Research

Early Pragmatic Accomplishments and Vocabulary Development in Preschool Children With Autism

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This longitudinal parallel case study followed the development of pragmatic accomplishments and vocabulary development in five children with autism from the prelinguistic to early one-word stage of language. As would be expected, there was considerable variability in the rates of vocabulary acquisition across the five children. Qualitative analyses suggested that rate of vocabulary acquisition was associated with both type and diversity of pragmatic skills. This preliminary investigation lends support to the hypothesis that not all pragmatic accomplishments are related to language outcomes in precisely the same way.

Key Words: autism, pragmatics, joint attention, vocabulary development

Speech-language pathologists are often among the first professionals to work with young children with autism. These children have delays in the development of language that are exacerbated by a significant deficit in pragmatics (e.g., the social use of language/communication) (Rollins & Snow, 1998; Stone & Caro-Martinez, 1990; Wetherby, Prizant, & Hutchinson, 1998; Wetherby, Schuler, & Prizant, 1997). Children with autism have pragmatic deficits both in how they communicate (i.e., communicative means) and how they express intentions (i.e., communicative intents). They have been found to use unconventional means of communication at all levels of language development. For example, preverbal children with autism use unconventional behaviors such as guiding the teacher's hand to open a container or initiating eye contact to communicate a request after unsuccessfully trying to open a container by themselves (Curcio, 1978). They also use aggression, tantrums, and self-injury to demonstrate the desire to communicate (Donnellan, Mirenda, Mesaros, & Fassbender, 1984). When vocal language is acquired, it may also take on idiosyncratic forms. Curious language patterns found in the speech of verbal children with autism include immediate echolalia (i.e., immediate repetition of a whole or partial utterance), delayed echolalia (i.e., delayed echoing of a phrase after some lapse in time), neologisms (i.e., made-up words), and metaphorical word usage (American Psychiatric Association, 1994).

The repertoires of communicative intentions displayed by children with autism are also qualitatively different from typical children (Baron-Cohen, 1988; Stone & Caro-Martinez, 1990; Wetherby, 1986; Wetherby & Prutting, 1984; Wetherby, Yonclas, & Bryan, 1989; Wetherby et al., 1998). Children with autism appear to acquire instrumental or regulatory communicative intentions (e.g., "give me," "I want") before acquiring intentions that are purely social in nature (e.g., "look at me" or "look at that") (Stone & Caro-Martinez, 1990;Wetherby & Prutting, 1984; Wetherby et al., 1989). The asynchrony between regulatory and social communicative uses suggests that the developmental sequence of pragmatic skills in children with autism may differ from the sequence observed in typical children (Wetherby, 1986). In typical children, behavioral regulations emerge early, as proto-imperatives (Bates, Camaioni, & Volterra, 1975) or demand vocalizations (Carter, 1979); however, acts to participate in social routines may be more frequent, at least during the early stages of development (Snow, Pan, Imbens-Bailey, & Herman, 1996). Social participation acts typically emerge earlier than joint attentional acts (Ninio & Snow, 1996) and demand a less sophisticated level of intersubjectivity (i.e., mutual understanding of an external object or event). Thus, these three categories of intention can be ordered by the degree to which they require infants to integrate information about the social world (Rollins & Snow, 1998).

Recently, several independent investigators have speculated that children's ability to participate in behavioral regulations may reflect a different set of underlying

cognitive skills than is required to regulate and maintain attention (Camaioni, 1996; Mundy & Gomes, 1997; Rollins & Snow, 1998). This proposal implies that different nonverbal pragmatic skills may relate to language outcomes in rather different ways. Preliminary evidence comes from the finding that for early language learning to take place, children must be able to coordinate attention to the caregiver with attention to the object or event of interest (Baron-Cohen, Baldwin, & Crowson, 1997; Tomasello, Kruger, & Ratner, 1993; Tomasello, Strosberg, & Akhtar, 1996). Moreover, recent studies suggest that the regulation and maintenance of shared attention has a stronger relationship with language outcomes than instrumental uses of language in typical children (Rollins, Marchman, & Thal, 1998; Rollins & Snow, 1998) and children with autism (Mundy, Sigman, & Kasari, 1990; Rollins & Snow, 1998). Contrary evidence has been found for children with Down syndrome, whose frequency of prelinguistic requesting was related to language outcomes (Mundy, Sigman, Kasari, & Yirmiya, 1988). Differences in the interpretation and coding of naturalistic events may account (at least in part) for the discrepancies across the studies.

Thus, children with autism have difficulties acquiring the early preverbal communicative intentions that may have a stronger relationship to later language outcomes. Nonetheless, *some* children with autism do eventually engage in acts that regulate and maintain a joint attention (Rollins & Snow, 1998; Wetherby et al., 1998; Stone & Caro-Martinez, 1990). It has been suggested that children with autism first acquire more social intentions through idiosyncratic or unconventional means, and only later express these intentions through conventional means (Prizant & Wetherby, 1988; Wetherby, 1986). In other words, unconventional means may eventually be replaced by more conventional and sophisticated means of communication (Donnellan et al., 1984; Prizant, 1984; Schuler, Prizant, & Wetherby, 1997). One outgrowth of this hypothesis has been the establishment of intervention procedures to assist children with autism in converting aberrant or idiosyncratic communicative behavior to more conventional forms (see Schuler, Prizant, & Wetherby, 1997, for a complete discussion).

Unfortunately, a lack of longitudinal research on the *development* of pragmatic skills during the early stages of language acquisition has impeded both our clinical and theoretical progress regarding the relationship between early pragmatic skills and language acquisition in children with autism. A notable exception is provided by Mundy, Sigman, and Kasari (1990). 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. Nevertheless, the children's skills in pointing, showing, and using eye gaze to direct another person's attention were predictive of language development a year later.

The purpose of this longitudinal parallel case study was to follow the development of communicative means and intentions in five children with autism. A major goal of this study was to move away from cross-sectional research and study children with autism over time. An important feature of the current design is that the children were followed from the prelinguistic to the early one-word stage of language development. In this way, the study explored the development of communication just before and during the lexical acquisition period and sheds light on the relationship between early communicative intentions and rate of vocabulary acquisition. In this parallel case study, I examined videotapes of children while they were enrolled in a university-based preschool program. The focus on a series of descriptive case studies forfeits generalizability to the population of children with autism as a whole, but contributes in a descriptive way to the body of information we have on this group of children. This preliminary investigation, then, allows us to describe the longitudinal development of pragmatic skills in terms of communicative means and intentions in five children with autism. By presenting the five case studies in parallel, we begin to identify sources of both within- and between-child variation in rate of vocabulary acquisition for the children in the study. Careful description of communication development in five children provides additional information concerning the developmental sequence of pragmatic skills and the relationship between early pragmatic skills and rate of vocabulary acquisition in children with autism.

Methods

Participants

Archival data from the clinical records of five children seen at the Callier Center for Communicative Disorders, a University of Texas at Dallas-affiliated clinic, were used for this study. A 3-year window (1992–1995) was chosen to control for the effects of history on the data (Cook & Campbell, 1963). That is, we wanted to rule out the possibility that differences in the children could be attributed to differences in the type or amount of intervention they received. To be included in the study, a child had to meet the following criteria: (a) have an initial diagnosis of autism by a psychologist or a neurologist, (b) have been preverbal at the time of intake, (c) have attended the Preverbal Intervention Program at the Callier Center for at least one year, and (d) have some conventional expressive vocabulary skills on completion of the program. The Preverbal Program serves preschool children (ages 18 months to 3;6 [years;months]) in a classroom atmosphere where a one-to-one clinician/child ratio is maintained. Graduate students in the communication disorders program obtain clinical training while providing services to the children. Of all the children serviced by the preverbal program from 1992–1995, only five children, all boys, met our stringent criteria. The two most common reasons for exclusion from the study were (a) an undocumented diagnosis, and (b) insufficient conventional expressive language by the end of the observation period. It is noteworthy that the onset of language acquisition is severely delayed in children with autism. Only 50% of the children acquire vocal language by age 5 (Rutter, 1978) and an estimated 28 to 61% remain mute (Paul, 1987). Furthermore, autism is a low-prevalence disorder, and

there has been a trend away from providing diagnostic labels, especially for very young children. These facts all contributed to the small number of children available for study.

The clinical records for each child in the program included scores on Vineland Adaptive Behavior Scales (Sparrow, Balla, & Cicchetti, 1984), as well as the expressive and receptive language test scores and protocols from the Sequenced Inventory of Communication Development (SICD-R; Hedrick, Prather, & Tobin, 1991). Individual subject characteristics are presented in Table 1. All of the children were relatively young (mean age of 2;7) and were severely delayed in language as measured by the SICD-R (mean receptive language age 1;2 and mean expressive language age 0;10). The delays in language skills were corroborated by the Vineland Adaptive Behavior Scales (Sparrow, Balla, & Cicchetti, 1984), as was the social impairment.

Data Collection

The clinical record for each child also included at least four 2.5-hour videotapes depicting typical communicative and social interactions within the Preverbal preschool program. (The Preverbal program routinely videotapes each participating child for the entire morning session several times during the school year.) For each child, four videotapes were selected for later transcription and analysis (the first, last, and two intermediate tapes). To capture each child's optimal level of on-task communicative functioning, only intervals where the child was interacting 1:1 with his clinician were transcribed and coded for analysis. Therefore, activities such as small group, music, and snack time were, by definition, excluded from the analyses. This criterion was used because the language skills of children with autism are influenced by both the setting and the participants (Bernard-Opitz, 1982; McHale, Simeonson, Marcus, & Olley, 1990; Sigman & Ungerer, 1984). Furthermore, efforts to capture the child's optimal level of on-task communicative behaviors were made by excluding from the total number of usable minutes the following intervals: (a) when the clinician or child was out of the room, (b) when another child or teacher talked with the target child and clinician, (c) when the clinician attempted to engage the target child in an activity but the target child refused to cooperate for longer than 30 seconds, (d) when the target child actively avoided an activity or interactions with the clinician for longer than 30 seconds, and (e) when the clinician and target child negotiated the next activity for longer than 60 seconds. This substantially reduced the total number of usable minutes available for analyses. Videotapes were viewed and catalogued. The catalogue included a time record for each activity so that the total number of usable minutes for coding could be calculated. Twenty minutes was the maximum number of usable minutes that was available for all children in the study at each time point. It is noteworthy that 20 minutes of on-task interaction is in keeping with other studies of early communicative and language skills in typical children (Snow et al., 1996) and children with autism (Rollins & Snow, 1998). To ensure that the sample of 20 minutes was representative for each child, the videotaped interactions were reviewed by persons familiar with each child.

Transcription

For each child, 20 minutes of on-task behavior were transcribed onto computer files and formatted in accordance with the CHAT transcription conventions of the CHILDES child language data archive (MacWhinney, 1991). Each communicative act was supported by behavioral evidence that the child had a plan/intention to achieve a goal with awareness that another person can be a means to that end. This behavioral evidence has been outlined by Prizant and Wetherby (1988) and includes the following: (a) alternating eye gaze between a goal and the listener, (b) persistent signaling until the goal has been met, (c) changing the quality of the signal until the goal has been met, (d) ritualizing or conventionalizing the form of signal within specific communicative contexts, (e) awaiting a response from the listener, (f) terminating the signal when the goal is met, and (g) displaying satisfaction when the goal is attained or dissatisfaction when it is not.

Measures

For each child, at each time point, measures of communicative intentions, communicative means, and vocabulary size were obtained.

Communicative Intentions. 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 and Wheeler (1984; see Ninio & Snow, 1996). The system is based both on Speech Act Theory (Austin, 1962; Searle, 1976) and on studies of

TABLE 1. Individual subject characteristics.

		SICD		Vineland ($M = 100$, $SD = 15$)			
Child	Age	Receptive	Expressive	Communication	Daily Living	Social	Motor
Marshall	3;1	1;0–1;4	N/A	68	65	76	79
Roger	2;6	1;0	1;4	63	65	72	73
Sid	2;2	1;2	1;5	66	71	77	93
Josh	2;5	1;4	0;8	64	67	62	86
Carl	2;8	1;4	1;0–1;4	N/A	72	72	89

face-to-face interaction (Goffman, 1974; Streeck, 1980) that emphasize the importance of socially constructed communicative interchanges. For the current study, only the social interchange level was analyzed. The social interchange level acknowledges the existence of communication being organized at a level higher than the single speech act (Dore & McDermott, 1982; Streeck, 1980). A social interchange is defined as one or more rounds of communication, all of which serve a unitary interactive function, implicitly agreed on by the interlocutors. The system was designed to provide coding of the communicative attempts expressed by children of varying ages (as well as their interlocutors). As such, it reflects development and continuity across a wide age range (see Ninio & Snow, 1996).

For each child, at each time point we assessed the percentage of initiations in each of four categories: (a) regulation interchanges in which the child communicated instrumentally to negotiate which actions would be carried out and by whom (e.g., extending arms upward to be picked up), (b) routine interchanges in which the child participated in social exchanges (e.g., wave bye bye) or performed a move in a game (e.g., hide eyes for peek-a-boo), (c) direct attention interchanges in which the child initiated shared attention to an object or event (e.g., pointed to an object or event), and (d) joint focus interchanges in which the child participated in a discussion with a joint focus of attention. It is important to note that the type of analysis employed is communicative rather than functional. On the level of the interchange, it is the communicator's overt (though not necessarily explicit) framing of the immediate social situation that is coded. Furthermore, children were credited only for initiatory communicative intents and not for responses, because initiatory intentions better reflect the child's underlying communicative ability (Rollins & Snow, 1998).

Communicative Means. At each observation, measures of communicative means were obtained for each child. Communicative means were coded as unconventional forms, vocalizations, gestures, and words. Unconventional forms of communication included, but were not limited to, manipulation of the clinician's hand to obtain a goal, throwing objects, and proxemic behaviors. Gestures included, but were not limited to, pointing and reaching. Usage of words varied widely among the children. Word-like vocalizations were counted as words when there was sufficient contextual information to identify the target lexical item (e.g., saying "ba" when holding a ball). As described above, behavioral evidence was used to indicate whether the child had a plan or intention to achieve a goal. For each child, at each observation, the percent of total communications that were unconventional, vocalizations, gestures, and words were calculated.

Vocabulary Development. For each child, at each point in time, the number of different words (NDW) produced in the 20-minute sample was used as a measure of vocabulary development (see Klee, 1992; Miller, 1991). Because NDW was computer generated through a CLAN program (MacWinney, 1991), reliability estimates were not calculated for this measure (see Sokolov & Snow, 1994).

Reliability. Transcribers and coders were all students seeking a master's degree in communicative disorders at the University of Texas at Dallas. Each student participated in a lengthy training where he or she was required to (a) read the coding manual (Ninio, Wheeler, Snow, Pan, & Rollins, 1990), (b) code a "practice transcript" with the author until the coder had an adequate grasp of the coding system, and (c) independently code additional practice tapes until a point-by-point reliability of 90% was achieved with the author. Furthermore, the coders were required to recalibrate their reliability every 3 months. This procedure has been used to establish reliability with typical children in the preverbal to semiverbal stages (Snow et al., 1996), as well as children with SLI (Rollins, Conti-Ramsden, Pan, & Snow, 1994) and children with autism (Rollins & Snow, 1998). The interrater reliability was estimated separately for communicative intentions and communicative means. A second rater (the author) independently coded 20% of the transcripts. Cohen's Kappa statistic, which takes account of chance agreement, was calculated based on the coding scheme from which the measures were derived (intentions or means), and therefore do not reflect point-by-point estimates on individual categories. The values for Kappa ranged from .74 to .88 ("substantial" to "almost perfect agreement" according to guidelines established in Landis and Koch, 1977).

Data Analysis

In studies that measure children at different times and at different ages, a flexible approach to analyzing change over time is required (Bryk & Raudenbush, 1992). In the current study, we used exploratory data analysis and adopted a growth modeling *perspective* to display individual changes over time for each child (Willett, 1989; Willett & Ayoub, 1991). Changes may be occurring over time with some complex and substantively interesting trajectories. Crude pre/post- measurements can never reveal the details of that trajectory. 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. The investigator must assemble an observed growth record for each child in the data set. If the attribute of interest—number of different words—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. However, if the trajectory of individual change is complex, then more measurements may be required (see Willett, 1989).

Under this approach, a suitable mathematical model was fit to the data through regression techniques. This is referred to as the within-child or level one model. All members in a given population are assumed to have the same underlying growth trajectories, but they may differ by the values on their level one growth parameters (Willett & Sayer, 1994). The p values associated with the growth parameters indicate whether the change in NDW is statistically significant, and the within-child mean square

error (*MSE*) statistic measures the quality of the estimated fit. There is no absolute rule concerning what constitutes an acceptable *MSE*. In general, a lower *MSE* signifies less error variance and is associated with the within-child model (Kleinbaum, Kupper, Muller, & Nizam, 1998). The predicted scores for NDW (e.g., scores that fall on the estimated regression line) at each month are considered better estimates of a child's true vocabulary skill than are any of the observed scores. Consequently, it was unnecessary for the intervals between time points to be identical for all of the participants in the study.

Finally, qualitative between-child analyses enabled us to explore whether changes in rate of vocabulary development are associated with changes in social-pragmatic skills. By using information about within-child and between-child performance variability, it is possible to compensate for the influences of measurement error and thereby increase the chances of detecting true differences in vocabulary development that are related to social-pragmatic skills (see Willett, 1989, for a discussion).

Results

The results are divided into two sections. In the pragmatics description results section, each child's change over time in communicative intentions and communicative means (Tables 2–6) is described. This section simply lays out the descriptive results from transcript analysis regarding pragmatic skill. In the vocabulary section, rate of vocabulary change for each child (the level one models) is presented first. A qualitative analysis follows, where the pattern of pragmatic abilities found in the children as a group is summarized and related to changes in vocabulary development.

Pragmatics Description

Results for the first child, Sid, are presented in Table 2. When Sid entered the preverbal program, he communicated primarily through behavioral regulations (84%). Although he was not observed to use routines, he did use both joint focus and direct attention. Taken together, these two intentions accounted for 16% of Sid's total communicative acts. Over the next 12 months, Sid's use of regulations continued to predominate (78% at 9 and 12 months). Sid still did not use routines, and he was observed to use *either* joint focus or direct attention without combining them. At 15 months, Sid's use of regulations decreased to 33%. He used both direct attention and joint focus; combined, these two intentions accounted for almost half of Sid's communicative acts (47%). In addition, at 15 months into treatment Sid was observed to participate in social routines 20% of the time.

Two general trends are noted in Sid's use of communicative means. Specifically, Sid's use of unconventional communicative acts decreased substantially during the first 12 months and his use of conventional gestures increased. At 15 months after the start of the study he continued to use a high proportion of conventional communications, replacing 44% of his gestures with words.

Results for Carl are presented in Table 3. When Carl entered the preverbal program, 100% of his initiatory communicative intentions were in the context of social routines. Three months later, he used intentions in all four categories. From months 3–7, Carl's development of communicative intentions was similar to the typical infants followed by Snow and her colleagues (see Snow et al., 1996). Specifically, Carl demonstrated a slow decrease in direct attention and routine acts while increasing the use of joint focus overall. From the beginning of the program, Carl predominantly used words to communicate with some gestures and vocalizations.

Results for Marshall are presented in Table 4. When Marshall entered the preverbal program, 67% of his communicative intentions were behavioral regulations, with the remainder in the context of social routines. Over the next 5 months, Marshall was observed to increase his social participation in routines and decrease his use of behavior regulations. By month 5 he engaged in both direct attention and joint focus. Taken together, these two intentions accounted for 20% of his communicative activity. During the last two observations, Marshall

TABLE 2. Results of early pragmatic measures across time for Sid (age at outset = 2;2).

	Month in the Preverbal Program			
	0	9	12	15
Number of communicative acts	90	75	72	185
Communicative intentions				
% routines	0	0	0	20
% regulations	84	78	78	34
% joint focus	6	22	0	11
% direct attention	10	0	22	36
Communicative means				
% unconventional	46	33	19	18
% vocalizations	44	17	13	24
% gestures	10	50	69	13
% words	0	0	0	44

TABLE 3. Results of early pragmatic measures across time for Carl (age at outset = 2;8).

	Month in the Preverbal Program			
	0	3	4	7
Number of communicative acts	59	258	211	218
Communicative intentions				
% routines	100	14	37	19
% regulations	0	36	37	33
% joint focus	0	36	16	43
% direct attention	0	14	11	5
Communicative means				
% unconventional	0	3	2	0
% vocalizations	7	15	33	5
% gestures	7	4	2	0
% words	87	79	63	95

TABLE 4. Results of early pragmatic measures across time for Marshall (age at outset = 3;1).

	Month in the Preverbal Program				
	0	2	5	7	10
Number of communicative acts	39	66	127	194	191
Communicative intentions					
% routines	33	52	64	41	40
% regulations	67	32	16	16	17
% joint focus	0	16	7	17	20
% direct attention	0	0	13	26	23
Communicative means					
% unconventional	33	0	15	8	0
% vocalizations	17	33	34	37	52
% gestures	0	8	5	8	2
% words	50	58	46	47	46

continued to engage in all four intentions, and the relative proportion of use remained fairly constant. Specifically, he decreased his routine activity to approximately 40% and increased his combined use of joint focus and direct attention to 43%. If one examines how Marshall communicated, it is clear that although he always used words for 46–58% of his communicative acts, his use of unconventional acts decreased over time and was replaced by vocalizations.

Results for Roger are presented in Table 5. When Roger entered the preverbal program, 62% of his intentions were in the context of routine activity, with only 33% in behavioral regulations. Over time, Roger decreased his use of routines, but this was not accompanied by an increase in direct attention and joint focus as we saw in Carl. Instead, Roger steadily increased his use of behavioral regulations over time. If one examines how Roger communicated, we find that he did not decrease the percentage of unconventional communicative acts over time, and there was a general trend to decrease the percentage of words used over time

Results for Josh are presented in Table 6. Josh entered the preverbal program using only behavioral regulations. At his 3-month observation, Josh decreased his use of regulations to 62% and began to participate in routines 38% of the time. Six months into treatment, he continued to decrease his use of behavioral regulations and increase his participation in routines. In addition, Josh was observed to use joint focus. Eight months after treatment began, Josh showed an increase in his use of behavioral regulations with a corresponding decrease in his more social communicative intentions (e.g., routines decreased to 50% and joint focus dropped out).

Josh entered the program using only unconventional means. At his 3-month observation, Josh had decreased the use of unconventional means to 31% of his communicative acts. Furthermore, he started to use vocalizations 31% and words 38% of the time. During the remainder of the program, Josh continued to decrease his use of unconventional acts to 0, decrease his use of vocalizations, and increase his use of words.

Vocabulary

The estimated growth trajectories for NDW for each child are presented in Figures 1 and 2. Inspection of the within-child plots suggested that either a linear or a quadratic model could be used to represent within-child change in NDW. Theoretically, all members of a given population are assumed to have the same underlying growth trajectories (Willett & Sayer, 1994). The quadratic model was judged to be the more suitable model for two reasons. First, the quadratic growth model has both a linear and a curvilinear component. The linear component (refer to $\hat{\beta}_1$ for the quadratic model in Table 7) is the instantaneous growth rate for each child at a given month, whereas the curvilinear component (refer to $\hat{\beta}_2$ for the quadratic model in Table 7) captures the acceleration in the growth trajectory. This means that when the underlying growth trajectory is fairly linear, as it was for Carl, the acceleration is quite low, whereas when the underlying growth trajectory is curvilinear, the acceleration rate is higher. Second, when the linear and quadratic models for the children in this study are compared directly (see Table 7), the *MSE* statistic is lower for the quadratic model for the majority of

TABLE 5. Results for early pragmatic measures for Roger (age at outset = 2;6).

	Month in the Preverbal Program			
	0	2	4	9
Number of communicative acts	104	95	60	93
Communicative intentions				
% routines	62	49	27	7
% regulations	33	43	60	93
% joint focus	0	5	0	0
% direct attention	5	5	13	0
Communicative means				
% unconventional	35	38	29	35
% vocalizations	13	33	13	37
% gestures	5	8	54	0
% words	47	21	4	27

TABLE 6. Results for early pragmatic measures for Josh (age at outset = 2;5).

	Month in the Preverbal Program			
	0	3	6	8
Number of communicative acts	39	130	100	40
Communicative intentions				
% routines	0	38	61	50
% regulations	100	62	21	50
% joint focus	0	0	18	0
% direct attention	0	0	0	0
Communicative means				
% unconventional	100	31	0	0
% vocalizations	0	31	18	0
% gestures	0	0	0	0
% words	0	38	82	100

FIGURE 1. Growth trajectories for four children with autism: Dashed lines indicate estimated trajectories and symbols indicate observed data.

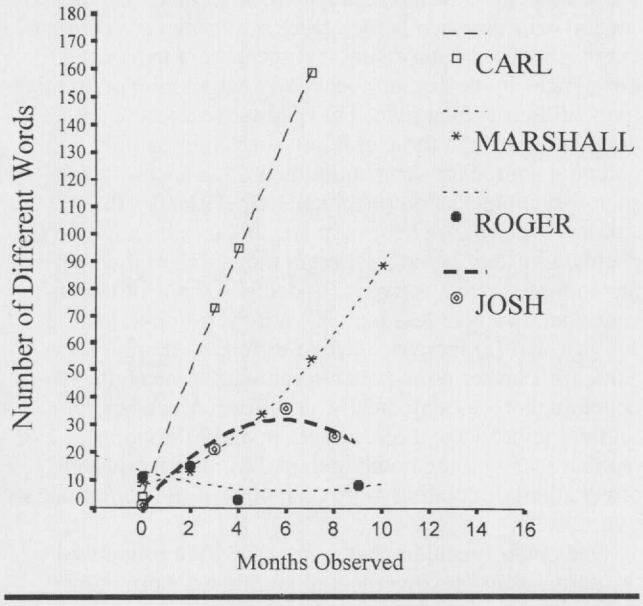
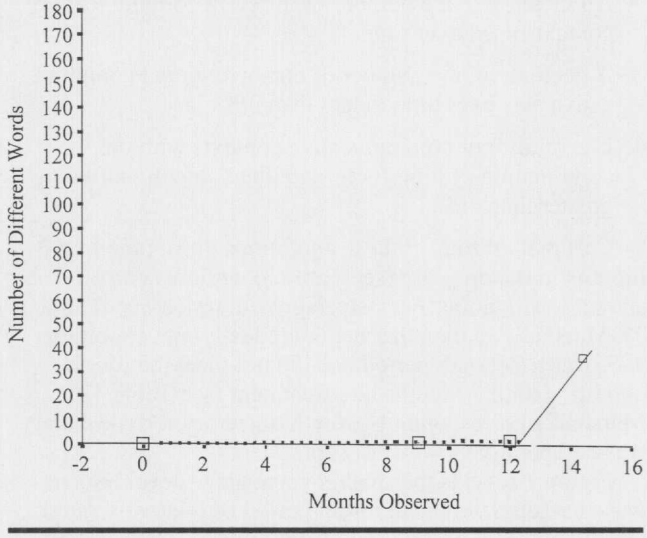


FIGURE 2. Growth trajectory for Sid: Dashed lines indicate estimated trajectories and symbols indicate observed data.



children in the study. Although every attempt was made to use the same model on all of the children, neither model seemed appropriate for Sid. Instead, two intersecting linear models (see Figure 2) best characterized Sid's growth trajectory. The linear model in the period from 0–12 months appeared to fit the data well ($MSE = 0.15$). Because of the limited number of data points in the period of 12–15 months, statistics could not be estimated for the second model.

In Figures 1 and 2, symbols indicate the observed data for each child and the dashed lines indicate the estimated growth trajectories. The p values associated with each model (refer to Table 7) indicate whether the change in NDW was statistically significant. As the figures show, the estimated growth trajectories varied considerably. Carl's vocabulary development was fast and steady, whereas Marshall's was somewhat slower. Sid's estimated growth trajectory for vocabulary was flat for the first 12 months, followed by a rapid vocabulary spurt (Figure 2). Josh started off learning new words, but this trend was followed by a decline in vocabulary over time. Finally, Roger did not develop vocabulary over the course of the study, and his change in vocabulary was not statistically significant.

I turn now to the qualitative between-child analyses. These analyses enabled me to explore whether changes in NDW were associated with differences in social-pragmatic influences (see Willett, 1989, for a discussion). To this end, I summarize similarities in pragmatic achievements found in the children who made statistically significant growth in vocabulary and explore whether these achievements varied systematically across the other children in the study. An analysis of Carl and Marshall's pragmatic skills revealed the following conditions were true for both boys:

TABLE 7. Comparison of the linear and quadratic regression model for five children.

	Linear Model		Quadratic Model						
	Months		Months		Months^2				
Child	$\hat{\beta}_1$	se($\hat{\beta}_1$)	$\hat{\beta}_1$	se($\hat{\beta}_1$)	$\hat{\beta}_2$	se($\hat{\beta}_2$)	*MSE*	*dfe*	*F*
Carl	22.14	0.354					3.13	1,2	3915.1**
			23.60	0.062	–0.208	0.008	0.010	2,1	613037.0**
Marshal	8.12	1.03					66.8	1,3	61.6**
			2.24	0.792	0.592	0.077	3.25	2,2	664.8**
Josh	3.54	1.60					95.1	1,2	4.84
			10.86	3.39	–0.922	0.411	31.5	2,1	9.80
Roger	–0.553	0.839					31.53	1,2	0.434
			–2.30	4.12	0.185	0.421	52.8	2,1	0.226
Sid	2.62	–0.932					622.2	1,2	0.360
			–7.10	5.14	0.840	15.9	255.2	2,1	0.347

*$p \leq .05$. **$p \leq .01$.

1. A decrease in the percentage of behavioral regulations over time to less than 40%.
2. An increase in the number of different communicative contexts used over time.
3. A decrease in the number of unconventional communicative acts over time to less than 30%.
4. Use of all four communicative contexts with the combination of joint focus and direct attention totaling greater than 40%.

Carl met all four of these conditions during the first 3 months in the program (see Table 3), and this corresponded with a relatively steep growth trajectory (Table 7). Marshall, on the other hand, gradually met conditions 1–3 over a 5-month period and did not meet the fourth condition until 7 months into treatment (see Table 4). Marshall's corresponding growth trajectory for vocabulary was comparatively slower (Table 7).

Figure 1 reveals that Josh's vocabulary development was characterized by an initial period of relatively rapid growth before a decline in vocabulary size. During the period of relative growth, Josh met the first three early pragmatic conditions. That is, Josh decreased his use of behavioral regulation intentions, as well as his use of unconventional means. During this time, he slowly increased his use of participation within routines and of joint focus (see Table 6, columns 3–4). Unlike the children who showed statistically significant growth in vocabulary, Josh never engaged in direct attention, nor was he observed to combine joint focus and direct attention. During the period of relative decline in vocabulary, Josh's use of behavioral regulations increased, and participation in routines and joint focus decreased (see Table 6, column 5). Thus, during the period of relative decline, Josh no longer engaged in the first three early pragmatic conditions.

Roger too did not exhibit statistically significant vocabulary development. Figure 1 reveals that his estimated growth curve was fairly flat over the course of the study. Unlike Carl, Marshall, and Josh, Roger never met any of the early pragmatic criteria for vocabulary development.

A quadratic model did not characterize Sid's vocabulary development. Instead, his growth trajectory was best described by a relatively long period of no development, followed by a short period of rapid growth (Figure 2). During the period of no developmental change, Sid did not meet conditions 1, 2, and 4. That is, although the total number of unconventional communicative acts decreased over time to less than 30%, Sid did not increase the number of different communicative contexts that he engaged in, nor did he decrease the percentage of acts used for behavioral regulations. In contrast, Sid met all four of the early pragmatic criteria for vocabulary development during the period of rapid growth.

Discussion

We initiated this study by proposing that careful longitudinal description of the pragmatic skills in children with autism, during the lexical acquisition stage, are necessary if we are to develop intervention techniques based on social-pragmatic theories. A unique aspect of this study was that children with autism were observed on several occasions while they were acquiring conventional language. It's not surprising that there were individual differences in the rate of vocabulary acquisition across the five children with autism. The qualitative analyses of pragmatic skills in these children shed light on one potential source for these individual differences—their socio-pragmatic accomplishments. Specifically, the children who made changes in vocabulary all exhibited (a) decreased use of behavioral regulations to less than 40% of the communicative activity, (b) decreased use of unconventional means to less than 30% of the communicative activity, and (c) increased use of different communicative contexts. Furthermore, the children whose vocabulary development was statistically significant all engaged in routine, joint focus, direct attention, and behavioral regulations, with the combined total of joint focus and direct attention totaling more than 40% of the communicative activity.

One could speculate that the results were influenced by the participants' involvement in an intensive program designed to enhance their communication. However, the five children were drawn from the same preschool program; therefore, all had equal opportunity to benefit from the intervention. Nevertheless, there was still substantial variability among the children in the study. It is precisely this variability in the data—the vocabulary trend from no progress (Roger) to practically significant (Josh) and then to statistically significant progress (Marshall and Carl) with a corresponding systematic variation in pragmatic achievements—that is significant. That is, on average, an increase in the diversity of conventionally mediated pragmatic skills, coupled with an increase in joint attention skills, is associated with an increase in the rate of vocabulary acquisition. The finding still held for Sid, whose underlying vocabulary growth trajectory differed from the rest of the children. That is, he was limited in his socio-pragmatic accomplishments when he was in the preverbal stage and used all four conditions when he had an NDW score of 54.

The five children were observed for varying lengths of time, ranging from 7 months for Carl to 15 months for Sid. Because the estimated values of NDW at any given month provides us with a better estimate of the child's true abilities than the observed scores, we can compare each child's growth in vocabulary over 7 months of treatment. If a vertical line is drawn on to Figure 1 at 7 months from the start of treatment, the results do not change. This is true even for Sid, whose vocabulary did not change over the first 7 months of the study (see Figure 2). Specifically, Sid was the youngest child studied (2;2 at the start of the study) and as such was eligible to be in the preschool for a longer period of time. If we had started observing him when he was closer in age to the other boys in the study, the length of time observed would not be so different.

To summarize, an overreliance on behavioral regulations, coupled with the deficit in joint attention observed

in many young children with autism, has devastating consequences on their language acquisition. Specifically, the data presented here indicate that the use of behavioral regulations may play a less important role in vocabulary acquisition than does participation in routine contexts and the ability to regulate and sustain joint attention. These results are consistent with recent studies on children developing typically (Rollins, Marchman, & Thal, 1998; Rollins & Snow, 1998) and children with autism (Mundy et al., 1990; Rollins & Snow, 1998). Furthermore, these findings indicate that joint attention skills may need to reach a certain threshold before vocabulary growth can accelerate. What is noteworthy, then, is the relationship between pragmatic achievements and rate of vocabulary acquisition. As can be seen in early sessions with Carl, Marshall, and Roger, words can be tied to behavior regulations and routines with the near exclusion of joint focus and direct attention. This means that the ability for children with autism to utter words is not primarily associated with social acts and, perhaps, reflects a conditioned response. Of course, the association found here does not prove that social communicative intentions caused an increased rate in vocabulary development. Perhaps an increase in vocabulary skills facilitated the social use of language. It is quite conceivable that a third underlying variable—the development of social-cognition—resulted in the observed changes in both socio-pragmatic skills and vocabulary development. The latter is consistent with recent advances in social-cognitive theory (Tomasello, 1995; Tomasello & Chall, 1997). Tomasello suggests that behavioral regulations differ from more social communicative intention. Behavioral regulations simply require the child to understand that another person can cause something to happen—the understanding that others are "animate agents" (Tomasello & Chall, 1996). In contrast, direct attention and joint focus require the child to understand that the interlocutor makes behavioral and perceptual choices—the understanding that others are "intentional agents." Tomasello and colleagues (Carpenter, Nagell, & Tomasello, 1998; Tomasello & Chall, 1997) argue that language development is ontogenetically related to children's emerging understanding that others are intentional agents. If this analysis is correct, then intervention techniques designed to facilitate social-pragmatic skills are warranted (see Schuler et al., 1997). Furthermore, interventionists may want to facilitate words in social contexts, like instances of mutual attention as described in Rollins, Wambacq, Dowell, Mathews, and Reese, 1998.

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