), or the ratio of child-centred to directive speech acts ($r = -0{\cdot}48$, $p < 0{\cdot}33$).

Discussion

The results clearly demonstrate that one source of variation in the estimated monthly change of IPSyn for children with autism is the ability to establish and maintain a joint focus of attention. In fact, the children who demonstrate little-to-no control over communicative acts related to joint attention did not show significant growth in IPSyn (i.e. Jack and Stu) suggesting that the establishment and manipulation of joint attention may be a pragmatic skill prerequisite to the development of productive syntax. The children with autism contrast strikingly to the typical children in that their mothers' conversational style did not relate to their growth on IPSyn. This may well reflect the more general social deficits of children with autism, leading to their lack of attention to social cues and difficulty of maintaining attention to social stimuli.

For children with autism, it has been claimed that the domains of grammar and pragmatics are discontinuous (see Tager-Flusberg, 1994). The results presented here suggest strongly that, while levels of achievement at any time in grammar and pragmatics might be quite different, there are relations nonetheless between these two systems even in children with autism. We contend that the methodology used in previous studies biased the outcome toward one of discontinuity, but that differences in achieved status do not necessarily imply discontinuity if prerequisite relationships can be found. Most of the research done on communicative intentions and/or grammatical skill in children with autism has been cross-sectional, and/or has focused on between-child differences without first exploring within-child differences in the context of development. In effect, the past research has been biased by a modular competency-based model. In this study we analyse the data from a truly longitudinal perspective. With a truly longitudinal analysis, the de-coupling of communicative intentions from syntactic skills suggested in the literature was not substantiated. Instead, the findings support the clinical observation that those children with autism who rarely established and/or maintained a joint focus of attention had extraordinary problems with language development.

These findings imply that the deficit in joint attention observed in young children with autism may have devastating consequences for their language acquisition, and as such, important implications for language therapy. Therapy for young children with autism should therefore attempt to facilitate shared attention (see Rollins, Wambacq, Dowell, Mathews & Reese, 1998, for a full explication of this approach).

GENERAL DISCUSSION

Taken together, the findings of the two studies reported here are strong and consistent. In normally developing children, the preverbal or semiverbal expression of communicative intents designed to ensure shared attention presaged morphosyntactic development, whereas expression of instrumental communicative intents did not show any relationship to later morphosyntax. It is true that variation on negotiations was truncated, which may have suppressed the possibilities of finding relationships for the normal children. However, the data from children with autism, whose frequency of negotiations ranged from 42 to 150, confirm that instrumental language is not obviously related to the acquisition of grammar. In children with autism, joint attention was even more strongly related to the development of grammatical skills, further strengthening the conclusion that their pragmatic understandings contribute to the child's acquisition of grammar.

Of course, these correlations do not prove causality. Although we can eliminate some possibly confounding variables in seeking these relationships, and have excluded child language status and maternal talkativeness as accounting for the relation, this remains a correlational study. A more powerful demonstration of a prerequisite relation between pragmatics and grammar would emerge if therapeutic interventions with children with autism that were directed at enhancing mutual attention capacities indeed led to grammar, whereas alternative therapies did not. Of course, carrying out a random assignment clinical trail with this population would constitute an enormous challenge, particularly in light of the limited number of children with autism who make significant progress in grammar in any case.

Our results suggest that, for normally developing children at least, maternal conversational style contributes to the development of grammar above and beyond the contribution of the child's pragmatic capacities. Of course, among the normally developing children, we can assume that even those who scored very low at age 1;2 on pragmatic indicators did eventually develop skills in regulating mutual attention; nonetheless, children whose mothers engaged in more child-centred, less directive talk progressed more rapidly toward grammar even if their pragmatic skills were quite limited. The absence of effect of maternal style on grammatical growth for the children with autism no doubt reflects their general difficulty in functioning in social settings, and highlights the importance of enhancing their own pragmatic understandings in promoting their language development.

We initiated this study with the question of whether pragmatic skills relate to grammar, and more specifically whether different components of pragmatic ability relate to grammar. Findings from nonhuman primates suggested that producing instrumental communication does not lead to grammar, a result we replicated both for normally developing children and even more

powerfully for the children with autism. The pattern of findings strongly suggests that mutual attention regulation is the key accomplishment leading to grammar, confirming the importance attributed to joint attention as a factor in language acquisition by Bruner (1995), Tomasello *et al*., (1993), and others.

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