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Having siblings is associated with better mentalizing abilities in adults

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ABSTRACT

Although typically-developing children all acquire the foundation for social cognition—a theory-of-mind (ToM)—at around age 6, there exists meaningful variability in social cognitive abilities among adults. Given that social cognition underpins our ability to relate and successfully collaborate with others, it is important to investigate potential contributors to this variability in adults. What factors, in particular developmental factors, help determine whether adults are better or worse at understanding other people? A likely factor to consider is siblinghood, as children with siblings tend to exhibit better ToM ability than only children. But does this influence extend into adulthood? In a pre-registered study, we examined whether various aspects of siblinghood predict mentalizing ability in a large and diverse young adult sample (N = 1792, M age = 24.12, Number of Siblings ranging from 0 to 9), using the Reading-the-Mind-in-the-Eyes Test (Baron-Cohen et al., 2001), an age-appropriate mentalizing task. Those who had more older siblings exhibited better mentalizing performance and the effect of siblinghood differed by gender. Men tended to have better mentalizing abilities when they had siblings, but this advantage was greatly attenuated for women. The results were robust, persisting even after controlling for age, race, and language ability.

Human beings are an intrinsically social species, making it essential that we accurately understand the thoughts, feelings, and motivations of our peers. What allows us to successfully navigate the social world is a suite of cognitive abilities known as social cognition. The foundation for social cognition is theory-of-mind (ToM; Apperly, 2012), which is acquired in childhood. However, there remains a wide range of variability in social cognitive abilities among adolescents and adults (Carpenter et al., 2016; Keysar et al., 2003), including variability in the ability to infer the mental states of others (i.e., mentalizing; Frith & Frith, 2003). Identifying the factors driving this variability—why some adults are better or worse at understanding their peers—is therefore of paramount importance. One likely candidate influence is siblinghood. Children with siblings tend to exhibit more advanced ToM compared to only children (Devine & Hughes, 2018). However, it is not currently known whether this influence of siblinghood persists into adulthood. We therefore examined whether the siblinghood effects observed for children's ToM persist into adulthood, with respect to mentalizing.

1. Siblinghood and child ToM

In children, various aspects of the family environment have been found to influence ToM development (Devine & Hughes, 2018).

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Frequent exposure to mental state talk from mothers, for example, is associated with better ToM in their children (Devine & Hughes, 2018; Dunn et al., 1991). Another particularly influential aspect of the family environment is the presence of siblings. There is a popular lay belief that children who have siblings are better off with respect to their social abilities compared to only children. The thinking is that those with siblings develop conflict management skills earlier on than only children, thanks to sibling conflict (e.g., disputes regarding property and ownership; Howe et al., 2011; Persram & Scirocco, 2019; Persram et al., 2019; Ross, 1996). These folk intuitions would seem to hold true: children who have siblings, compared to only children, tend to do better on ToM tasks (Devine & Hughes, 2018; McAlister & Peterson, 2007; Perner et al., 1994; Peterson, 2000). In studies with children, ToM is often operationalized as false belief reasoning, the understanding that others can hold beliefs about the world that depart from reality. Growing up with siblings is thus associated with greater understanding of the beliefs of others.

Several studies have added additional nuance and complexity to these initial findings. For example, many studies on the effect of siblinghood on ToM have highlighted the importance of older siblings: having an older sibling may be particularly beneficial for ToM. Younger siblings often become "apprentices" to older siblings, by habitually eliciting help from older siblings, and older siblings in turn often spontaneously teach their younger siblings (Azmitia & Hesser, 1993; Howe et al., 2017, 2015; Lewis et al., 1996; Perner et al., 1994; Ruffman et al., 1998; Segal et al., 2018). Having larger families, with more older siblings, may also allow for more consistent and sophisticated mental state language exposure which is a known predictor of theory-of-mind ability (Lewis et al., 1996). These close interactions with an older sibling in possession of more developed cognitive and social cognitive abilities could thus help scaffold the development of these same abilities in the younger sibling.

However, it could also be the case that this is not limited to siblings. Rather, any instance of development within an environment rich with meaningful social interactions could confer these social cognitive benefits (Perner, 1994). This would be consistent with evidence that interactions with younger siblings, and simply having more siblings in general, can improve ToM (Devine & Hughes, 2018; Leblanc et al., 2017; Paine et al., 2018; Peterson, 2000). The key here is the nature and quality of the sibling interactions. For example, meta-analytic evidence suggests that the effect of siblinghood on false belief reasoning is stronger for those with similar-aged siblings (Devine & Hughes, 2018). It is likely that interactions with siblings similar in age are likely to be more meaningful in nature, compared to those with siblings far younger or older (McAlister & Peterson, 2007; Peterson, 2000; Ruffman et al., 1998). Differences between siblings can also require more demanding forms of perspective-taking (e.g., opposite-gender siblings; Ruffman et al., 1998). Consistent with this idea, having a single sibling who is a twin is actually associated with lower ToM performance compared to having just one non-twin sibling (Cassidy et al., 2005). The similarity commonly found between twins might reduce the demand for mentalizing, which means less of an opportunity to develop these mental inference abilities. All these findings highlight the importance of investigating a wealth of sibling variables when examining this topic, including number of younger siblings, number of older siblings, and overall number of siblings.

Lastly, gender might also be important, as there is some evidence that gender plays a factor in the association between siblinghood and ToM (Sang & Nelson, 2015). This may result from potentially different types of interactions that girls and boys have with their siblings as children. Whether the influence of siblings on social cognition persists into adulthood, however, has rarely been investigated.

2. Adult mentalizing abilities

Although a working ToM is typically acquired in childhood (Flavell, 1999), there remains a great deal of variability in how well adults can infer the mental states of others. The most well-known measure of adult mentalizing is the Reading-the-Mind-in-the-Eyes Test (RMET; Baron-Cohen et al., 2001), which asks participants to infer mental states from photographs of a person's eye-region, choosing from among 4 options. Not surprisingly, there is considerable variability in scores for this task, with these differences in scores often affirming the validity of this measure. For example, scores on the RMET result in the expected mentalizing advantage that neurotypical individuals have over high-functioning individuals with Autism Spectrum Disorder (Baron-Cohen et al., 2001). Completing the RMET also activates brain regions associated with mentalizing (see appendix of Adams et al., 2010), and a double-blind placebo-controlled study found that intranasal administration of oxytocin (a neuropeptide key to social cognition; Insel, 2010) results in better performance on this task (Domes et al., 2007). Women also typically outperform men on the RMET (Kirkland et al., 2013), consistent with previously observed gender differences in social cognition.

Exposure to different environments can influence adult mentalizing as captured by the RMET, parallel to what is observed with children and ToM. Culture and social class both affect mentalizing in adults, for example (Adams et al., 2010; Bjornsdottir & Rule, 2016; Kraus et al., 2010; cf. as with other aspects of social cognition, Dietze & Knowles, 2020; Wu & Keysar, 2007). Unfortunately, although there are many studies on how siblinghood affects childhood ToM, there are no studies to-date that investigate whether siblings continue to have an influence on adult social cognitive abilities, such as mentalizing. The most relevant work available examined children over 6 years of age, but only up to 9 or 11 years-old, and these have produced contradictory findings (Calero et al., 2013; Kennedy et al., 2015).

We should not simply assume that the siblinghood effects on ToM observed in childhood will persist into adulthood. Growing into adulthood involves increasing opportunities to socialize outside of one's family, widening the scope of one's social environment. Adults can easily improve their social cognitive abilities through a myriad of influences, including peer interactions, romantic relationships, and working with others at school or at work. Moreover, the nature of sibling relationships changes from childhood to adulthood, as siblings begin to rely on and relate to each other in different ways. That said, there are also reasons to believe why this influence of siblings on childhood ToM might translate into an adult advantage in mentalizing relative to only children. For one, siblings remain an influence even for adults. There is no reason for sibling rivalry, for example, to cease simply because both siblings

are now adults. Not all aspects of sibling relationships are conflictual, of course, with other aspects of sibling relationships also likely to have a positive influence on adult mentalizing. This includes discussing with a sibling how to handle family dynamics (e.g., conflict between parents, among extended family), gaining an extended social network by virtue of knowing a sibling's friends and coworkers, and even trying to take into account the feelings and reactions of a sibling when sharing news with family.

It is also necessary to consider that almost all the extant evidence for an effect of siblinghood on ToM has been observed using false belief tasks. These tasks are designed for young children and pertain to a specific aspect of mentalizing: higher-order reasoning about the beliefs of others. The RMET has the advantage of being designed for adults, our population of interest, and it likely measures a different aspect of mentalizing social cognition than false-belief tasks: decoding subtle nonverbal cues for mental states. This difference is another reason why the effects observed in children with false belief tasks may not be observed when examining adults with the RMET. In other words, using the RMET provides a very conservative test of the siblinghood effect as it requires these prior observations to generalize to other aspects of mentalizing. If the siblinghood effect is not observed with the RMET in adults, then this effect might be unique to the aspects of mentalizing measured by false belief tasks or there may be no siblinghood effect among adults. Considering this myriad of possibilities, it is necessary to empirically examine whether the advantage that children with siblings have over only children regarding ToM persists into adulthood, with respect to mentalizing.

3. Current Study

We examined the association between siblinghood and mentalizing in an adult sample, using four siblinghood variables widely employed in developmental research. First, we predicted that those who had at least one sibling would tend to have better mentalizing ability compared to those with no siblings (McAlister & Peterson, 2007; Peterson, 2000). Second, we predicted that a greater number of older siblings would be associated with better mentalizing ability, based on evidence that younger children learn from older ones (Lewis et al., 1996; Perner et al., 1994; Ruffman et al., 1998). Third, we tested whether the number of younger siblings would be beneficial, since younger children might also confer social cognitive benefits onto older siblings (Leblanc et al., 2017; Paine et al., 2018; Peterson, 2000). Fourth, we examined the potential benefit of the overall number of siblings, as having a socially-rich environment, per se, might promote social cognition (Perner, 1994; N.B. particularly similar-aged siblings, Devine & Hughes, 2018).

Given that there may be small gender differences in social cognition (Bayliss et al., 2005; Hall et al., 2010; Kirkland et al., 2013), and potential siblinghood by gender interactions (Sang & Nelson, 2015), we also conducted an exploratory analysis of how these siblinghood variables interact with gender. Evidence for gender differences in the sibling benefit for mentalizing is unclear. There is a report that siblings may mention mental states more frequently to female siblings compared to male ones (Brown et al., 1996), which suggests that sisters may have more sibling interactions that promote mentalizing compared to brothers. However, there is also evidence that girls with an older brother exhibit worse perspective-taking skill than girls with no siblings (Sang & Nelson, 2015). Boys with brothers, on the other hand, exhibit somewhat better perspective-taking skills than boys with no siblings (Sang & Nelson, 2015). Given these mixed findings, it is important to explore whether gender moderates any benefit of siblinghood.

The data for this study originates in multiple archived datasets from previous studies conducted in our laboratory. This allows us to test our research questions using a large sample of adults (~1700), far larger than those typically employed to previously examine this question in children. We also adopt a highly conservative statistical approach by controlling for gender, age, English language ability, and whether participants are the same race as the targets, all of which are known to influence performance on the RMET (Baker et al., 2014; Elfenbein & Ambady, 2003; Kirkland et al., 2013; Phillips et al., 2002). Our analyses were pre-registered in advance, and appear on the Open Science Framework, along with all materials, analysis scripts, and supplementary materials (osf.io/xn9tr; data will be promptly shared upon request). We thus present a high-powered, pre-registered, examination of whether the childhood advantages in ToM that siblings afford persists into adulthood, in the form of better mentalizing ability, after controlling for several relevant demographic factors.

4. Method

Data was pooled from 27 pre-existing datasets, collected by our laboratory for separate and unrelated purposes. To qualify for this study, a dataset had to include the following data: (1) scores for the Reading-the-Mind-in-the-Eyes Test (RMET), (2) demographic information regarding siblings, and (3) at least 10 valid cases (i.e., not completely missing by row).

5. Participants

The initial sample size after aggregation was 2317. Our pre-registered exclusion criteria included removing any participants if there were any missing responses for the RMET items ($n = 520$), if participants reported an unusually low or high age (ages 8, 10, and 99; $n = 3$), and if they were deemed an outlier based on visual inspection of box plots, leverage plots, and plots for Cook's D ($n = 2$). Our final sample consisted of 1792 individuals. The average age of our respondents was 24.12 years ($SD = 9.68$) and 62% were female. Almost all this sample comprised of university undergraduates from a large multicultural city in Canada, with about 13% ($n = 235$) recruited from Amazon's Mechanical Turk (MTurk; an online crowdsourcing platform). Slightly less than half of the sample were of European heritage (46%), with the remainder being a mix of South Asian (12%), East and Southeast Asian (12%), African/Caribbean (6%), and Middle Eastern (6%; the remainder being other or unknown, 18%). About two-thirds of the sample had English as their first language (66%).

With respect to siblinghood, an overwhelming majority had at least one sibling (87%). Across the entire sample (including only

children), the number of siblings ranged from 0 to 9, but the average number of siblings was between 1 and 2 ($M = 1.70$, $SD = 1.31$; $Mdn = 1$), with the modal number of siblings being 1 ($n = 737$). Participants on average had almost 1 older and younger sibling (Older Sibling: $M = 0.80$, $SD = 1.04$, $Mdn = 1$; Younger Sibling: $M = 0.86$, $SD = 1.03$, $Mdn = 1$; mode for both was 0). When looking at only those with siblings, the modal response for the number of older siblings was 0, and for the number of younger siblings the mode was 1.

6. Measures

6.1. Mentalizing ability

We measured mentalizing ability using the Reading-the-Mind-in-the-Eyes Test (RMET; Baron-Cohen et al., 2001). In this task, participants choose the mental state a person is experiencing based on a grayscale image depicting the region around their eyes. The appropriate mental state is selected based on 4 possible options. In order to reduce the role of vocabulary in task performance, all options were accompanied by definitions. We scored the RMET as the number of correct items out of 36 total items. This measure has acceptable test-retest reliability (Fernández-Abascal et al., 2013; Khorashad et al., 2015), captures the mentalizing deficit found among those with high-functioning autism or Asperger's syndrome (Baron-Cohen et al., 2001), the gender advantage women hold over men (Warrier et al., 2017), and can also detect the boost in mentalizing performance that follows an administration of oxytocin (Domes et al., 2007). There is also some evidence that the RMET might predominantly capture an aspect of social cognition closely related to mental inference: emotion identification (Oakley et al., 2016). In our sample, this measure exhibited good internal reliability, $\alpha = .78$ (95% CI: 0.77, 0.80), consistent with previous research (Kittel et al., 2021).

6.2. Siblinghood information

Participants self-reported how many siblings they have and their own birth order, which we then used to compute the four siblinghood variables. Overall number of siblings was re-coded into a binary variable indicating whether participants had any siblings at all, which we refer to as *sibling status* (0 = only child, 1 = have at least one sibling). In addition to our pre-registered analysis of birth order, we also decomposed this variable into reports of number of older and younger siblings, given past research on the importance of older siblings. We computed the number of older siblings by taking birth order and subtracting 1 (e.g., first-borns have 0 older siblings [1–1 = 0]; second-borns have 1 older sibling [2 – 1 = 1]). Although this calculation for older siblings was not pre-registered, it is a simple linear transformation of birth order (i.e., number of older siblings = birth order – 1) and analyzing birth order was pre-registered. Because it is a simple linear transformation, this does not change the results of any covariance analysis. Number of

Table 1
Zero-Order Correlation Matrix.

Variable	1	2	3	4	5	6	7	8	9
1. RMET									
2. Age	.20 * [.15,.24]								
3. Gender†	.08 * [.03,.12]	-.11 * [− .16, − .06]							
4. Race†	.22 * [.17,.27]	.41 * [.37,.45]	-.09 * [− .14, − .04]						
5. English†	.15 * [.10,.19]	.30 * [.25,.34]	-.08 * [− .13, − .04]	.45 * [.41,.49]					
6. Birth Order	.06 * [.01,.10]	-.02 [− .07,.03]	-.03 [− .07,.02]	-.02 [− .07,.03]	.05 * [.00,.10]				
7. Older Sibs.	.06 * [.01,.11]	-.00 [− .05,.04]	-.03 [− .08,.02]	-.00 [− .05,.05]	.06 * [.01,.10]	.96 * [.96,.96]			
8. Sib. Status†	-.00 [− .05,.04]	-.08 * [− .12, − .03]	.01 [− .04,.06]	-.06 * [− .11, − .01]	-.00 [− .05,.04]	.52 * [.49,.56]	.29 * [.25,.33]		
9. Num. Sibs	.03 [− .02,.07]	.04 [− .01,.08]	.04 [− .00,.09]	-.06 * [− .11, − .01]	.03 [− .02,.07]	.66 * [.63,.68]	.61 * [.58,.64]	.48 * [.45,.52]	
10. Younger Sibs.	-.01 [− .05,.04]	.06 * [.01,.10]	.08 * [.03,.12]	-.05 * [− .10, − .00]	-.01 [− .06,.03]	-.08 * [− .12, − .03]	-.20 * [− .24, − .16]	.31 * [.27,.35]	.61 * [.58,.64]

Note. * = $p < .05$. † Dichotomous variables are dummy-coded in favor of predicting RMET (i.e., 1 = Female, Same race as target, English as a first language, Have siblings). Correlations between two dichotomous variables are phi coefficients. Correlations between continuous and dichotomous variables are point-biserial correlations. *Race* = Same race as target, *English* = English as a first language, *Older Sibs.* = number of older siblings, *Sib. Status* = sibling status, *Num. Sibs* = overall number of siblings, *Younger Sibs.* = number of younger siblings

younger siblings was then computed by taking the total number of siblings and subtracting number of older siblings. For only children, their total number of siblings, birth order, number of older siblings, and number of younger siblings were all coded as 0.

6.3. Control variables

Key demographic variables were incorporated as control variables, including gender, age, English as a first language, and race. Each of these variables has been associated with our key constructs in past research. For example, women have an advantage over men when it comes to mentalizing, empathy, and social cognition (Hall et al., 2010; McClure, 2000), with a meta-analysis of 40 studies identifying a small, but robust advantage for women on the RMET ($M_g = .18$; Kirkland et al., 2013). Older individuals also tend to have better mentalizing abilities (Phillips et al., 2002; Ruffman et al., 2010), as do those with higher verbal intelligence (Baker et al., 2014). Although definitions for all response options in the RMET were included in our studies, we decided to control for English as a first language in order to adopt a statistically conservative approach. Lastly, there may be an in-group advantage for social cognition, whereby emotional displays for same-race faces are recognized more rapidly and with greater accuracy (e.g., Elfenbein & Ambady, 2003). Since all the RMET faces are White, we coded for whether respondents reported also being White (i.e., European) and controlled for this in our analyses.

7. Results

7.1. Descriptive statistics

All analyses were conducted using R (R Core Team, 2021) and RStudio (1.3.1073; RStudio Team, 2020). Zero-order correlations between all variables appear in Table 1. As expected, number of siblings was correlated with both number of older and younger siblings, and there was a negative relationship between number of older and younger siblings. Age, one of our control variables, was positively related to RMET accuracy. Average RMET accuracy was approximately 24 out of 36 items correct (67%; $M = 24.24$, $SD = 5.62$), consistent with past reports with non-clinical adult samples (Baron-Cohen et al., 2001; Dietze & Knowles, 2020; Kraus et al., 2010). These scores ranged from 4 to 36 items answered correctly, also consistent with past work (Dietze & Knowles, 2020).

7.2. Primary analyses

The following primary analyses were all pre-registered (osf.io/q8z46). Regression diagnostics were conducted for all models and

Table 2
Siblinghood Variables Predicting Mentalizing, Controlling for Other Demographics.

Predictor	*B* [95% CI]	*p*	Predictor	*B* [95% CI]	*P*
Age	0.07 [0.05, 0.11]	< .001	Age	0.07 [0.04, 0.10]	< .001
Gender	1.24 [0.67, 1.81]	< .001	Gender	1.23 [0.66, 1.80]	< .001
Race	1.64 [0.99, 2.28]	< .001	Race	1.65 [1.00, 2.31]	< .001
English	0.73 [0.07, 1.39]	.03	English	0.72 [0.06, 1.38]	.03
Sibling Status	-0.39 [− 1.24, 0.46]	.37	Num. Sibs.	0.10 [− 0.11, 0.32]	.34
Adj R^2	.07		Adj R^2	.07	
Δ Adj R^2	< −.001		ΔAdj R^2	< −.001	
Predictor	*B* [95% CI]	*p*	Predictor	*B* [95% CI]	*p*
Age	0.07 [0.05, 0.11]	< .001	Age	0.08 [0.05, 0.11]	< .001
Gender	1.26 [0.69, 1.83]	< .001	Gender	1.25 [0.68, 1.82]	< .001
Race	1.65 [1.00, 2.30]	< .001	Race	1.61 [0.96, 2.26]	< .001
English	0.68 [0.02, 1.34]	.04	English	0.74 [0.08, 1.41]	.03
Older Sibs.	0.33 [0.06, 0.60]	.02	Younger Sibs.	-0.06 [− 0.32, 0.21]	.69
Adj R^2	.08		Adj R^2	.07	
Δ Adj R^2	.003		ΔAdj R^2	< .001	

Note. Change in adjusted R^2 reflects additional variance explained from previous model with only demographic control variables. *Race* = Same race as target. *English* = English as first language. *Num. Sibs.* = overall number of siblings. *Older Sibs.* = number of older siblings. *Younger Sibs* = number of younger siblings.

our data satisfied all assumptions. For all models we report unstandardized coefficients. We first conducted simple linear regressions examining whether our siblinghood variables predict mentalizing ability. Those who were later born tended to do better on the RMET, $B = 0.27$ (95% CI: 0.06, 0.49), $p = .01$. This is consistent with the idea that older siblings help foster social cognition. In contrast, sibling status (i.e., being an only child or not) and overall number of siblings, did not show the same prediction of mentalizing, Sibling Status: $B = 0.04$ (95% CI: −0.75, 0.85), $p = .90$; Overall Number of Siblings: $B = 0.11$ (95% CI: −0.09, 0.31), $p = .29$. These results fail to support the idea that having many siblings of any age is important for fostering social cognition in adults.

Next, we further explored the birth order effect by examining the number of older siblings and younger siblings, separately (these exploratory analyses were not pre-registered). Those who had older siblings tended to have better mentalizing, similar to birth order, $B = 0.32$ (95% CI: 0.07, 0.57), $p = .01$. However, number of younger siblings had no association with mentalizing, $B = -0.03$ (95% CI: −0.28, 0.22), $p = .82$. Collectively, these results support past work with children that it is the presence of older siblings that supports

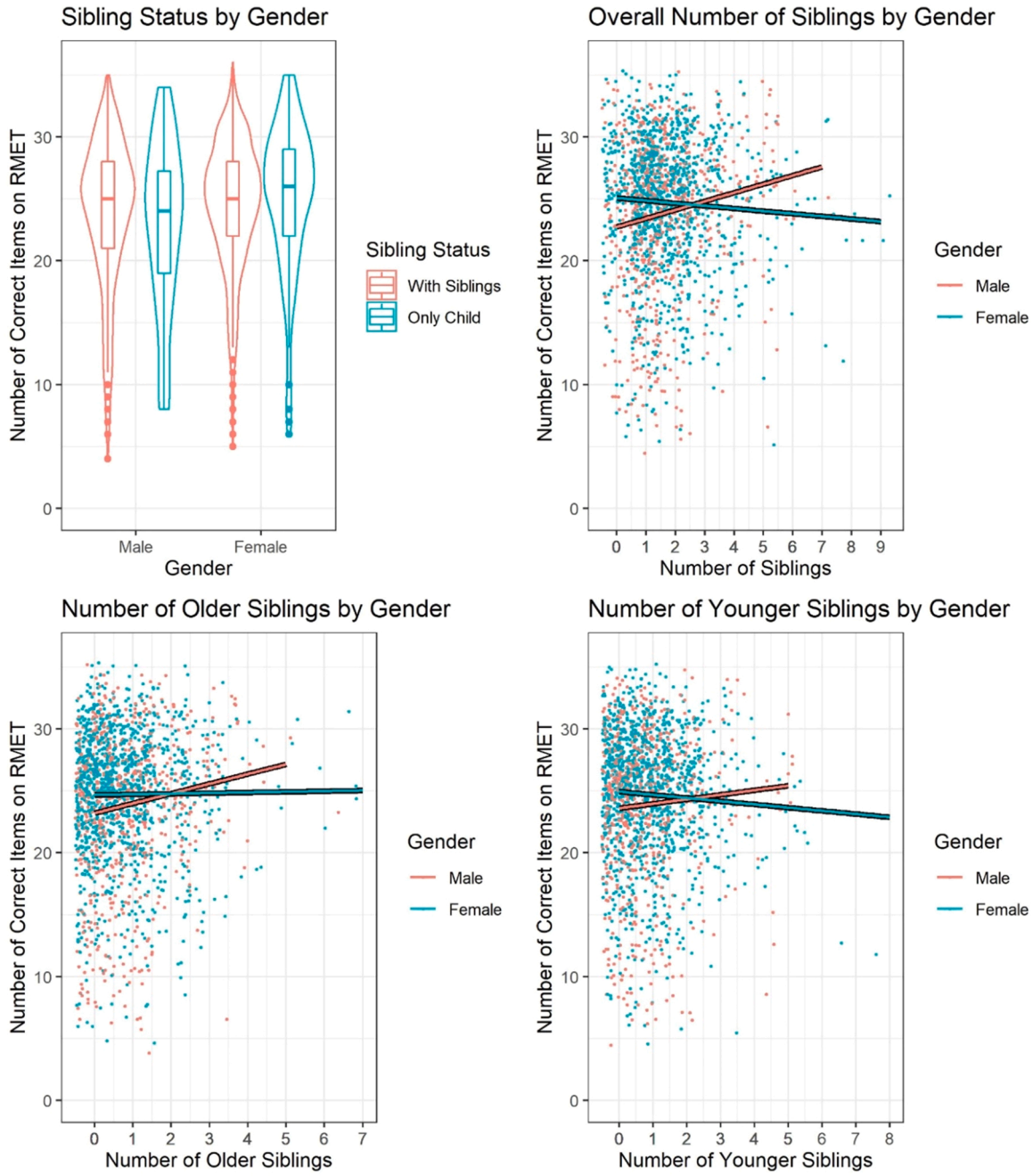

Fig. 1. Interaction Plots for Siblinghood Variables by Gender.

the development of social cognition, with no evidence that younger siblings have a similar influence.

Hierarchical regressions were next conducted, adding our control variables to examine if the observed associations persist after accounting for demographics. In Step 1, we controlled for age, gender, race, and English as a first language. These control variables explained 7% of the variance in mentalizing accuracy, with each control variable acting as a unique predictor, $R^2_{adj} = 0.07$. Individuals who were older ($B = 0.07$, [95% CI: 0.05, 0.11], $p < .001$), were the same race as the targets ($B = 1.62$ [95% CI: 0.98, 2.27], $p < .001$), female ($B = 1.24$, [95% CI: 0.67, 1.81], $p < .001$), and had English as their first language ($B = 0.74$, [95% CI: 0.08, 1.40], $p = .03$) tended to do better than those who were younger, a different race than the targets, male, and learned English as a second language, respectively. This result validates our decision to control for these demographic variables.

In Step 2, birth order was added to the model. Even after controlling for these demographic variables, birth order still acted as a unique predictor of mentalizing ability, $B = 0.30$ (95% CI: 0.07, 0.54), $p = .01$, $\Delta R^2_{adj} = 0.003$, and improved the model, χ^2 (1, $N = 1532$) = 6.48, $p = .01$. Number of older siblings was also added in a separate model, and had similar results to birth order, $B = 0.33$ (95% CI: 0.06, 0.60), $p = .02$, $\Delta R^2_{adj} = 0.003$; model improvement: χ^2 (1, $N = 1532$) = 5.76, $p = .02$. In other words, every additional older sibling is associated with a 1% increase in percent accuracy for the RMET. Our finding that those who have more older siblings perform better on this mentalizing task appears to be robust, persisting even after controlling for several relevant demographic variables. As with our simple regressions, our other siblinghood variables did not predict mentalizing ability after accounting for these control variables (Table 2).

8. Exploratory analyses

We next conducted a series of exploratory analyses, which were not pre-registered. Given previously observed gender differences in mentalizing, we explored the moderating role of gender for our main siblinghood predictors (sibling status, overall number of siblings, number of older siblings, and number of younger siblings), with respect to RMET accuracy (Fig. 1). Distribution of RMET scores by

Table 3
Exploratory Hierarchical Regressions for Moderation by Gender.

Predictor		*B* [95% CI]	*p*	Predictor		*B* [95% CI]	*p*
Step 1				Step 1			
	Age	0.08 [0.05, 0.11]	< .001		Age	0.07 [0.04, 0.10]	< .001
	Gender	0.99 [0.38, 1.59]	.001		Gender	2.39 [1.46, 3.32]	< .001
	Race	1.61 [0.96, 2.25]	< .001		Race	1.60 [0.95, 2.25]	< .001
	English	0.75 [0.09, 1.41]	.03		English.	0.76 [0.10, 1.42]	.02
Step 2				Step 2			
	Sibling Status	-1.64 [− 3.00, − 0.29]	.02		Num. Sibs.	0.55 [0.20, 0.91]	.002
Step 3				Step 3			
	Gender × Sibling Status	2.07 [0.34, 3.81]	.02		Gender × Num. Sibs.	-0.70 [− 1.14, − 0.26]	.002
Adj R^2		0.08		Adj R^2		0.08	
Δ Adj R^2		0.003		ΔAdj R^2		0.005	
Predictor		*B* [95% CI]	*p*	Predictor		*B* [95% CI]	*p*
Step 1				Step 1			
	Age	0.07 [0.04, 0.10]	< .001		Age	0.07 [0.04, 0.10]	< .001
	Gender	1.81 [1.09, 2.54]	< .001		Gender	1.55 [0.82, 2.28]	< .001
	Race	1.64 [1.00, 2.29]	< .001		Race	1.59 [0.94, 2.24]	< .001
	English	0.69 [0.03, 1.35]	.04		English	0.76 [0.10, 1.42]	.03
Step 2				Step 2			
	Older. Sibs.	0.73 [0.31, 1.16]	< .001		Younger. Sibs.	0.18 [− 0.26, 0.63]	.42
Step 3				Step 3			
	Gender × Older Sibs	-0.67 [− 1.22, − 0.13]	.02		Gender × Younger Sibs.	-0.37 [− 0.93, 0.19]	.19
Adj R^2		0.08		Adj R^2		0.07	
Δ Adj R^2		0.003		ΔAdj R^2		< .001	

Note. Adjusted R^2 reflects explained proportion of variance with all steps in the model. Change in adjusted R^2 reflects additional variance explained from Step 2 to Step 3. *English* = English as first language. *Num. Sibs.* = overall number of siblings. *Older Sibs.* = number of older siblings. *Younger Sibs.* = number of younger siblings.

gender were somewhat similar, with women scoring about 1 more item correct than men on average, Men: $M = 23.70$, $SD = 6.08$, range = 4–35; Women: $M = 24.60$, $SD = 5.27$, range = 5–36, $t(1259.2) = -3.16$, $p = .002$, $d = 0.16$ (95% CI: 0.06, 0.26).

In a multiple regression model that included gender, number of older siblings, the interaction term, and the demographic control variables, gender moderated the effect of number of older siblings on mentalizing (Table 3). The addition of this interaction term also improved the model, χ^2 (1, $N = 1532$) = 5.82, $p = .02$. Simple slope analyses, controlling for demographic variables, revealed that men with more older siblings were more accurate mentalizers than those with fewer older siblings, $B = 0.73$ (95% CI: 0.31, 1.16), $p < .001$. In contrast, the number of older siblings did not much influence mentalizing accuracy for women, $B = 0.06$ (95% CI: −0.28, 0.41), $p = 0.72$ (Fig. 1). For men, every additional older sibling is associated with a 2% increase in accuracy for the RMET, whereas for women this is associated with only a 0.2% increase.

This pattern was somewhat consistently observed for the other siblinghood variables (Fig. 1). Even after controlling for demographics variables, gender moderated the effect of sibling status and overall number of siblings (Table 3), and inclusion of the interaction terms improved the models, Gender × Sibling Status: χ^2 (1, $N = 1532$) = 5.49, $p = .02$; Gender × Overall Number of Siblings: χ^2 (1, $N = 1532$) = 9.57, $p = .002$. For the Gender × Sibling Status model, men with siblings exhibited slightly better mentalizing ability than men who are only children, with this difference falling just above threshold for statistical significance, With Siblings: $M = 23.6$, $SE = 0.3$; Only Child: $M = 22.0$, $SE = 0.6$, $t(1525) = 2.38$, $p = .08$, $d = 0.28$ (95% CI: 0.05, 0.51). This effect was substantially weaker for women, however, With Siblings: $M = 24.6$, $SE = 0.2$; Only Child: $M = 25.1$, $SE = 0.5$, $t(1525) = -0.77$, $p = .87$, $d = 0.07$ (95% CI: −0.11, 0.26). When examining moderation by gender for the overall number of siblings, having more siblings was associated with mentalizing benefits for men but not for women, Men: $B = 0.55$ (95% CI: 0.20, 0.91), $p = .002$; Women: $B = -1.45$ (95% CI: −0.41, 0.12), $p = .28$. We did not observe evidence of moderation by gender for number of younger siblings (Table 3).

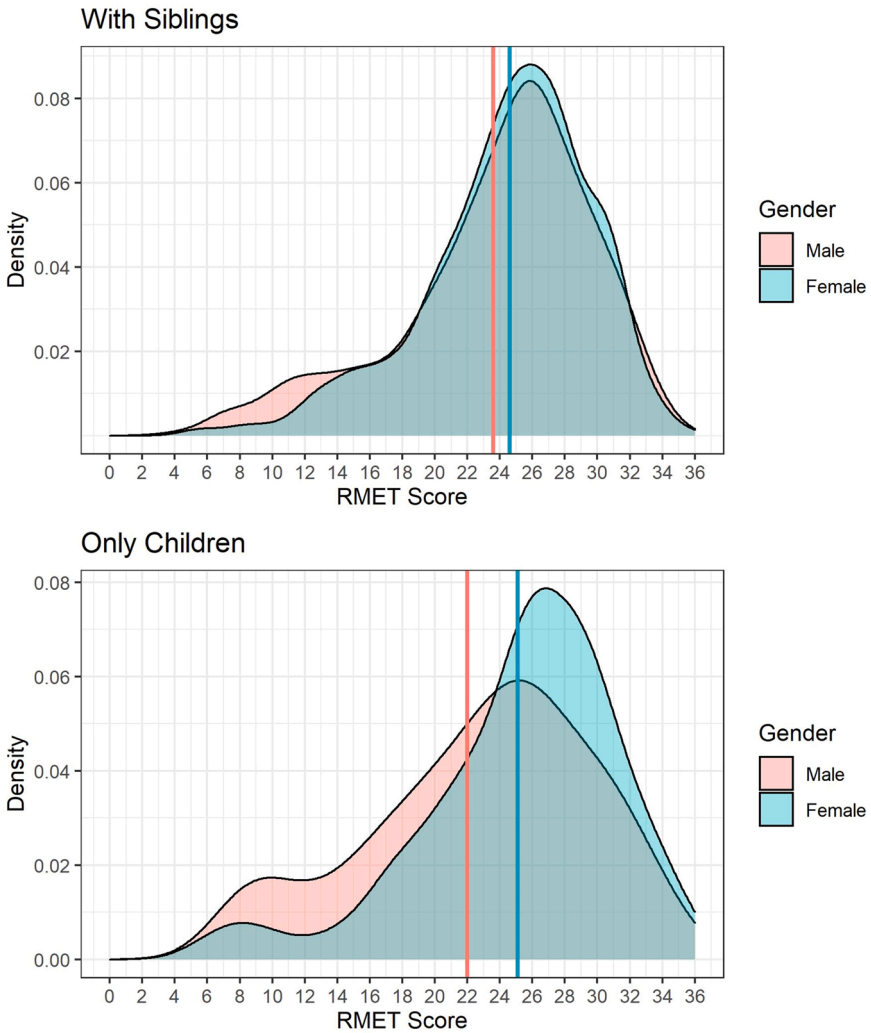

Fig. 2. Density Plots of RMET Scores by Sibling Status and Gender Note. Vertical lines indicate mean number of RMET items answered correctly after controlling for demographic variables.

Lastly, when comparing genders, women who are only children exhibited better mentalizing ability than men who are only children, scoring on average 3 more items correctly, $t(1525) = -3.68$, $p = .001$, $d = 0.52$ (95% CI: 0.24, 0.79). There was a much smaller mentalizing difference between men and women with siblings, however. In this case, women scored 1 more item correctly than men on average, $t(1525) = -3.20, p = .008, d = 0.17$ (95% CI: 0.06, 0.27). This indicates that the much remarked upon advantage that women have over men with respect to mentalizing is far more pronounced among those who are only children (Fig. 2).

9. Discussion

Our data show that mentalizing accuracy is shaped by various aspects of siblinghood, even for adults. Specifically, adults with more older siblings possess more accurate mentalizing, replicating the effect seen in children for ToM (Leblanc et al., 2017; Paine et al., 2018; Peterson, 2000). There was no other main effect for the other siblinghood variables. However, we did observe a unique moderation by gender for the other aspects of siblinghood.

Gender moderated associations with mentalizing, with the strongest effect observed for number of older siblings and overall number of siblings. In all cases, men with siblings tended to have better mentalizing (whether it was more older siblings, or more siblings overall), but women with siblings exhibited no such advantage. This provides support for the idea that men may receive greater social cognitive benefits from having siblings compared to women (Sang & Nelson, 2015). Although the number of older siblings predicts mentalizing ability across our entire sample, our follow-up analyses demonstrate that it is more likely to be men, rather than women, who benefit from having siblings. Lastly, we found that the advantage that women have in mentalizing over men is far more pronounced among only children, relative to those with siblings.

What could explain this positive influence of siblings for adult mentalizing? Presumably, adults raised as only children and those with siblings should both have experienced plenty of opportunities to develop their mentalizing abilities outside of the family (e.g., through friendships, dating, and work). One possible explanation lies in the consistent and potentially unique interactions one has with a sibling, which qualitatively changes from childhood to adulthood. For example, siblings in childhood frequently engage in pretend play, which is associated with using mental state language (e.g., talking about other people's emotions; Howe et al., 2005). Another example that is more relevant in adulthood is teaching among siblings, not only from older to younger siblings, but from younger to older siblings (Howe et al., 2017), perhaps because both older and younger siblings have opportunities to teach each other as they accrue domain expertise. Also, sibling conflict is a common mainstay of sibling relationships, with conflict more common between siblings than in other relationships (Furman & Buhrmester, 1985). Learning to navigate sibling conflict, in both childhood and adulthood, may help one anticipate and manage different viewpoints in other social relationships; this is something that only children do not experience. Managing conflict as a younger sibling may be particularly necessary, as younger siblings may experience rejection from older siblings more consistently than older siblings experiencing rejection from their younger sibling. An indirect reason for why we may observe a sibling advantage for mentalizing among adults is that siblings may increase the size of one's social network by proxy, through their friends, romantic partners, coworkers, and so forth. Siblings might also strengthen ties to family, with adults who have siblings tending to socialize more with relatives compared to only children (Trent & Spitze, 2011).

Lastly, it could well be that the childhood advantages in ToM afforded by siblings acts as a scaffold to better mentalizing in adulthood: a kind of social cognitive "Matthew effect" (Stanovich, 2009). This means that children who gain accuracy in mentalizing based on interactions with siblings early on as children, also accumulate more opportunities to socialize and practice these skills later, compared to only children. Repeated exposure to these unique socializing experiences subsequently help to fine tune these socio-cognitive mechanisms resulting in an upward spiral of better mentalizing (cf. much as with reading and verbal abilities; Mol & Bus, 2011). In this way, "the rich get richer", in terms of developing cognitive mechanisms that support social functioning, such as improved perception of social cues through gazes (Freire et al., 2004).

Although we did not predict the observed moderation by gender in advance, the fact that men benefited more from the presence of siblings is not so surprising in hindsight. Men typically have smaller social networks and are less close to their friends in adulthood, whereas women socialize more frequently and consistently, and boast larger social networks (Aukett et al., 1988; McLaughlin et al., 2010). Men's friendships tend to involve engaging in shared activities, whereas women's friendships tend to involve emotional sharing and problem-solving (Aukett et al., 1988). Women are also expected, by most societies, to demonstrate greater social understanding and empathy. All these factors might mean that women gain more practice at mentalizing, which means that the addition of siblings has little influence on these already rather well-developed skills. Men, in contrast, may have more "room to grow" when it comes to mentalizing. That said, we did not observe any evidence of a ceiling effect for women in our data.

Although women were better than men at mentalizing regardless of sibling status, the advantage women had over men was greater among only children (~3 more items correct) than among those with siblings (~1 more item correct; Fig. 2). This indicates that the vaunted advantage that women have over men with respect to social cognition is most true of only children, with this advantage much less apparent among those with siblings. Future research that examines gender differences in social cognition should control for sibling status or actively investigate it. Our sample size of only children was just large enough to test for gender differences ($n = 216$), and the field would benefit from future confirmatory data.

It is worth noting some limitations of our study. These data are correlational, which typically means that causal inferences cannot be supported. That said, in this case reverse causation is impossible: particularly empathetic children cannot motivate parents to produce older siblings (perhaps only younger ones). Moreover, potential tertiary causal variables are difficult to imagine, in light of the moderation observed. Factors such as social class (Dietze & Knowles, 2020; Kraus et al., 2010) and larger families, cannot explain why this effect would emerge for men but not for women. Lastly, only true experiments can support causal inferences and it is not feasible (ethically or practically) to randomly assign children to have siblings or remain an only child. Another limitation is that the archival

nature of our dataset does not allow us to conduct a more granular examination of sibling characteristics, such as gender constellation or age gap, and potential explanatory mediators, such as the frequency and quality of sibling interactions. Future research should directly examine potential mediators that could explain why siblinghood can benefit mentalizing, such as sibling conflict management or social network size, and why this may be particularly influential for men with siblings. As a final limitation, the effects observed were small in magnitude, which is not surprising considering the wealth of influences on adult mentalizing. That said, our effects are of the same magnitude as other well-known and notable predictors of adult social cognition (e.g., gender), and even small effects are noteworthy when associated with important outcomes (Meyer et al., 2001) such as mental inference ability. Siblinghood variables also predicted mentalizing above and beyond several relevant demographic variables (including gender), indicating that siblinghood provides incremental prediction above known predictors and should be considered when studying social cognition. It is also worth noting that our study employs a far larger sample size than is typically used for research on this topic and in social cognition in general. Our observed effect sizes thus may be a more accurate and realistic estimation of the effect of environmental factors on social cognition compared to past investigations.

In light of these results, the influence of siblings on adult social cognition would seem to be a promising topic for further research. Future work should incorporate a wide range of social cognitive measures and sample diverse populations. In addition, the possibility of a moderation by gender should also be investigated in child samples. Our own study relied on a single measure of mentalizing, that some have critiqued as possibly measuring emotion recognition instead of pure mentalizing (Oakley et al., 2016; Quesque & Rossetti, 2020). Future work should include a diversity of tasks, including others with greater ecological validity than judgements based solely on pictures of an individual's eye-region (Keysar et al., 2003; Quesque & Rossetti, 2020). That said, given the world-wide increase in mask-wearing and consequent reliance on eye-based cues due to COVID-19, the real-world validity of the RMET has likely, and unexpectedly, increased in the current context (cf. Trainin & Yeshurun, 2021). Lastly, our sample was primarily composed of undergraduate students, although more ethnically diverse than a typical undergraduate sample. This means that the relatively homogenous and privileged nature of our sample may have led to an attenuated estimate of the influence of siblings. Subsequent research on this topic should examine participants from diverse backgrounds, social statuses, and ages.

In closing, our study demonstrates that the siblinghood effect on social cognition extends beyond childhood and into adulthood, and also varies depending on gender. Our statistically conservative approach, controlling for other relevant predictors, shows that this effect is surprisingly robust. Growing up with a sibling, as opposed to being an only child, does not only matter for the social abilities of children, but also matters for adults.

Author note

We have no conflicts of interest to disclose. The data are not publicly available due to ethical restrictions, but they are promptly available upon request from the corresponding author.

Data Availability

Data will be made available on request.

References

Adams, R. B., Jr., Rule, N. O., Franklin, R. G., Jr., Wang, E., Stevenson, M. T., Yoshikawa, S., … Ambady, N. (2010). Cross-cultural reading the mind in the eyes: An fMRI investigation. *Journal of Cognitive Neuroscience, 22*, 97–108. https://doi.org/10.1162/jocn.2009.21187

Apperly, I. (2012). What is "theory of mind"? Concepts, cognitive processes and individual differences, 2006 *Quarterly Journal of Experimental Psychology, 65*(5), 825–839. https://doi.org/10.1080/17470218.2012.676055.

Aukett, R., Ritchie, J., & Mill, K. (1988). Gender differences in friendship patterns. *Sex Roles, 19*, 57–66. https://doi.org/10.1007/BF00292464

Azmitia, M., & Hesser, J. (1993). Why siblings are important agents of cognitive development: A comparison of siblings and peers. *Child Development, 64*(2), 430–444. https://doi.org/10.2307/1131260

Baker, C. A., Peterson, E., Pulos, S., & Kirkland, R. A. (2014). Eyes and IQ: A meta-analysis of the relationship between intelligence and "Reading the Mind in the Eyes". *Intelligence, 44*, 78–92. https://doi.org/10.1016/j.intell.2014.03.001

Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y., & Plumb, I. (2001). The "Reading the Mind in the Eyes" Test revised version: A study with normal adults, and adults with Asperger syndrome or high-functioning autism. *Journal of Child Psychology and Psychiatry, and Allied Disciplines, 42*(2), 241–251. https://doi.org/10.1111/1469-7610.00715

Bayliss, A., Pellegrino, G., & Tipper, S. (2005). Sex differences in eye gaze and symbolic cueing of attention. *The Quarterly Journal of Experimental Psychology A, Human Experimental Psychology, 58*(4), 631–650. https://doi.org/10.1080/02724980443000124

Bjornsdottir, R., & Rule, N. (2016). On the relationship between acculturation and intercultural understanding: Insight from the Reading the Mind in the Eyes test. *International Journal of Intercultural Relations, 52*, 39–48. https://doi.org/10.1016/j.ijintrel.2016.03.003

Brown, J. R., Donelan-McCall, N., & Dunn, J. (1996). Why talk about mental states? The significance of children's conversations with friends, siblings, mothers. *Child Development, 67*(3), 836–849. https://doi.org/10.2307/1131864

Calero, C. I., Salles, A., Semelman, M., & Sigman, M. (2013). Age and gender dependent development of theory of mind in 6- to 8-years old children. *Frontiers in Human Neuroscience, 7*, 281. https://doi.org/10.3389/fnhum.2013.00281

Carpenter, J. M., Green, M. C., & Vacharkulksemsuk, T. (2016). Beyond perspective-taking: Mind-reading motivation. *Motivation and Emotion, 40*(3), 358–374. https://doi.org/10.1007/s11031-016-9544-z

Cassidy, K. W., Fineberg, D. S., Brown, K., & Perkins, A. (2005). Theory of mind may be contagious, but you don't catch it from your twin. *Child Development, 76*(1), 97–106. https://doi.org/10.1111/j.1467-8624.2005.00832.x

Devine, R. T., & Hughes, C. (2018). Family correlates of false belief understanding in early childhood: A meta-analysis. *Child Development, 89*(3), 971–987. https://doi.org/10.1111/cdev.12682

Dietze, P., & Knowles, E. D. (2020). Social class predicts emotion perception and perspective-taking performance in adults. *Personality and Social Psychology Bulletin, 47*(1), 42–56. https://doi.org/10.1177/0146167220914116

Domes, G., Heinrichs, M., Michel, A., Berger, C., & Herpertz, S. C. (2007). Oxytocin improves "mind-reading" in humans. *Biological Psychiatry, 61*(6), 731–733. https://doi.org/10.1016/j.biopsych.2006.07.015

Dunn, J., Brown, J., Slomkowski, C., Tesla, C., & Youngblade, L. (1991). Young children's understanding of other people's feelings and beliefs: Individual differences and their antecedents. *Child Development, 62*(6), 1352–1366. https://doi.org/10.2307/1130811

Elfenbein, H. A., & Ambady, N. (2003). Universals and cultural differences in recognizing emotions. *Current Directions in Psychological Science, 12*(5), 159–164. https://doi.org/10.1111/1467-8721.01252

Fernández-Abascal, E. G., Cabello, R., Fernández-Berrocal, P., & Baron-Cohen, S. (2013). Test-retest reliability of the 'Reading the Mind in the Eyes' test: A one-year follow-up study. *Molecular Autism, 4*(3). https://doi.org/10.1186/2040-2392-4-33

Flavell, J. H. (1999). Cognitive development: Children's knowledge about the mind. *Annual Review of Psychology, 50*, 21–45. https://doi.org/10.1146/annurev.psych.50.1.21

Freire, A., Eskritt, M., & Lee, K. (2004). Are eyes windows to a deceiver's soul? Children's use of another's eye gaze cues in a deceptive situation. *Developmental Psychology, 40*(6), 1093–1104. https://doi.org/10.1037/0012-1649.40.6.1093

Frith, U., & Frith, C. D. (2003). Development and neurophysiology of mentalizing. *Philosophical Transactions of the Royal Society of London Series B: Biological Sciences, 358*(1431), 459–473. https://doi.org/10.1098/rstb.2002.1218

Furman, W., & Buhrmester, D. (1985). Children's perceptions of the personal relationships in their social networks. *Developmental Psychology, 21*(6), 1016–1024. https://doi.org/10.1037/0012-1649.21.6.1016

Hall, J. K., Hutton, S. B., & Morgan, M. J. (2010). Sex differences in scanning faces: Does attention to the eyes explain female superiority in facial expression recognition? *Cognition and Emotion, 24*(4), 629–637. https://doi.org/10.1080/02699930902906882

Howe, N., Della Porta, S., Recchia, H., Funamoto, A., & Ross, H. (2015). "This bird can't do it 'cause this bird doesn't swim in water": Sibling teaching during naturalistic home observations in early childhood. *Journal of Cognition and Development, 16*(2), 314–332. https://doi.org/10.1080/15248372.2013.848869

Howe, N., Della Porta, S., Recchia, H., & Ross, H. (2017). "Because if you don't put the top on it will spill": A cross sectional and longitudinal study of sibling teaching in early childhood. *Developmental Psychology, 52*(11), 1832–1842. https://doi.org/10.1037/dev0000193

Howe, N., Petrakos, H., Rinaldi, C. M., & LeFebvre, R. (2005). "This is a bad dog, you know…": Constructing shared meanings during sibling pretend play. *Child Development, 76*(4), 783–794. https://doi.org/10.1111/j.1467-8624.2005.00877.x

Howe, N., Ross, H., & Recchia, H. (2011). Sibling relations in early childhood. In P. K. Smith, & C. H. Hart (Eds.), *Wiley-Blackwell Handbook of Childhood Social Development* (2nd ed..,, pp. 356–372). New York: Wiley.

Insel, T. R. (2010). The challenge of translation in social neuroscience: A review of oxytocin, vasopressin, and affiliative behavior. *Neuron, 65*(6), 768–779. https://doi.org/10.1016/j.neuron.2010.03.005

Kennedy, K., Lagattuta, K. H., & Sayfan, L. (2015). Sibling composition, executive function, and children's thinking about mental diversity. *Journal of Experimental Child Psychology, 132*, 121–139. https://doi.org/10.1016/j.jecp.2014.11.007

Keysar, B., Lin, S., & Barr, D. J. (2003). Limits on theory of mind use in adults. *Cognition, 89*(1), 25–41. https://doi.org/10.1016/S0010-0277(03)00064-7

Khorashad, B. S., Baron-Cohen, S., Roshan, G. M., Kazemian, M., Khazai, L., Aghili, Z., … Afkhamizadeh, M. (2015). The "Reading the Mind in the Eyes" test: Investigation of psychometric properties and test–retest reliability of the persian version. *Journal of Autism and Developmental Disorders, 45*(9), 2651–2666. https://doi.org/10.1007/s10803-015-2427-4

Kirkland, R. A., Peterson, E., Baker, C. A., Miller, S., & Pulos, S. (2013). Meta-analysis reveals adult female superiority in "reading the mind in the eyes" test. *North American Journal of Psychology, 15*(1), 121–146.

Kittel, A., Olderbak, S., & Wilhelm, O. (2021). Sty in the mind's eye: A meta-analytic investigation of the nomological network and internal consistency of the "reading the mind in the eyes" test. *Assessment, 1073191121996469 Advance Online Publication*. https://doi.org/10.1177/1073191121996469

Kraus, M. W., Côté, S., & Keltner, D. (2010). Social class, contextualism, and empathic accuracy. *Psychological Science, 21*(11), 1716–1723. https://doi.org/10.1177/0956797610387613

Leblanc, E., Bernier, A., & Howe, N. (2017). The more the merrier? Sibling composition and early manifestations of theory of mind in toddlers. *Journal of Cognition and Development, 18*(3), 375–391. https://doi.org/10.1080/15248372.2017.1327438

Lewis, C., Freeman, N. H., Kyriakidou, C., Maridaki-Kassotaki, K., & Berridge, D. M. (1996). Social influences on false belief access: Specific sibling influences or general apprenticeship? *Child Development, 67*(6), 2930–2947. https://doi.org/10.1111/j.1467-8624.1996.tb01896.x

McAlister, A., & Peterson, C. (2007). A longitudinal study of child siblings and theory of mind development. *Cognitive Development, 22*(2), 258–270. https://doi.org/10.1016/j.cogdev.2006.10.009

McClure, E. B. (2000). A meta-analytic review of sex differences in facial expression processing and their development in infants, children, and adolescents. *Psychological Bulletin, 126*(3), 424–453. https://doi.org/10.1037/0033-2909.126.3.424

McLaughlin, D., Vagenas, D., Pachana, N. A., Begum, N., & Dobson, A. (2010). Gender differences in social network size and satisfaction in adults in their 70s. *Journal of Health Psychology, 15*(5), 671–679. https://doi.org/10.1177/1359105310368177

Meyer, G. J., Finn, S. E., Eyde, L. D., Kay, G. G., Moreland, K. L., Dies, R. R., … Reed, G. M. (2001). Psychological testing and psychological assessment: A review of evidence and issues. *American Psychologist, 56*(2), 128–165. https://doi.org/10.1037/0003-066X.56.2.128

Mol, S. E., & Bus, A. G. (2011). To read or not to read: A meta-analysis of print exposure from infancy to early adulthood. *Psychological Bulletin, 137*(2), 267–296. https://doi.org/10.1037/a0021890

Oakley, B. F. M., Brewer, R., Bird, G., & Catmur, C. (2016). Theory of mind is not theory of emotion: A cautionary note on the reading the mind in the eyes test. *Journal of Abnormal Psychology, 125*(6), 818–823. https://doi.org/10.1037/abn0000182

Paine, A. L., Pearce, H., van Goozen, S. H. M., de Sonneville, L. M. J., & Hay, D. F. (2018). Late, but not early, arriving younger siblings foster firstborns' understanding of second-order false belief. *Journal of Experimental Child Psychology, 166*, 251–265. https://doi.org/10.1016/j.jecp.2017.08.007

Perner, J., Ruffman, T., & Leekam, S. R. (1994). Theory of mind is contagious: You catch it from your sibs. *Child Development, 65*(4), 1228–1238. https://doi.org/10.2307/1131316

Persram, R. J., Della Porta, S., Scirocco, A., Howe, N., & Ross, H. S. (2019a). A 2-year longitudinal study of naturalistic parent-child- and sibling-originated polyadic conflicts. *Merrill-Palmer Quarterly, 65*(4), 377–401. https://doi.org/10.13110/merrpalmquar1982.65.4.0377

Persram, R. J., Scirocco, A., Della Porta, S., & Howe, N. (2019b). Moving beyond the dyad: Broadening our understanding of family conflict. *Human Development, 63*, 38–70. https://doi.org/10.1159/000501880

Peterson, C. (2000). Kindred spirits: Influences of siblings' perspectives on theory of mind. *Cognitive Development, 15*(4), 435–455. https://doi.org/10.1016/S0885-2014(01)00040-5

Phillips, L. H., MacLean, R. D. J., & Allen, R. (2002). Age and the understanding of emotions: Neuropsychological and sociocognitive perspectives. *The Journals of Gerontology: Series B: Psychological Sciences and Social Sciences, 57*(6), P526–P530. https://doi.org/10.1093/geronb/57.6.P526

Quesque, F., & Rossetti, Y. (2020). What do theory-of-mind tasks actually measure? Theory and practice. *Perspectives on Psychological Science, 15*(2), 384–396. https://doi.org/10.1177/1745691619896607

R Core Team (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Ross, H. S. (1996). Negotiating principles of entitlement in sibling property disputes. *Developmental Psychology, 32*(1), 90–101. https://doi.org/10.1037/0012-1649.32.1.90

RStudio Team (2020). RStudio: Integrated Development Environment for R. RStudio, PBC, Boston, MA URL http://www.rstudio.com/.

Ruffman, T., Murray, J., Halberstadt, J., & Taumoepeau, M. (2010). Verbosity and emotion recognition in older adults. *Psychology and Aging, 25*(2), 492–497. https://doi.org/10.1037/a0018247

Ruffman, T., Perner, J., Naito, M., Parkin, L., & Clements, W. (1998). Older (but not younger) siblings facilitate false belief understanding. *Developmental Psychology, 34*(1), 161–174. https://doi.org/10.1037/0012-1649.34.1.161

Sang, S. A., & Nelson, J. A. (2015). The effect of siblings on children's social skills and perspective taking. *Infant and Child Development, 26*(6), Article e2023. https://doi.org/10.1002/icd.2023

Segal, A., Howe, N., Persram, R. J., Martin-Chang, S., & Ross, H. S. (2018). "I'll show you how to write my name": The contribution of naturalistic sibling teaching to the home literacy environment. *Reading Research Quarterly, 53*(4), 391–404. https://doi.org/10.1002/rrq.199

Stanovich, K. E. (2009). Matthew effects in reading: Some consequences of individual differences in the acquisition of literacy. *Journal of Education, 189*(1–2), 23–55. https://doi.org/10.1177/0022057409189001-204

Trainin, N., & Yeshurun, Y. (2021). Reading the mind with a mask? Improvement in reading the mind in the eyes during the COVID-19 pandemic. *Emotion, 21*(8), 1801–1806. https://doi.org/10.1037/emo0001014

Trent, K., & Spitze, G. (2011). Growing up without siblings and adult sociability behaviors. *Journal of Family Issues, 32*(9), 1178–1204. https://doi.org/10.1177/0192513×11398945

Warrier, V., Bethlehem, R. A., & Baron-Cohen, S. (2017). The "Reading the Mind in the Eyes" Test (RMET). In V. Zeigler-Hill, & T. Shackelford (Eds.), *Encyclopedia of Personality and Individual Differences*. Cham: Springer. https://doi.org/10.1007/978-3-319-28099-8_549-1.

Wu, S., & Keysar, B. (2007). The effect of culture on perspective taking. *Psychological Science, 18*(7), 600–606. https://doi.org/10.1111/j.1467-9280.2007.01946.x