RESEARCH ARTICLE

Theory of Mind in Children with Autism Spectrum Disorder: Do Siblings Matter?

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Research indicates a positive relation between the sibling constellation and theory of mind (ToM) development in typically developing (TD) children. Less is known about this association in children with autism spectrum disorder (ASD). The current study examined the association among the presence and number of siblings, birth order, and false belief (FB) understanding in children with ASD and a TD comparison group. Two FB tasks (change of contents and change of location) and the Peabody Picture Vocabulary Test were administered to 57 children with ASD and 28 TD children during a home visit. One parent of each child reported on demographics and the sibling constellation. Separate hierarchical regressions controlled for age, receptive language ability, and scores on the Social Communication Questionnaire. In children with ASD, no association was observed between presence or number of siblings and ToM. However, the presence of older (but not younger) siblings was found to be positively associated with ToM. Children with ASD who had at least one older sibling performed similarly to the TD group, whereas children with ASD who had no older siblings performed significantly worse than the TD group. These findings indicate an advantage for FB performance in children with ASD who have an older sibling. They may bear on decisions to include older siblings or peers in intervention programs and may also contribute to a more complete understanding of the origins of individual differences in ToM ability in children with ASD. ***Autism Res** 2013, ••: ••–••.* © 2013 International Society for Autism Research, Wiley Periodicals, Inc.

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Theory of mind (ToM), or the ability to understand the mental states of the self and others, follows a common developmental trajectory in typically developing (TD) children in that children's understanding of their own and others' desires, true and false beliefs (FB), emotions and other mental states undergoes considerable development during the preschool period [Wellman, Fang, & Peterson, 2011]. At the age of 3, most TD children do not demonstrate ToM on traditional behavioral tasks; however, by 4 or 5 years of age, the majority of TD children exhibit an understanding of the beliefs and mental states of themselves and others [Peterson, Wellman, & Slaughter, 2012].

The development of ToM does not seem to follow this established trajectory in children with autism spectrum disorder [ASD; see Yirmiya, Erel, Shaked, & Solomonica-Levi, 1998, for a meta-analytic review]. ASD is a neurodevelopmental disorder characterized by a dyad of socio-communicative impairments and the display of restricted and repetitive behaviors and interests [American Psychiatric Association, 2013]. The majority of children with ASD demonstrate a delay in ToM; however, ToM is multifaceted, and reported delays or deficits among this population are inconsistent [Hughes & Leekam, 2004]. Individual differences in performance on ToM tasks have been observed in both TD and ASD populations. In fact, much of the research on ToM during the last two decades has examined possible contextual influences on these individual differences, including culture, attachment, and family factors, including discussion of mental states within the family environment [see Hughes & Leekam, 2004, for a review]. The role of siblings on ToM performance among children with ASD is a relatively understudied but theoretically important area of research because of the opportunities for social interaction afforded by siblings. The primary goal of the current study was to examine ToM abilities in relation to the sibling constellation in children with ASD and a TD comparison group.

The sibling constellation is perhaps the most documented contextual correlate of ToM development in TD children [Dunn, Brown, Slomkowski, Tesla, & Youngblade, 1991; Jenkins & Astington, 1996; McAlister & Peterson, 2006, 2007, 2012; Perner, Ruffman, & Leekam, 1994; Ruffman, Perner, Naito, Parkin, & Clements, 1998]. Researchers have proposed that the presence of child-aged siblings provides opportunities for social interaction that are uniquely facilitative of ToM acquisition through increased opportunities for interaction with a social partner who is close in age and less likely than parents, adult siblings, or teenagers to com-

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pensate for immature mentalizing abilities [McAlister & Peterson, 2007]. Specifically, the presence of similar-aged siblings allows the opportunity for certain types of pretend play (i.e., joint play and role-taking) through which children gain exposure to the mental states of their interaction partners or the character they are pretending to be, respectively [Harris, 2005]. Even arguments between siblings may contribute positively to ToM development [Foote & Holmes-Lonergan, 2003]. Also, children more frequently use mental state language during conversations with friends and peers than with mothers [Brown, Donelan-McCall, & Dunn, 1996].

Most studies about siblings and ToM performance have utilized inferential FB tasks, which assess the understanding of another person's incorrect belief about reality and traditionally take the form of a story acted out by the researcher using props. In the stories, the participant is privy to information that is withheld from the protagonist; thus, the story indicates that the protagonist has a FB that differs from the participant's belief. The participant is asked to predict the protagonist's behavior. A lack of FB understanding is implicated if the participant predicts the protagonist's behavior based on the participant's own belief rather than the protagonist's FB [Wellman, Cross, & Watson, 2001].

The sibling constellation is multifaceted, and includes the presence, number, and age of siblings, as well as birth order. A robust relationship has been observed between the various aspects of the sibling constellation and ToM performance in TD children. With few exceptions [e.g., Cutting & Dunn, 1999; Hughes & Ensor, 2005], TD children with more siblings or larger families performed better on ToM tasks than children with no siblings or smaller families [e.g., Perner et al., 1994]. Birth order has been less studied, but there is support for a specific benefit of older siblings for ToM performance compared with no siblings or younger siblings [Ruffman et al., 1998].

A related line of research suggests a particularly facilitative role of "child-aged" siblings [McAlister & Peterson, 2007]. Children whose siblings are not child-aged (i.e., infants, teenagers, and adults) perform more similarly to singletons on ToM tasks than to children with at least one child-aged sibling. Interpretations of these findings suggest that infant siblings may not yet be capable of participating in the type of social interaction that promotes ToM growth, and that interactions with teenage or adult siblings may not be childish enough to contribute to children's burgeoning understanding of mental states. Thus, "child-like" social interaction may provide the optimal developmental context for ToM abilities [McAlister & Peterson, 2007].

Recent findings from a cross-lagged longitudinal study delineated the influence of child-aged siblings on the developmental trajectories of both ToM and executive functioning in preschool- and kindergarten-aged TD children. McAlister and Peterson [2012] found that the presence and number of child-aged siblings during preschool were associated with ToM ability concurrently and 1 year later, with no particular advantage for children who had older siblings. Presence, but not number, of child-aged siblings was also associated with executive functioning concurrently and 1 year later. Interestingly, the associations among the sibling constellation and ToM appeared to be direct, whereas the longitudinal association between the presence of child-aged siblings and executive functioning was at least partially mediated by children's ToM performance. These findings further strengthen evidence for a meaningful link between the sibling constellation and ToM, and they counter the proposal that improved executive functioning is the mechanism by which sibling interactions improve ToM [McAlister & Peterson, 2012]. Thus, it appears that interactions with siblings, older siblings, and child-aged siblings exert unique, positive influences on ToM development.

Although several studies have examined siblings and sibling relationships of children with ASD [Aksoy & Bercin Yilidirim, 2008; Kaminsky & Dewey, 2001; Knott, Lewis, & Williams, 2007; Rivers & Stoneman, 2008], research examining the associations among facets of the sibling constellation and ToM in children with ASD is limited. Only one study, to our knowledge, has examined the presence, number, and birth order of siblings and ToM ability in a sample of children with ASD. This study of 60 children with relatively low-functioning ASD, conducted by O'Brien, Slaughter, and Peterson [2011], found no significant associations among the presence of at least one child-aged sibling, number of siblings, and performance on several types of ToM tasks. Also, unlike previous studies of TD children, O'Brien and colleagues found that having an older TD sibling was negatively associated with ToM performance in children with ASD. However, they found that children with ASD who had at least one younger sibling performed marginally better on ToM tasks than children with ASD who had no siblings or only older siblings. Perhaps, as the authors suggest, children with older siblings receive fewer resources, including parental attention, interaction with parents, and autism interventions, than only children or firstborn children with ASD. They also hypothesized that older TD siblings may consciously or subconsciously overcompensate for delayed ToM skills in their younger siblings with ASD. These results, which suggest a different role for siblings in the development of ToM in children with and without ASD, are intriguing and merit further examination in an ASD sample with a wider range of abilities. Research on sibling relationships of children with autism indicates that the behavioral problems of children with autism are positively associated with siblings' behavioral problems and conflict within the sibling dyad, and negatively associated with sibling warmth [Petalas et al., 2012]. Thus, the associations among facets of the sibling constellation and ToM could be influenced by severity of autism symptoms. The inclusion of a TD comparison group could also be helpful in interpreting the performance of children with ASD who do and do not have siblings. The current study includes these elements.

Before addressing the major study aims, a preliminary goal of this study is to replicate previous research indicating that children with ASD demonstrate poorer performance on ToM tasks than TD children. The primary goals of this study are the following: (a) to examine whether the presence and the number of child-aged siblings is associated with performance on FB tasks in children with ASD, and (b) to determine whether birth order is associated with FB task performance in children with ASD.

Based on previous research, we expected the following:

1. Children with ASD who had child-aged siblings would perform better on FB tasks than children with ASD who had no child-aged siblings, and children with ASD who had more siblings would demonstrate a more advanced ToM than children with ASD who had fewer or no siblings. It is reasonable to believe that the child-like interaction that is proposed to occur among TD siblings may also occur among children with ASD and their TD siblings.
2. There would be a difference in FB performance in children with and without ASD with younger vs. older siblings. We made no prediction as to which sibling age group would perform better, given the contradictory findings that indicate a benefit of older siblings for TD children [e.g., Ruffman et al., 1998], but a negative association between the presence of older siblings and ToM performance for low-functioning children with ASD [O'Brien et al., 2011].
3. Additionally, if a difference was observed between ASD sibling subgroups (e.g., siblings/no siblings; older siblings/no older siblings), we expected that the subgroups might demonstrate differing patterns of performance when compared with the TD comparison group. For example, if the data supported hypothesis 1 (i.e., children with ASD who had siblings outperformed children with ASD who did not have siblings), we expected the best performance by the TD group, followed by ASD children with siblings, and then by ASD children with no siblings.

In post hoc analyses, we explored whether receptive language [Peabody Picture Vocabulary Test (PPVT) scores] mediated observed associations between the sibling constellation and FB performance in the ASD group. The possibility that receptive language was mediating relationships between the sibling constellation and FB performance was based on considerable evidence linking language and ToM development [see Milligan, Astington, & Dack, 2007].

Method

Participants

Eighty-five children (57 children with a parent-reported diagnosis of ASD, 42 boys, and 28 TD children, 17 boys) between the ages of 4 and 12 years [M age = 6.86, standard deviation (SD) = 2.08] participated in the study. Children were recruited from autism-related community events and Listservs, community newsletters, local preschools, kindergarten classrooms, and child-care centers. The sample was diverse in race (59% Caucasian, 30.1% mixed race or other, 10.1% Asian) and ethnicity (26.5% Hispanic or Latino). The majority of mothers and fathers reported completing at least a 4-year degree (62.6% of families with a child with ASD and 67.4% of families with TD children). Mothers and fathers of TD children had significantly higher educational levels than parents of children with ASD [mothers: $F(1, 65) = 12.96$, $P < .001$; fathers: $F(1, 66) = 7.10$, $P = .01$]. However, sibling presence was not significantly related to maternal or paternal education [mothers: $F(1, 65) = 1.25$, $P = .27$; fathers: $F(1, 66) = 0.05$, $P = .83$]. There was no significant interaction between diagnostic group (ASD/TD) and presence of siblings (no siblings/siblings) for maternal [$F(1, 65) = 3.35$, $P = .07$] or paternal education [$F(1, 66) = 0.40$, $P = .84$], indicating that parents' level of education did not differ between children with and without siblings in the ASD or TD groups.

Five children with ASD were excluded because they were unable to complete the FB tasks ($n = 3$) or the receptive language measure (described below; $n = 2$). Scores on the Lifetime Social Communication Questionnaire [SCQ; Rutter, Bailey, Berument, Lord, & Pickles, 2003; described below] were relied upon to confirm a parent-reported ASD diagnosis and to confirm the absence of ASD symptoms in the TD group. Inclusionary criteria for the ASD sample was a professional diagnosis of ASD and an SCQ score of 12 or higher, as research indicates that the traditional cutoff score of 15 may increase the possibility of false negatives [Allen, Silove, Williams, & Hutchins, 2007; Eaves, Wingert, Ho, & Mickelson, 2006]. Nine children with ASD had scores of 11 or less, and were thus excluded from the analyses. No participants were excluded from the TD group based on SCQ score. The final sample size was 71: 43 children with ASD and 28 TD children. Of the 43 children with ASD in the final sample, 20 were diagnosed with autism, 19 were diagnosed with Asperger's disorder, or high-functioning autism, and 4 were diagnosed with pervasive developmental disorder—not otherwise specified. Demographic and sibling information for the study groups is reported in Table 1.

Procedure

Study procedures were prospectively approved by the university institutional review board. Data were collected

Table 1. Descriptive Statistics by Diagnostic Group (TD or ASD) and Sibling Age

	TD children			Children with ASD		
Study variables	All (n = 28)	No older sibs (n = 17)	Older sibs (n = 11)	All (n = 43)	No older sibs (n = 28)[a]	Older sibs (n = 12)[a]
Child age (years)						
M (SD)	6.12 (1.46)	5.77 (1.48)	6.67 (1.30)	7.20 (2.28)	7.16 (2.41)	6.45 (1.04)
Range	4–9	4–9	4–8	4–12	4–12	4–8
Receptive language (PPVT)[b]						
M (SD)	111.43 (11.25)	115.53 (10.57)	105.09 (9.49)	88.35 (24.39)	91.11 (24.82)	84.75 (21.63)
Median	112.50	117.00	107.00	96.00	100.50	80.50
Range	88–133	95–133	88–116	40–129	40–129	40–115
Gender (Number/% male)	17/61%	12/71%	5/46%	34/79%	22/79%	9/75%
Social Communication Questionnaire						
M (SD)	3.75 (2.29)	3.82 (2.35)	3.64 (2.29)	18.93 (4.89)	17.89 (4.35)	20.50 (5.13)
Range	0–8	0–8	0–8	12–31	12–28	15–31
False belief performance						
M (SD)	3.96 (1.93)	3.35 (2.03)	4.91 (1.38)	2.58 (1.70)	2.36 (1.75)	2.92 (1.51)
Range	1–6	1–6	2–6	0–6	0–6	0–5

[a]Descriptive statistics reflect the exclusion of three outlying cases.
[b]Standardized PPVT scores.
ASD, autism spectrum disorder; TD, typically developing; PPVT, Peabody Picture Vocabulary Test; SD, standard deviation.

during one 60-min home visit. One parent (86% mothers) of each child completed the questionnaires. Each child was administered the PPVT-III [Dunn & Dunn, 1997] and a battery of ToM tasks by the first author or trained research assistants. Specific procedures for administering the ToM tasks are described below.

Measures

Demographic and sibling information. Parents completed a questionnaire that included items regarding their own and child age, race/ethnicity, and socioeconomic status. Additionally, parents answered questions about sibling constellation, including *number of siblings* and *sibling age* (calculated from the date of birth). From these questions, we created four variables: (a) a continuous variable for the number of child-aged (i.e., 1–12 years of age) siblings; (b) a dichotomous variable representing the presence of siblings in which children with no child-aged siblings were coded as 0, and children with at least one child-aged sibling were coded as 1; (c) a dichotomous variable representing the presence of younger siblings in which children with no siblings or only older siblings were coded as 0 (i.e., no younger siblings), and children with at least one younger sibling were coded as 1; and (d) a dichotomous variable representing the presence of older siblings in which children with no siblings or only younger siblings were coded as 0, and children with at least one older sibling were coded as 1. Descriptive statistics for sibling constellation variables are reported in Table 2.

Autism symptomatology. Parents completed the SCQ [Current and Lifetime versions; Rutter et al., 2003], a 40-item measure of socio-communicative abilities and impairments that is often used to screen for ASD [Eaves et al., 2006]. The Lifetime SCQ was used to confirm parental report of a professionally rendered clinical diagnosis of ASD in the ASD group and to confirm the absence of undiagnosed ASD in the TD participants. The SCQ has been used in previously published studies to confirm

Table 2. Sibling Constellation of TD Children and Children with ASD

	TD children (n = 28)	Children with ASD (n = 43)
Sibling(s) present	23 (82.1%)	33 (76.74%)
Number of siblings		
M (SD)	0.93 (0.54)	1.49 (1.26)
Range	0–2	0–5
Number of child-aged siblings		
M (SD)	0.79 (0.57)	1.05 (1.05)
Range	0–2	0–3
Age of child-aged siblings		
M (SD)	7.18 (2.63)	7.36 (3.36)
Range	2–12	2–12
Child-aged sibling(s) present	20 (71%)	27 (62.80%)
Older child-aged sibling(s)	11 (39.3%)	13 (30.23%)
Younger child-aged sibling(s)	9 (32.1%)	18 (41.86%)
Sibling(s) with an ASD[a]	0 (0%)	10 (23.26%)
Child-aged sibling(s) with an ASD[a]	0 (0%)	9 (20.93%)
No TD child-aged sibling(s)	–	6
1 + TD child-aged sibling(s)	–	3

[a]Sibling diagnostic information was missing for one participant with ASD.
ASD, autism spectrum disorder; TD, typically developing; SD, standard deviation.

parent report of an ASD diagnosis [e.g., DeRosier, Swick, Davis, McMillen, & Matthews, 2011]. Additionally, studies using data from the Interactive Autism Network, a national ASD research registry that uses parent report on the SCQ to characterize participants, have indicated strong validity and reliability of parent-reported ASD diagnoses with the Autism Diagnostic Observation Schedule and the Autism Diagnostic Interview-Revised when children receive an SCQ score of 12 or higher [Daniels et al., 2012; Lee et al., 2010].

Receptive language ability. The PPVT-III [Dunn & Dunn, 1997] is a verbally administered standardized measure of single-word receptive language ability with well-established reliability and validity. It has been used to control for language abilities when assessing ToM performance in children with and without ASD [e.g., Matthews et al., 2011; Pellicano, 2010].

ToM tasks. Children were administered two analogous versions of two established ToM tasks to measure *false belief understanding*: (a) the change of location task [i.e., Sally–Anne; Baron-Cohen, Leslie, & Frith, 1985], and (b) the change of contents task [i.e., Smarties; Wimmer & Hartl, 1991]. The names of the critical objects and characters were changed for the administration of the analogous versions of each task, which were included in order to prevent participants from passing by guessing. Thus, a passing score was only achieved for a particular task (e.g., change of location) by correctly responding to the control and target questions in both versions of the task. Administration of the ToM tasks was counterbalanced across participants.

Change of location task. Dolls were used to act out a story in which the first character changed the location of an object belonging to the second character while the second character was out of the room. When the second character returned, children were asked the target question (e.g., "Where will Megan look for the ball?") and two control questions (e.g., "Where is the ball really?" and "Where was the ball in the beginning?"). As in previous research [e.g., Baron-Cohen et al., 1985], children passed the task if they correctly answered the two control questions, and reported that the second character (i.e., the character with a FB) would look for the object in the location in which she left it. Children could receive zero points (no pass) or one point (pass) for each version of the change of location task. Children who responded correctly to the target question but answered incorrectly to one or both of the control questions received a no pass. Thirteen children with ASD and 1 TD child responded incorrectly to at least one control question on the first version of the task; 17 children with ASD and 2 TD children responded incorrectly to at least one control question on the second version of the task.

Change of contents task. Children were shown a tube of M&Ms or Play-Doh (analogous version) with an unexpected object inside (i.e., crayons or a bouncy ball, respectively). Before the unexpected object was revealed, children were asked what they thought was in the tube. The researcher then revealed that there was actually an unexpected object in the tube, and asked the own-belief target question (e.g., "In the beginning, what did you think was in the tube?"). The researcher then revealed a doll named Diego, and explained that Diego did not hear anything that the child or the researcher had previously said. Then, the researcher asked the other-belief question (e.g., "What will Diego think is in the tube?"). In order to receive points for this task, children had to correctly state the expected object(s) (i.e., M&Ms/Play-Doh) and the unexpected object(s) (i.e., crayons/bouncy ball). Children received one point for a correct answer to the own-belief question (i.e., M&Ms/Play-Doh) and one point for a correct answer to the other-belief question (i.e., M&Ms/Play-Doh). Thus, children could receive up to two points on each of the analogous change of contents tasks: zero points for incorrectly responding to both of the belief questions or to one or both of the control questions, one point for correctly answering one of the belief questions, or two points for correctly answering both of the belief questions. Three children with ASD and one TD child responded incorrectly to at least one control question in the first version of the task. Three children with ASD responded incorrectly to at least one control question in the second version of the task.

Scoring. Scores from both versions of each task were summed to create a total score for each task. In the total score for the change of location task, children could receive a maximum score of two. In the total score for the change of contents task, children could receive a maximum score of four. Total scores were summed to create a composite ToM score ranging from zero to six.

Data screening. Prior to analysis, data screening revealed that 8% ($n = 7$; 1 TD and 6 ASD) of the cases were missing some data from the FB tasks. These missing data were managed by assigning each participant's FB task mean from the completed tasks for use in creating a FB composite score. FB composite scores in the TD and ASD groups were inspected; departures from normality were not detected. Unstandardized PPVT scores and chronological age were included as separate covariates in the current analyses in order to control for their unique contributions to variance in the FB outcome variable. Scores on the SCQ were also included as a covariate in the reported analyses in order to control for autism symptomatology.

Assumptions of an ordinary least square (OLS) regression were checked through residual plots and diagnostics. In each regression model, the same one to three ASD cases were found to meet the definition of outliers due to leverage or discrepancy; there was no detectable evidence of contamination. Each model was rerun excluding these outliers. In one instance, excluding the outliers altered the significance level but not the direction of the association. Following the recommendation of Cohen, Cohen, Stephen, and Aiken [2003], this regression model is reported without the outliers, and results including outliers are provided in a footnote.

Results

Descriptive statistics for child age, receptive language ability, gender, SCQ score, and FB performance are shown in Tables 1 and 2. To test the preliminary objective, OLS hierarchical regressions were conducted to compare FB performance in the TD and ASD groups. Child age and receptive language ability (unstandardized PPVT scores) were entered as control variables in the first step of the regression model. Diagnostic group (TD or ASD) was entered in the final step with the FB composite score as the outcome variable. As expected, the TD group performed significantly better than the ASD group on the FB tasks (see Table 3). Entering the diagnostic variable in the second step resulted in a statistically significant increase in explained variance [$\Delta R^2 = 0.07$, $F(3, 67) = 12.27$, $P < .001$].

In order to test the first hypothesis, that the presence and number of siblings would be positively associated with FB performance in children with ASD, separate OLS hierarchical regressions were conducted within the ASD group. The association between (a) the presence of child-aged siblings and FB performance, and (b) the number of child-aged siblings and FB performance was tested by entering child age, PPVT score, and SCQ score as control variables in to the first step of each model. Sibling presence (see Table 4) and sibling number (see Table 5) variables were entered in the second step of each regression model, with composite FB performance as the outcome variable. The first hypothesis was not supported; entering the presence or number of siblings variables in the second step of the models did not result in a significant increase in explained variance [presence: $\Delta R^2 = 0.00$, $P = 0.65$, $F(4, 38) = 4.33$, $P < .01$; number: $\Delta R^2 = 0.01$, $P = 0.56$, $F(4, 38) = 4.38$, $P < .01$].

To test the second hypothesis about the association between sibling age and FB performance in the ASD group, child age, PPVT score, and SCQ score were entered as control variables during the first step, and the younger siblings/no younger siblings and older siblings/no older siblings variables were entered during the second step of the regression model, with composite FB performance as the outcome variable. As shown in Table 6, a significant positive association was observed between the presence of at least one older sibling and FB performance, indicating that children with ASD who had at least one older sibling outperformed children with ASD who had no siblings or only younger siblings even when controlling for the presence of younger siblings. No significant association was found between the presence of younger siblings and ToM in the ASD group. The inclusion of the sibling age variables (younger siblings/no younger siblings and older siblings/no older siblings) during the second step of the model resulted in a statistically significant increase in explained variance [$\Delta R^2 = 0.11$, $P = .04$, $F(5, 34) = 5.69$, $P < .001$]. Descriptive statistics for children with and without older siblings are reported in Table 1.

In order to test the third hypothesis that the ASD older sibling and no older sibling subgroups would demonstrate differing patterns of performance when compared with the TD group, OLS hierarchical regression analysis was conducted. In addition to entering child age and PPVT score in the first step of each model, two dummy-coded variables were entered during the second step of each model, with FB composite score as the outcome variable. The first dichotomous variable contrasted the

Table 3. Hierarchical Regression Model for False Belief Performance in TD and ASD Groups (*n* = 71)

Variables	*b*	*SE(b)*	β	*P* ≤	ΔR^2	*F(df, df)*
Step 1					0.29**	13.62 (2,68)**
Chronological age	0.07	0.11	0.08	0.49		
Receptive language (PPVT)[a]	0.03	0.01	0.50	0.001		
Step 2					0.07*	12.27 (3,67)**
Chronological age	0.21	0.11	0.22	0.07		
Receptive language (PPVT)[a]	0.02	0.01	0.35	0.01		
Diagnostic group (ASD as reference)	1.19	0.45	0.31	0.01		

[a]Unstandardized PPVT scores.
*$P < .01$; **$P < .001$.
ASD, autism spectrum disorder; PPVT, Peabody Picture Vocabulary Test; TD, typically developing.

Table 4. Hierarchical Regression Model for Presence of Siblings and False Belief Performance in Children with ASD (*n* = 43)

Variables	*b*	*SE(b)*	β	*P* ≤	ΔR^2	*F(df, df)*	*M* (SD)
Step 1					0.31*	5.82 (3,39)*	
Chronological age	0.12	0.12	0.16	0.32			
Receptive language (PPVT)[a]	0.02	0.01	0.45	0.01			
Social Communication Questionnaire	−0.03	0.05	−0.09	0.53			
Step 2					0.00	4.33 (4,38)*	
Chronological age	0.12	0.12	0.15	0.35			
Receptive language (PPVT)[a]	0.02	0.01	0.46	0.01			
Social Communication Questionnaire	−0.03	0.05	−0.08	0.61			
Presence of sibs (no sibs as reference)	−0.23	0.50	−0.06	0.65			
False belief performance by subgroup							
No sibs (*n* = 16)							2.56 (1.93)
1 + sib(s) (*n* = 27)							2.63 (1.64)

**P* < .01.
[a]Unstandardized PPVT scores.
ASD, autism spectrum disorder; PPVT, Peabody Picture Vocabulary Test; SD, standard deviation.

Table 5. Hierarchical Regression Model for Number of Siblings and False Belief Performance in Children with ASD (*n* = 43)

Variables	*b*	*SE(b)*	β	*P* ≤	ΔR^2	*F(df, df)*
Step 1					0.31*	5.82 (3,39)*
Chronological age	0.12	0.12	0.16	0.32		
Receptive language (PPVT)[a]	0.02	0.01	0.45	0.01		
Social Communication Questionnaire	−0.03	0.05	−0.09	0.53		
Step 2					0.01	4.38 (4,38)*
Chronological age	0.12	0.12	0.16	0.32		
Receptive language (PPVT)[a]	0.02	0.01	0.44	0.01		
Social Communication Questionnaire	−0.03	0.05	−0.10	0.50		
Number of sibs	0.13	0.23	0.08	0.56		

[a]Unstandardized PPVT scores.
**P* < .01.
ASD, autism spectrum disorder; PPVT, Peabody Picture Vocabulary Test.

ASD older sibling group with the TD group, and the second dichotomous variable contrasted the ASD no older sibling group with the TD group (see Table 7). The TD group performed significantly better than children with ASD who had no older siblings, but there was no difference observed between the TD group and the group of children with ASD who had at least one older sibling. Thus, not only did the children with ASD who had at least one older sibling perform better than children with ASD who had no older siblings, children with ASD who had at least one older sibling also did not differ significantly from the TD group. The inclusion of the comparison variables during the second step resulted in a statistically significant increase in explained variance [$\Delta R^2 = 0.08$, $P = .02$, $F(4, 66) = 9.62$, $P < .001$]

To test the post hoc hypothesis that receptive language was mediating the associations between the sibling constellation and FB performance in children with ASD, corresponding mediation models were conducted for all sibling variables using Preacher and Hayes' [2008] SPSS Macro for multiple mediation (see Table 8). No evidence of mediation was observed. Further, there was no significant association between the older siblings/no older siblings variable and PPVT scores ($b = -6.93$, $P = .50$), but a significant positive association between the younger siblings/no younger siblings variable and PPVT scores ($b = 20.18$, $P = .03$).[1]

Discussion

The objective of the current study was to examine the role of siblings on ToM performance in a diverse sample

[1]Results including outliers yielded a similar pattern to the results excluding outliers, although not significant. The association between having a younger sibling and FB performance was negligible [$b = -0.07$, $t(42) = -0.14$, $P = .89$]. The association between having an older sibling and FB performance was in the positive direction [$b = 0.70$, $t(42) = 1.35$, $P = .19$].

Table 6. Hierarchical Regression Model for Sibling Age and False Belief Performance ($n = 40$)

Variables	b	$SE(b)$	β	$P \leq$	ΔR^2	$F(df, df)$	M (SD)
Step 1					0.34**	6.28 (3, 36)**	
Chronological age	0.11	0.12	0.14	0.38			
Receptive language (PPVT)[a]	0.03	0.01	0.50	0.002			
Social Communication Questionnaire	−0.05	0.05	−0.14	0.30			
Step 2					0.11*	5.69 (5,34)***	
Chronological age	0.15	0.12	0.19	0.20			
Receptive language (PPVT)[a]	0.03	0.01	0.57	0.001			
Social Communication Questionnaire	−0.09	0.05	−0.24	0.08			
Younger sibs (no younger sibs as reference)	−0.15	0.46	−0.045	0.75			
Older sibs (no older sibs as reference)	1.28	0.49	0.36	0.01			
FB performance by subgroup							
No younger sibs ($n = 22$)							2.27 (1.72)
Younger sibs ($n = 18$)							2.83 (1.62)
No older sibs ($n = 28$)							2.36 (1.75)
Older sibs ($n = 12$)							2.92 (1.51)

*$P < .05$; **$P < .01$; ***$P < .001$.
[a]Unstandardized PPVT scores.
FB, false belief; PPVT, Peabody Picture Vocabulary Test.

Table 7. Hierarchical Regression Model for Comparison of ASD Birth Order Subgroups and TD Group on FB Performance ($n = 71$)

Variables	b	$SE(b)$	β	$P \leq$	ΔR^2	$F(df, df)$
Step 1					0.29**	13.62 (2,68)**
Chronological age	0.07	0.11	0.08	0.49		
Receptive language (PPVT)[a]	0.03	0.01	0.50	0.001		
Step 2					0.08*	9.62 (4,66)**
Chronological age	0.21	0.11	0.23	0.06		
Receptive language (PPVT)[a]	0.02	0.01	0.36	0.01		
Birth order (TD as reference)						
Older sibs	−0.04	0.34	−0.02	0.91		
No older sibs	−0.67	0.27	−0.32	0.02		

[a]Unstandardized PPVT scores.
*$P < .05$; **$P < .001$.
ASD, autism spectrum disorder; TD, typically developing; FB, false belief; PPVT, Peabody Picture Vocabulary Test.

Table 8. Mediation Models for Sibling Variables, Receptive Language, and False Belief Performance in Children with ASD ($n = 43$)[a]

	a Paths		b Paths		c Paths		c′ Paths		Bootstrap CIs	
Variables	b	$SE(b)$	b	$SE(b)$	b	$SE(b)$	b	$SE(b)$	Lower	Upper
Presence of sibs (no sibs as reference)	13.72	9.34	0.02**	0.01	0.10	0.53	−0.23	0.50	−0.19	1.44
Number of sibs	2.62	4.44	0.02**	0.01	0.19	0.24	0.13	0.23	−0.21	0.69
Younger sibs (no younger sibs as reference)	20.18*	8.98	0.03***	0.01	0.45	0.50	−0.15	0.46	−0.08	1.79
Older sibs (no older sibs as reference)	−6.93	10.22	0.03***	0.01	1.08†	0.57	1.28*	0.49	−1.45	0.57

[a]Chronological age and SCQ were included as covariates in all models. The younger sibs/no younger sibs and older sibs/no older sibs variables were controlled for in the older sibs and younger sibs models, respectively. Outliers were excluded in the older sibs and younger sibs models ($n = 40$).
†$P = .07$; *$P \leq .05$; **$P \leq .01$; ***$P \leq .001$.
ASD, autism spectrum disorder; FB, false belief; CI, confidence interval; SCQ, Social Communication Questionnaire.

of children with ASD. Study findings both confirmed and extended prior research in this area. The null findings regarding the presence and the number of siblings and FB performance in children with ASD replicated the findings of O'Brien et al. [2011], the only other published study to our knowledge that has investigated the sibling constellation as it relates to ToM in children with ASD. Extending past research on mentalizing abilities in children with

ASD, the current study introduced new data that demonstrate a "sibling advantage" for ToM development, provided that the siblings are older than the target child.

The current inclusion of a TD comparison group allowed for the examination of the differences in ToM performance among TD children and ASD birth order subgroups. The TD group performed significantly better on FB tasks than children with ASD who had no older siblings. In contrast, there was no difference between the TD comparison group and children with ASD with at least one older child-aged sibling; this is an indicator that ToM development in children with ASD may be facilitated by the presence of at least one older sibling. However, although the current sample had adequate power to detect medium and large effects, power was inadequate to detect small effects. Thus, one cannot rule out the possibility that a small difference might exist between children with ASD with at least one older child-aged sibling and children in the TD comparison group.

Interpretations of the sibling constellation–ToM link have included the idea that the presence of similar-aged siblings provides a unique context for interaction that is not provided by parents or other adults. Siblings who are similar in age may serve as partners for child-like interactions that offer no affordances for an immature ToM, and thus elicit understanding of others' mental states [McAlister & Peterson, 2007]. Current findings partially replicate those of the only other study that examines the sibling constellation and ToM in children with ASD [O'Brien et al., 2011] in that no significant associations were observed between the presence and number of siblings and FB performance in children with ASD. The lack of association in the only two studies to examine this relationship speaks to the unique and pervasive social deficits that characterize ASD. It is conceivable that the social-communicative impairments observed in children with ASD preclude or inhibit the positive effects on ToM that are thought to result from child-like interactions with any child-aged sibling in TD children. Instead of the presence of any child-aged sibling, birth order in particular may be of importance in the development of ToM understanding in children with ASD.

O'Brien et al. [2011] suggested that children with ASD who are not firstborns may experience reduced social interaction with parents and reduced access to resources (e.g., behavioral interventions) because their parents' attention might be split between the child with ASD and his or her older sibling(s). Further, they suggested that older siblings may overcompensate for a younger sibling with ASD, which in turn might hinder ToM development. Younger siblings might be less cognizant of their older sibling's ASD diagnosis and socio-communicative impairments, which would render younger siblings less likely to overcompensate and more likely to engage in the unique, child-like interactions with their sibling that are thought to facilitate ToM development in TD children.

In contrast, children in the ASD sample in the current study who had at least one older sibling outperformed their counterparts with no older siblings, and there was no significant benefit of having a younger sibling. The observed pattern of findings departs from those of O'Brien and colleagues, but is in line with previous literature that has suggested a positive association between the presence of older siblings and ToM performance in TD children [Ruffman et al., 1998]. Importantly, the sample of children with ASD examined by O'Brien and colleagues was restricted to children whose siblings were TD, whereas some of the children in the current study had at least one sibling diagnosed with ASD. Restricting inclusion to children with only TD siblings has merit (i.e., it removes the confound of siblings' social-communicative impairments). However, including children with ASD regardless of their siblings' diagnostic status likely better approximates actual sibling constellations of children with ASD, as sibling recurrence of ASD has been extensively documented [Constantino, Zhang, Frazier, Abbacchi, & Law, 2010]. Importantly, post hoc analysis revealed no significant difference in FB performance between children with ASD with siblings who (a) had one or more siblings with ASD, and (b) had only TD siblings [$t(40) = -0.06$, $P = .96$].

A number of methodological differences between this study and O'Brien et al. may account for the divergent findings. As discussed above, children with ASD in the O'Brien and colleagues study only had TD siblings, whereas no restriction was placed on siblings' diagnostic status in the current sample. The current study employed two analogous versions of two FB tasks; in contrast, O'Brien and colleagues employed additional ToM tasks and different covariates. Perhaps the role of siblings varies with different aspects of ToM, which is a multifaceted construct [Wellman et al., 2011]. The samples were drawn from different countries: United States and New Zealand/Australia. Although both samples are from Western industrialized nations, there are likely to be cultural and demographic differences between the two samples of children, and differences in the availability and access to interventions for ASD. Last, O'Brien and colleagues reported results for a sample of children with ASD who were functioning on the lower end of the spectrum, whereas close to half of the current sample of children was diagnosed with Asperger's disorder or high-functioning autism. Additionally, this sample had standardized PPVT scores approaching average ($M = 88.35$, SD = 24.39, median = 96). Despite these differences, both studies show a role for siblings in the development of ToM in children with ASD, and suggest that further research would be valuable.

Among many possible theoretical interpretations of the current findings, two seem most plausible. It could be the case that children with ASD benefit most from scaffolding provided by older siblings rather than the match in mentalizing ability that they likely experience when interacting with younger siblings. Because the social-communicative impairments in ASD are pervasive, children with ASD may need to experience child-like interactions with siblings who are relatively more mature and understanding in order for sibling interactions to benefit the development of FB understanding.

An alternative interpretation draws upon strong evidence for an association between language ability and ToM development [see Milligan et al., 2007]. One possible explanation of the observed positive association between having an older sibling and FB performance is that interaction with older siblings could also play a role in language development, and language ability could therefore be mediating the association between sibling age and FB performance in children with ASD. This possibility was examined in the current study, and as reported in the results, no evidence for mediation was observed. However, the presence of younger, but not older, siblings seems to be associated with language ability in the ASD sample; this is opposite to the associations observed between sibling age and FB performance. These findings suggest that language is unlikely to be mediating the reported positive association between having an older sibling and FB performance. Even though having a younger sibling was positively associated with receptive language ability, this advantage did not extend to FB performance in the current sample. Future research might incorporate other aspects of language ability.

Future research also might extend to other family members and interactive partners. The "general apprenticeship" model of ToM development in TD children [Lewis, Freeman, Kyriakidou, Maridaki-Kassotaki, & Berridge, 1996] embraces many interaction partners, including adult kin, other adults, and older children. In the ASD literature, certain maternal narrative patterns have been found to be associated with ToM development in children with and without ASD [Slaughter, Peterson, & Mackintosh, 2007]. Whereas the current study provides evidence for a specific link between older siblings and ToM development in children with ASD, it does not rule out the important contributions offered through interactions with other members of the child's social environment.

Indeed, research in this area could benefit from a fuller characterization of the siblings of children with ASD. Because ASD "runs in families" [Kendler, 2010], siblings of children with ASD may have an underlying ASD diagnosis or may exhibit the broader autism phenotype. Future research with larger sample sizes should delineate the relative influence of siblings with and without ASD on ToM development. Understanding whether sibling influence varies by siblings' position on the broad autism phenotype is also of importance.

Results of the current study supplement and move forward the understanding of this theoretically and practically important area of research, and should benefit both families affected by ASD and professionals who administer interventions to children with ASD. Parents and professionals would likely be interested in facilitating sibling interactions that are associated with improved ToM. Additionally, a better understanding of this relationship will contribute to the delineation of the origins of individual differences in ToM ability in children with ASD.

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