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Social communication in children with autism

The relationship between theory of mind and discourse development

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ABSTRACT This longitudinal study investigated the developmental trajectory of discourse skills and theory of mind in 57 children with autism. Children were tested at two time points spaced 1 year apart. Each year they provided a natural language sample while interacting with one parent, and were given standardized vocabulary measures and a developmentally sequenced battery of theory of mind tasks. The language samples were coded for conversational skills, specifically the child's use of topic-related contingent utterances. Children with autism made significant gains over 1 year in the ability to maintain a topic of discourse. Hierarchical regression analyses demonstrated that theory of mind skills contributed unique variance to individual differences in contingent discourse ability and vice versa, when measured concurrently; however, they did not predict longitudinal changes. The findings offer some empirical support for the hypothesis that theory of mind is linked to communicative competence in children with autism.

KEYWORDS *discourse skills; social communication; theory of mind*

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Deficits in language and communication are among the core features of autism spectrum disorders. Research has demonstrated that problems in the area of language pragmatics, the use of language in social contexts, are universal among children and adults with autism (Lord and Paul, 1997; Tager-Flusberg, 2000). DSM-IV (American Psychiatric Association, 1994), for example, highlights impairments in discourse, especially initiating or sustaining conversations with other people, as a primary symptom of autism.

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Unlike typically developing children, children with autism are impaired in the effective use of discourse for social participation and connection. These social communicative deficits have been theoretically linked to underlying cognitive impairments in the acquisition of a theory of mind because successful communication entails the understanding that language is a means for sharing information, beliefs and feelings with others (Tager-Flusberg, 1993). Thus far, few studies have directly investigated the relationship between discourse skills and theory of mind in autism, and there have been no developmental studies that have directly tested the relationship between these domains over time. The study reported in this article is designed to address these issues by investigating discourse development and theory of mind skills in a relatively large sample of children with autism who were followed longitudinally over the course of a year.

Theory of mind in autism

One of the most productive areas in autism research in recent years has explored the hypothesis that children with autism have fundamental and specific deficits in the domain of theory of mind, which refers to the cognitive ability to predict and explain human behavior in terms of mental states such as intention, desire and belief (Baron-Cohen et al., 1993; 2000). This hypothesis has been used to explain the core impairments in both communication and social functioning, which constitute two of the major symptoms of this disorder (Baron-Cohen, 1988; Frith, 1989; Happé, 1994). Since the initial demonstration by Baron-Cohen and his colleagues that the majority of children with autism fail to understand false belief (Baron-Cohen et al., 1985a; 1985b), many studies have confirmed the finding that children with autism have difficulty with a wide variety of theory of mind tasks (Baron-Cohen, 2000). From the earliest reports on the theory of mind deficit in autism, the emphasis was on the theoretical significance of this deficit in providing a cognitive explanation for a range of symptoms that characterize the syndrome (Baron-Cohen, 1988; Frith, 1989; Happé, 1994).

Although the idea that autism involves specific deficits in theory of mind has been generally accepted among researchers and clinicians, critics have argued that too much emphasis has been placed on false belief and related tasks as key measures of this impairment, because they tap transitions in conceptual developments that take place during a limited developmental period. Autism emerges much earlier than age 4 when children are first able to pass false belief tasks, suggesting that deficits in theory of mind must predate this stage of development if it is to be used to provide a cognitive explanation of autism symptoms (Klin and Volkmar, 1993; Klin et al., 1992). In response to these concerns, there has been a shift toward incorporating a broader conception of theory of mind. Taking a developmental perspective, theory of mind is now viewed as emerging in infancy, and developments extend into later childhood both among normally developing children (Flavell, 1999; Perner, 1988; Wellman and Lagattuta, 2000) and among children with autism (Steele et al., 2003; Tager-Flusberg, 2001). Children with autism are not only seriously delayed in the acquisition of theory of mind (Happé, 1995), but may also never achieve the same endpoint, as deficits remain evident even among high-functioning adolescents and adults (Baron-Cohen et al., 1997; Rutherford et al., 2002). Research has demonstrated that in autism, performance on theory of mind tasks is closely related to language skills (e.g. Happé, 1995; Tager-Flusberg and Sullivan, 1994) and other cognitive skills such as executive functions (Pennington et al., 1997; Russell, 1997).

Theory of mind and pragmatic deficits in autism

Impairments in pragmatic functioning are evident across the spectrum and at all developmental stages, even among highly verbal adults with autism (Lord and Paul, 1997). In autism, there are unique and specific problems in understanding that language is a means for interacting with others and in understanding that communication is about the expression and interpretation of intended meaning (Happé, 1993; Sperber and Wilson, 1986; Tager-Flusberg, 1993). Related to this, children with autism have difficulty taking into account the listener's perspective, which affects their ability to engage in conversations in a sustained or meaningful way (Tager-Flusberg, 1996).

The earliest manifestations of communicative impairment in autism may be found in selective deficits that have been interpreted as a reflection of a lack of understanding of mind. Both naturalistic and experimental studies have shown a selective paucity of protodeclarative communicative gestures (i.e. pointing to objects in order to direct another person's attention to them) in both preverbal and verbal children with autism (Baron-Cohen, 1989; Mundy et al., 1986; Wetherby, 1986). Unlike protoimperative gestures, which may only involve an expression of the child's needs or desires, protodeclaratives critically involve joint attention and require an understanding of intentionality, both of which are profoundly impaired in young children with autism (Loveland and Landry, 1986; Mundy et al., 1994). Thus, joint attention skills may be important precursors to theory of mind as well as language and discourse skills. When language is acquired in autism, verbal communication continues to be primarily limited to the expression of requests and needs, or simple labeling (Tager-Flusberg, 1996). While children with autism do use language to maintain some social contact (Wetherby and Prutting, 1984), they rarely comment on ongoing or past activity, use language to seek or share attention, provide new information, or express intentions, volition or other mental states (Tager-Flusberg, 1992; 1993; 1994). Thus, autism is characterized by significant limitations in the range of functions served by language.

Verbal children with autism also exhibit significant difficulties in conversational contexts. Their impairment in understanding the speaker–listener relationship is illustrated in pronoun reversal errors (Lee et al., 1994; Tager-Flusberg, 1994). They also have difficulty conforming to conversational rules such as initiating conversations and engaging in reciprocal conversations (Ball, 1978; Baltaxe, 1977; Fine et al., 1994). They cannot appropriately maintain an ongoing topic of discourse (Tager-Flusberg and Anderson, 1991); instead they introduce irrelevant comments or fail to extend a topic by adding new relevant information.

These conversational impairments have been interpreted as stemming from a lack of understanding that others have access to different information or knowledge, and that communication occurs through the exchange of information. This lack of understanding, or theory of mind deficit, accounts for difficulty engaging in reciprocal social discourse (Tager-Flusberg, 1999). Effective discourse requires the use of pragmatic knowledge to organize information to be communicated in the most useful manner. This involves taking into account what the speaker knows about the listener, including knowledge, feelings, and other mental states (Tager-Flusberg, 1993). Therefore, an effective communicative exchange is achieved when both partners employ a theory of mind to structure ongoing discourse (Sperber and Wilson, 1986). Given the theoretical significance of theory of mind abilities for communication, it is not surprising that children with autism suffer significant impairments in this domain.

At the same time, it has also been proposed that engaging in reciprocal discourse contributes significantly to the development of theory of mind. For example, Dunn and her colleagues have demonstrated that engaging in conversations with mothers, especially about mental and feeling states, facilitates the acquisition of theory of mind in typically developing preschoolers (Brown et al., 1996; Dunn and Cutting, 1999; Dunn et al., 1991). Dunn argues that this kind of participation in conversation is crucial to gaining insight into other minds (Dunn and Brophy, in press). Similarly, Peterson and Siegal (2000) argue that deficits found in theory of mind, both in autism and among deaf children, are, in part, attributable to the paucity of their conversations with other people. Thus, theoretical proposals suggest that there is a dynamic and reciprocal relationship between discourse skills and theory of mind, which may be strongly mediated by language ability.

To date, there has been limited empirical research linking theory of mind to communicative functioning in autism. Tager-Flusberg and Anderson (1991) first suggested that the ability to maintain and develop a topic of discourse, as measured by the ability to respond in a contingent or topic-related way, is related to theory of mind skills. In a longitudinal study comparing conversation skills in autism and Down syndrome, they found that children with autism were less able to respond contingently to their mothers than children with Down syndrome. In comparison to children with Down syndrome, the children with autism showed no developmental change in discourse ability; advances in discourse ability did not parallel advances in structural aspects of language. Thus, as language advanced, children with autism looked increasingly different from children with Down syndrome in both the content and style of their communication. Although Tager-Flusberg and Anderson (1991) interpreted their findings from a theory of mind perspective, they did not directly investigate whether the communicative impairments they identified were related to performance on theory of mind tasks.

Only one study has directly explored this link in a group of children with autism. Capps et al. (1998) found a significant relationship among 15 children with autism between false belief performance and the ability to contribute new information in conversation with an examiner; however, this relationship was no longer significant after the effects of language ability were partialled out. The failure to find a strong link between conversational ability and theory of mind independent of language may be because of the relatively small sample and the use of a restricted measure of theory of mind ability, the false belief test.

The goal of our study was to explore in greater detail the relationship between theory of mind and discourse in a well-characterized and representative sample of verbal children with autism. In order to address the limitations of prior studies, we included a large group of children with autism and a battery of theory of mind tasks designed to span the developmental range from late infancy to middle childhood. We were explicitly interested in investigating within-group variability in discourse and theory of mind, rather than investigating whether children with autism show unique impairments in these domains. Thus, we did not include comparison groups. Our goal was to test both concurrent and predictive relationships between theory of mind and contingent discourse skills in autism. Therefore, we collected these measures, as well as standardized language measures, at two time points spaced approximately 1 year apart.

***Table 1* Participant characteristics at time 1 and time 2**

	Time 1		*Time 2*	
	Mean	*(SD)*	*Mean*	*(SD)*
Age (months)	88.84	(29.40)	101.13	(29.70)
Full-scale IQ score[a]	77.47	(19.19)	n/a	
PPVT–III standard score[b]	77.14	(20.88)	78.68	(22.70)
EVT standard score[c]	75.08	(21.91)	75.36	(24.93)

[a] IQ measured by the Differential Ability Scales.
[b] Peabody Picture Vocabulary Test.
[c] Expressive Vocabulary Test.

Methods

Participants

The participants for this study included 57 children with autism ranging in age from 4:0 to 13:11 at the start of the study (time 1). They were selected on the basis of having at least some language, defined as the ability to spontaneously use phrase speech. Children were diagnosed according to DSM-IV criteria using algorithm scores on the Autism Diagnostic Interview–Revised (ADI–R: Lord et al., 1994), the Autism Diagnostic Observation Schedule (ADOS: Lord et al., 2000) and confirmation by an expert clinician. The ADI–R and ADOS were administered during the first year of the study by trained personnel who had demonstrated reliability in scoring with the authors of the instruments and on-site trainers. Children with Rett syndrome, childhood disintegrative disorder, or autism-related medical conditions (e.g. neurofibromatosis, tuberous sclerosis, fragile X syndrome) were not included in this study.

The children all returned for a second round of data collection about 1 year after their initial visits; however, portions of the data from two children were lost, leaving 55 children ranging in age from 5:0 to 14: 9 at the second time point (time 2). Details about the participants at time 1 and time 2 are presented in Table 1.

Procedures

All measures were administered each year in two visits scheduled approximately 2 weeks apart. During the first visit, diagnostic assessments and IQ data were collected at time 1 and the standardized language testing was completed at both time 1 and time 2. During the second visit at both time 1 and time 2, the theory of mind tasks were administered and a natural language sample was collected during an unstructured parent–child interaction.

Measures

Cognitive ability IQ level was assessed in the first year with the Differential Ability Scales (DAS: Elliott, 1990). Children were administered either the Preschool or the School-Age version of the DAS depending on their age and ability level. The DAS yielded a full-scale IQ and verbal and nonverbal subscores for all the children tested within age level.

Language Two standardized measures of vocabulary were obtained at time 1 and time 2: the Peabody Picture Vocabulary Test–Third Edition (PPVT–III: Dunn and Dunn, 1997), which measures receptive vocabulary, and the Expressive Vocabulary Test (EVT: Williams, 1997), which measures expressive vocabulary. We used vocabulary tests for our language measure because across the wide range of children included in this study, we were not able to complete an omnibus language test (the Clinical Evaluation of Language Fundamentals: CELF) with all the participants. Lower-functioning children or children with more limited language skills could not reach the basal on all subtests of the CELF and were thus not eligible for obtaining valid standard or age-equivalent scores. Nevertheless, in other research we have found high correlations between these vocabulary measures and the CELF among children with autism, suggesting that the more limited vocabulary tests provide an adequate measure of language ability in this population (Condouris et al., 2003). Because scores on the PPVT–III and EVT were highly correlated in our sample of children with autism ($r(55) = 0.83$, $p < 0.001$), and the tests were developed with the same normative sample, we combined the raw scores on these tests to yield a single vocabulary score that would provide a more robust language measure.

Theory of mind Ten theory of mind tasks were administered. The tasks were divided into three developmentally sequenced batteries: early, basic and advanced. The early battery included a desire and a pretend task tapping the emergence of these simple mental state concepts. The basic battery included four tasks: perception/knowledge, location-change false belief, unexpected-contents false belief and sticker hiding, all tapping a representational understanding of mind. The advanced battery included four tasks that assessed more complex social cognitive concepts: second-order false belief, lies and jokes, traits and moral judgment.

The tasks, which are described below, all included both control and test questions. Children received a certain number of points for each task, based on the number of key test questions that were answered correctly to yield a single theory of mind score. Children could earn a total of 56 points on the theory of mind tasks: 8 points for the early battery, 22 points for the basic battery and 26 points for the advanced battery.

There were four versions of the stories and stimuli used for each theory of mind task. Children were randomly assigned to one of the versions at time 1, and then were given a different version at time 2. This counter-balancing procedure ensured minimal learning or repeated measures effects over time. At time 1, all participants were administered the tasks from the early battery. Participants who scored at least 2 points on the desire task were also administered the basic battery; participants who were able to pass at least one false belief test question were also administered the advanced battery. Children were always administered all the tasks in each battery. At time 2, children who had passed both tasks in the early battery at time 1 began with the basic battery and were given credit (8 points) for the early battery.

- *Pretence task*. Based on Kavanaugh et al. (1997), this task tested the ability to use a doll as an independent agent in a pretend scenario. The task included four vignettes involving a mother and baby. Participants were asked to complete each vignette by using the mother doll to act out the next logical event (e.g. feeding the hungry baby) in a scenario initiated by the experimenter. Maximum score = 4.
- *Desire task*. Based on Wellman and Woolley (1990), this task tested the ability to predict action based on an agent's stated desire. Two stories were narrated using props. In each story the main character is looking for an object, which could be in one of two named locations. The character fails to find the desired object in the first location. The test questions asked whether the character will continue to search and why. Maximum score = 4.
- *Perception/knowledge task*. Based on Pillow (1989) and Pratt and Bryant (1990), this task tested the ability to infer knowledge from perceptual access. On each trial, participants observed one doll that looked in a box and another doll that simply touched the box, and were then asked a knowledge question ('Does X know what's in the box?'). Maximum score = 2.
- *Location-change false belief task*. Based on Wimmer and Perner (1983), this task included two stories in which an object is moved while the main character is absent. The stories were told using props, and participants were asked a knowledge ('Does X know where Y is?'), prediction ('Where will X look first for Y?'), and justification question ('Why?'). Maximum score = 6.

- *Unexpected-contents false belief task*. Based on Perner et al. (1987), participants were shown four different familiar containers that had unexpected objects inside. Test questions included representational change ('When you first saw this container, what did you say/think was inside?') and false belief ('What will X say/think is inside?'). Maximum score = 8.
- *Sticker-hiding task*. Based on the penny-hiding game (Devries, 1970), this task required the participant to hide a sticker in one hand. The experimenter guessed the location of the sticker; wrong answers resulted in the participant keeping the sticker. After training on the task, 10 test trials ensued. The ability to hide the sticker from the experimenter on the last five trials (score range 0–5) and to engage in deceptive strategies (score range 0–1) was scored. Maximum score = 6.
- *Second-order false belief task*. Based on Sullivan et al. (1994), two picture stories were told. In each story, a child character is to receive a surprise gift from a parent. Unbeknown to the parent, the child inadvertently finds the object. Second-order ignorance, belief and justification questions tapped participants' ability to conceptualize what the parent character thinks/knows about what the child character thinks/knows. Maximum score = 6.
- *Lies and jokes task*. Based on Sullivan et al. (1995), this task tested participants' ability to distinguish between lies and ironic jokes (or sarcasm). In each of four picture stories, a child utters a literal falsehood (e.g. 'I did a good job eating my peas') that an adult character knows to be false. To distinguish a joke from a lie, participants had to take into account whether the child knows that the adult knows the truth. Test questions included judging the false statement as a joke or lie (score range 0–2, across pairs of stories) and justifying the answer (score range = 4). Maximum score = 6.
- *Traits task*. This task, based on Yuill (1992), tested participants' ability to judge intent on the basis of personality traits. Participants were told eight picture stories in which one of two characters is described in terms of a personality trait (e.g. kind, mean). Each story ends with a negative outcome (e.g. an art project is knocked to the floor) of ambiguous intent. Test questions tapped participants' ability to use the trait information to judge whether the outcome was intended or by accident. Maximum score = 8.
- *Moral judgment task*. Based on Mant and Perner (1988), participants were told four picture stories in which two classmates make plans to meet, for example, to go to the movies. In each story, the main character fails to come to the planned meeting as a result of canceling the plans without telling the other character or because of an uncontrollable event (e.g. the bus breaks down). At the end of each story, participants

were asked to make a moral judgment (score range 0–2 across pairs of stories), and justify their answer ('Was it good, bad, or in between?') about the main character's behavior (score range 0–4). Maximum score = 6.

Natural language sample and discourse coding

At time 1 and time 2, natural language samples were collected from the children while they interacted with one of their parents (almost always the mother) for 30 minutes in the laboratory. Participants were provided with a standard set of developmentally appropriate toys and asked to interact with each other as they would at home. The sessions were recorded using video- and audiocassette equipment.

Transcripts were prepared from the audiotapes. The natural language samples were transcribed using Systematic Analysis of Language Transcripts Research Version 6.1 (SALT: Miller and Chapman, 2000). The transcripts of the language samples were typed into computer files, using the SALT format to facilitate coding and analysis, by a team of research assistants trained in transcription procedures. Utterance segmentation was based on procedural guidelines specified by Miller and Chapman (2000). A sample of 100 consecutive, complete, intelligible child utterances was selected from each transcript. MLU-morpheme, a measure of utterance length and grammatical complexity, was computed for each sample based on 100 consecutive intelligible spontaneous utterances, using the SALT program. To ensure transcription reliability across the language sample, a second, trained transcriber checked each transcript. All disagreements were resolved through consensus.

The transcripts were coded for use of topic contingent discourse using a coding scheme adapted from Tager-Flusberg and Anderson (1991). Each intelligible child utterance that immediately followed a parent utterance was coded as contingent, noncontingent, or imitation. Contingent utterances were defined as maintaining the topic of discourse in the parent's prior utterance. Noncontingent was defined as child utterances that were not related to the topic of the prior adult utterance. Utterances that were exact or partial imitations of the parent's prior utterance were coded as such. The proportion of child intelligible utterances directly following a parent utterance that were contingent, noncontingent, or imitation was computed for each transcript.

Two individuals were trained by the primary coder to assess reliability. Training included the completion of several practice transcripts for which the reliability coder received feedback. The reliability coder had to achieve 80 percent agreement with the primary coder on all the practice transcripts in order to begin reliability coding. Once this level was achieved, 20 new

Table 2 **Discourse and theory of mind scores at time 1 and time 2**

	Time 1		*Time 2*	
	Mean	*(SD)*	*Mean*	*(SD)*
Discourse scores:				
Contingent*	72.44	(13.41)	80.43	(9.78)
Noncontingent	20.95	(10.59)	18.40	(9.3)
Imitation*	6.62	(7.19)	2.87	(3.89)
Theory of mind	13.07	(14.01)	16.8	(16.33)

* $p < 0.05$.

transcripts (not included in the practice) were randomly selected for reliability coding. These transcripts were selected from both time 1 and time 2, and represented about 20 percent of the total transcripts included in this study. Two coders coded these transcripts independently. Reliability was assessed using Cohen's (1960) kappa and percentage exact agreement. Mean kappa values ranged from 0.88 to 1.00, and percentage agreement ranged from 0.80 to 1.00.

Results

The data were analyzed in two ways. First, we analyzed the concurrent relationships between contingent discourse and theory of mind using data collected at both time 1 and time 2. Second, we analyzed the data to investigate developmental changes in discourse skills and theory of mind and to examine which variables from time 1 predicted discourse and theory of mind 1 year later.

Concurrent relationship between contingent discourse and theory of mind

Table 2 presents the scores for the discourse and theory of mind measures at both time 1 and time 2. To examine whether theory of mind predicts contingent discourse concurrently we conducted separate hierarchical regression analyses on the data from time1 and time 2. For these analyses, control variables including age, IQ and language (using the combined raw scores from the vocabulary measures) were entered first, followed by the theory of mind score at the second step.

An exploratory analysis revealed that the theory of mind variable did not meet the requirement of linearity. Therefore, following nonlinear transformation procedures outlined by Cohen and Cohen (1983), the theory of

Table 3 Concurrent correlations between contingent discourse, theory of mind and control variables at time 1 and time 2

	Contingent discourse		*Contingent discourse*
Time 1		*Time 2*	
Age	0.28*	Age	0.12
IQ	0.24	IQ	0.29*
Language	0.40**	Language	0.43**
Theory of mind	0.49***	Theory of mind	0.55***

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

mind scores were recalculated using a logarithmic transformation, and the regression analyses were conducted on the transformed data.

Table 3 presents the correlations between contingent scores and the predictor variables at time 1 and time 2. Results of the regression analyses, summarized in Table 4a, show that at time 1 the theory of mind was a significant unique predictor of time 1 contingent score, independent of language, age and IQ. At the first step of the analysis, control variables including language, age and IQ were entered, $R^2 = 0.16$, $F(3, 53) = 3.5$, $p < 0.05$. These control variables accounted for 16 percent of the variance in contingent discourse scores, which was significant. After the addition of theory of mind score, $R^2_{change} = 0.08$, $F_{change}(1, 52) = 5.57$, $p < 0.05$. Thus, theory of mind contributed an additional, significant 8 percent variance to contingent discourse scores, beyond the variance contributed by the control variables.

The same regression analysis was conducted on the time 2 data, omitting age, which this time was not significantly correlated with contingent discourse. Table 4b shows the results of this analysis; the regression coefficients shown are those at the final step. For step 1, the control variables language and IQ accounted for 26 percent of the variance in contingent discourse: $R^2 = 0.26$, $F(2, 52) = 9.2$, $p < 0.001$. After the addition of theory of mind, $R^2_{change} = 0.08$, $F_{change}(1, 51) = 6.3$, $p < 0.05$. Thus, at both time points, theory of mind contributed unique variance, about 8 percent, to the contingent discourse score.

The same analyses were conducted to investigate whether contingent discourse was a significant concurrent predictor of theory of mind scores. Table 5 presents the concurrent correlations between theory of mind and predictor scores at time 1 and time 2. The regression analysis summarized in Table 6a shows that at time 1, contingent score was a significant unique

Table 4

(a) Summary of hierarchical regression analysis predicting contingent score at time 1

Variable	β^a	*SE* β^a	β^b	R^2 *or* R^2_{change}
Step 1				
Language	0.15	0.12	0.33	0.16*
Age	3.69	0.09	0.82	
Full-scale IQ	2.63	0.14	0.03	
Step 2				
Theory of mind	10.02	4.2	0.43	0.08*

(b) Summary of hierarchical regression analysis predicting contingent score at time 2

Variable	β^a	*SE* β^a	β^b	R^2 *or* R^2_{change}
Step 1				
Language	0.14	0.04	0.42	0.26**
Full-scale IQ	0.15	0.0	0.26	
Step 2				
Theory of mind	7.3	2.8	0.42	0.08*

* $p < 0.05$; ** $p < 0.001$.
[a] Unstandardized beta coefficient.
[b] Standardized beta coefficient.

predictor of time 1 theory of mind score, independent of language, age and IQ. At the first step of the analysis, language, age and IQ were entered as control variables. Together, they accounted for 57 percent of the variance in theory of mind, $R^2 = 0.57$, $F(3, 53) = 24.33$, $p < 0.001$. After the addition of contingent score, $R^2_{change} = 0.04$, $F_{change}(1, 52) = 5.57$, $p < 0.05$.

The same regression analysis was conducted on the time 2 data, omitting age and IQ, which were not significantly correlated with theory of mind. Table 6b shows the results of this analysis; the regression coefficients shown are those at the final step. When language was entered first, $R^2 = 0.51$, $F(1, 53) = 55.26$, $p < 0.001$; language explained over half the variance in theory of mind. After the addition of contingent score, $R^2_{change} = 0.07$, $F_{change}(1, 52) = 9.22$, $p < 0.01$, contributing an additional 7 percent unique variance to theory of mind scores at time 2. Thus, at both time points, contingent discourse contributed unique variance to theory of mind, though language was clearly the most significant predictor of theory of mind at both time points.

Table 5 Concurrent correlations between theory of mind, contingent discourse and control variables at time 1 and time 2

	Theory of mind		*Theory of mind*
Time 1		*Time 2*	
Age	0.51***	Age	0.02
IQ	0.53***	IQ	0.23
Language	0.74***	Language	0.71***
Contingent discourse	0.49***	Contingent discourse	0.55***

*** $p < 0.001$.

Table 6

(a) Summary of hierarchical regression analysis predicting theory of mind at time 1

Variable	β^a	$SE\ \beta^a$	β^b	R^2 or R^2_{change}
Step 1				
Language	7.47	0.04	0.36	0.57***
Age	4.60	0.00	0.23	
Full-scale IQ	7.15	0.04	0.23	
Step 2				
Contingent score	9.65	0.04	0.22	0.04*

(b) Summary of hierarchical regression analysis predicting theory of mind at time 2

Variable	β^a	$SE\ \beta^a$	β^b	R^2 or R^2_{change}
Step 1				
Language	1.16	0.02	0.58	0.51***
Step 2				
Contingent score	1.76	0.06	0.30	0.07**

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.
[a] Unstandardized beta coefficient.
[b] Standardized beta coefficient.

Developmental change from time 1 to time 2

We first examined change in the children's discourse and theory of mind scores, using the data presented in Table 2. Paired samples t-tests revealed no significant difference between time 1 and time 2 theory of mind score,

Table 7 **Correlations between time 1 measures and time 2 contingent discourse**

Time 1 measures	*Time 2 contingent discourse*
Age	0.11
IQ	0.29*
Language	0.31*
Theory of mind	0.11
Contingent discourse	0.16

* $p < 0.05$.

Table 8 **Correlations between time 1 measures and time 2 theory of mind score**

Time 1 measures	*Time 2 theory of mind*
Age	0.02
IQ	0.23
Language	0.07
Contingent discourse	0.03
Theory of mind	0.16

$t(54) = 1.43$, n.s. There was also no significant difference between time 1 and time 2 noncontingent score, $t(54) = 1.36$, n.s. However, there was a significant difference between time 1 and time 2 contingent score, $t(54) = 3.88$, $p < 0.001$, and time 1 and time 2 imitation score, $t(54) = 3.88$, $p < 0.001$. Table 2 shows that the proportion of contingent utterances increased while the proportion of imitation utterances decreased over the course of 1 year.

We then explored which time 1 variables were significant predictors of contingent discourse at time 2. Table 7 presents the correlations between the time 1 variables and time 2 contingent discourse. The only measures that correlated moderately with time 2 contingent scores were IQ and language, the combined vocabulary score. These were entered into a hierarchical regression analysis. When vocabulary was entered at the first step, $R^2 = 0.11$, $F(1, 53) = 3.34$, $p < 0.05$; at the second step IQ contributed no additional variance. Thus, language was the only significant longitudinal predictor of contingent discourse, accounting for just over 10 percent of the variance in this discourse measure. Table 8 shows the correlations between time 1 variables and time 2 theory of mind. None of the time 1 variables were significantly correlated.

Discussion

The main goals of this study were to investigate the reciprocal relationships between theory of mind and communicative competence in a heterogeneous group of verbal children with autism. Our study examined the children's ability to engage in reciprocal, social communication through the ability to maintain an ongoing topic of conversation during a parent–child interaction.

In contrast to previous findings by Tager-Flusberg and Anderson (1991), the findings from this study showed that the children with autism demonstrated significant gains in the ability to maintain a topic of discourse, as measured by the proportion of contingent utterances. Thus, rejecting a common pessimistic view of this disorder, we found that children with autism do show improvement over time in critical aspects of social communication. One explanation for the difference in the findings reported here and those reported in Tager-Flusberg and Anderson (1991) is the inclusion of a significantly larger group of children (55 compared with six in the earlier study), who covered a wider age range at the start of the study. With a very small number of children, it is unlikely that the earlier study had the statistical power to detect developmental changes that might have occurred over the course of 1 year. This is especially the case given the enormous variability among children with autism in their language and communicative abilities. Thus, we conclude that, as a group, children with autism do make significant gains in contingent discourse, developing improved skills in engaging in reciprocal conversation over time. Although the mean score on theory of mind increased by over three points over the course of 1 year, this change did not reach statistical significance because of the large variance in theory of mind scores across the broad range of children in this study.

A second goal of this study was to investigate the relationship between theory of mind and discourse skills among children with autism. One of the most appealing features of the theory of mind hypothesis of autism is that it provides a unified explanation for a range of symptoms, especially the social and communicative impairments that are among the primary diagnostic features (Baron-Cohen, 1988; Happé, 1994; Tager-Flusberg, 1993; 1996). Yet despite the widespread view that communicative impairments are closely linked to deficits in theory of mind, there is little direct empirical support for this hypothesis. The only study to report a relationship between communicative skills and theory of mind in autism (Capps et al., 1998) found that this relationship was mediated by linguistic ability. In contrast to these earlier findings, our data showed that theory of mind contributes unique variance in contingent discourse skills among children with autism beyond the significant contribution made by language skills. Results from hierarchical regression analyses indicated that, independent of age, IQ and language, theory of mind skills were significantly related to concurrent contingent discourse ability at both time points that were tested.

There were several important differences between this study and the earlier study by Capps et al. (1988) that may explain why we were able to detect a direct link between theory of mind and discourse skills. First, our sample was significantly larger, providing the statistical power needed to obtain significant results after including other variables that contribute to variation in conversational skills. Second, we used a broader measure of theory of mind, including a large battery of tasks that spanned the developmental range of the participants in our study and that had a sensitive score range without floor or ceiling effects. Capps et al. (1998) used performance on false belief tasks that were scored as either pass or fail, which may not have been sufficient for assessing its relation to conversational abilities. Finally, we should note that our measure of discourse skill was the degree to which children with autism are able to maintain an ongoing conversational topic while interacting with their mothers. In contrast, Capps et al. (1998) coded the children's ability to contribute new information to an ongoing conversational topic while interacting with a clinician, not a parent. Nevertheless, we also found a significant relationship between language and contingent discourse at both time points, confirming that language is related in important ways to this aspect of communicative competence. Furthermore, our findings suggest that theory of mind and contingent discourse are reciprocally related, indicating that there is a dynamic interaction between social cognition and social communication among children with autism.

It is also important to note that the relationships between theory of mind and contingent discourse were only found in the concurrent analyses; theory of mind performance did not correlate at all with later contingent discourse abilities, and contingent discourse did not correlate with later theory of mind. Overall, the variables included in this study explained relatively little of the variance in contingent discourse, both concurrently and especially in the longitudinal analysis. With respect to the role of language in the development of contingent discourse, it may be that grammatical skills are more significantly linked than vocabulary, which was the measure that we included in this study (cf. Bloom et al., 1976). Nevertheless, it seems that factors beyond the children's age, cognitive and language levels, and even theory of mind, contribute in important ways to the ability of children with autism to engage in reciprocal and effective conversation with others. These may include additional child factors such as joint attention skills, social engagement or other aspects of social cognition not included in theory of mind. The children's history of participation in effective interventions, especially those focusing on social and communicative skill development, may also explain some of the individual differences in discourse ability. Moreover, the ability to maintain an ongoing conversation may be significantly influenced by the effectiveness of the child's conversational partner, especially mothers, who were the main participants in this study. A recent study by Siller and Sigman (2002), for example, found that parental sensitivity and ability to synchronize their behavior to their children's activity was significantly related to later communication skills in children with autism.

Theory of mind is only one of many potential factors that contribute to variation in discourse skills among children with autism. Future studies should consider incorporating a broader perspective on this important aspect of social communication in autism by including measures of theory of mind and other aspects of social cognition and joint attention in addition to measures of parental functioning and effectiveness. The ultimate goal of this line of research is to develop more effective interventions to foster advances in everyday communicative interactions for children with autism.

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