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Sibling cognitive sensitivity as a moderator of the relationship between sibship size and children's theory of mind: A longitudinal analysis

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ABSTRACT

Inconsistent findings regarding the association between sibship size (i.e., number of children in the home) and children's theory of mind led us to hypothesize a moderating role for quality of sibling interactions. In line with a parental resource dilution framework, it was expected that coming from a large sibship (3+ children) would be associated with lower theory of mind scores in the absence of a cognitively sensitive older sibling. Data were collected from 385 children and their next in age older siblings: at Time 1 children were 3.15 years ($SD = 0.27$) and their older siblings were 5.57 years ($SD = 0.77$). Children were, on average, 1.65 years older at Time 2. A longitudinal design, wherein theory of mind (Time 2) was predicted while controlling for earlier theory of mind (Time 1), was used to support directionality of effects. Results indicated that sibship size was negatively related to theory of mind at low but not high levels of sibling cognitive sensitivity. Findings suggest a compensatory role for cognitively sensitive older siblings in large families and highlight the need to consider process-based features of sibships.

A child's ability to represent their own and others' mental states and identify how they relate to behavior is critical to their ability to engage in meaningful social exchanges. Preschool represents a developmental period of substantial growth in mental state understanding and, despite a similar trajectory of development in typically developing children, individual differences in the speed of attainment are evident (Hughes et al., 2005; Wellman & Woolley, 1990). Different accounts for observed variability in theory of mind (ToM) development have been offered, including child- (e.g., language and executive functioning; Astington, 2001; Hughes & Ensor, 2005) and family-level (e.g., social disadvantage; Cutting & Dunn, 1999), as well as genetic (Hughes & Cutting, 1999) influences.

Children's social understanding is constructed within social interactions (Carpendale & Lewis, 2004; Fernyhough, 2008). Given that siblings afford children with heightened exposure to social contexts related to social-cognitive growth (i.e., pretend play, conflict, conversations; Dunn, 2002), there has been interest in children's ToM development in the context of their sibling environments. Perner, Ruffman, and Leekam (1994), as well as Jenkins and Astington (1996), showed a linear progression in false belief understanding with increasing sibship size (i.e., number of children in the home), suggesting that children learn about the effects of beliefs on behavior through interactions involving siblings. Since that time, however,

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findings with respect to sibship size and ToM have been inconsistent. Some studies indicate that it is older and not younger siblings that are particularly important for children's ToM (Ruffman, Perner, Naito, Parkin, & Clements, 1998; McAlister & Peterson, 2013), while others suggest that the effect lies in the presence of more knowledgeable partners (e.g., older peers, parents, grandparents) rather than older siblings specifically (Lewis, Freeman, Kyriakidou, Maridaki-Kassotaki, & Berridge, 1996). Some studies have suggested that exposure to child-like minds (i.e., ages 12 months to 12 years) accounts for the sibling advantage rather than the total number of older and younger siblings in the household (Cassidy, Fineberg, Brown, & Perkins, 2005; McAlister & Peterson, 2007; Peterson, 2000). Finally, there are studies that have failed to show any advantage of having siblings in ToM development (Arranz, Artamendi, Olabarrieta, & Martin, 2002; Carlson & Moses, 2001; Hughes & Ensor, 2005; Pears & Moses, 2003; Peterson & Slaughter, 2003), and others that have indicated a disadvantage of having siblings (Cole & Mitchell, 2000; Tompkins, Farrar, & Guo, 2013). Thus, the current status of the association between sibship size and children's ToM abilities remains unclear.

Previous studies on this topic have focused on the structural features of sibships, which may be contributing to the observed inconsistencies in the literature (Arranz et al., 2002; Cutting & Dunn, 1999; Dunn, 2002). Assessing mere exposure to social input is not sufficient, as it is not just the amount but also the nature of children's social interactions that influence children's mental state understanding (Carpendale & Lewis, 2004; Dunn, 2002). For instance, affective quality is an important feature of social exchanges, functioning as it does to promote engagement, conversation and further interaction (Carpendale & Lewis, 2004). Additionally, cognitively-attuned input assists children in their internalization of social interactions, a key process in children's ToM development (Fernyhough, 2008). Indeed, sensitive qualities of parental behavior (i.e., affectionate and cognitively-attuned) have been linked to gains in children's social understanding (Laranjo, Bernier, Meins, & Carlson, 2010; Meins et al., 2002; Stevens, 2008).

Given the evidence for the relationship between cognitively-attuned and positively valenced input and children's ToM found in the parenting literature, the current study sought to look at sibling sensitivity as a potential moderator of the relationship between sibship size and ToM. Typical processes explored in sibling dyads include affective quality (Dunn, Slomkowski, & Beardsall, 1994), teaching and scaffolding behaviour (e.g., Howe & Recchia, 2009; Klein, Feldman, & Zarur, 2002), as well as provision of mind-related input such as internal state talk (e.g., Dunn, Brown, Slomkowski, Tesla, & Youngblade, 1991; Howe, Petrakos, & Rinaldi, 1998; Jenkins, Turrell, Kogushi, Lollis, & Ross, 2003). Previously, a measure called *cognitive sensitivity* was developed to gauge the extent to which social partners (i.e., parents and siblings) engage in behaviours that promote the development of children's social and cognitive development (Prime et al., 2015; Prime, Perlman, Tackett, & Jenkins, 2014). The measure integrates elements of affective (i.e., positively valenced turn-taking), communicative (i.e., provision of readily understandable information) and mind-reading (i.e., assessing and responding to verbal and nonverbal cues) behavior to measure partner sensitivity to children's inferred cognitive states. There is demonstrated variability in the extent to which siblings can identify and sensitively respond to children's levels of cognitive functioning (Prime, Perlman et al., 2014). The current study utilized this measure to index a potential moderating factor.

In thinking about the ways in which the relationship between sibship size and ToM development might change as a function of sibling cognitive sensitivity, it is useful to consider the larger literature on sibship size and children's cognitive development. Children growing up with siblings have been shown to demonstrate poorer language skills, IQ, and academic achievement (Downey, 1995, 2001; Zubrick, Taylor, Rice & Slegers, 2007). This pattern of findings has been explained primarily through a process of resource dilution; as families grow, a finite amount of parental resources (both economic and interpersonal) are diluted so that each individual child receives less from their parents (Downey, 1995, 2001; Lawson & Mace, 2009). There is evidence to suggest that sensitive older siblings can compensate for this effect. In a recent study, children from large sibships were at risk for poor receptive vocabulary development when they had siblings with low levels of sensitivity. This effect was not observed in children whose siblings were high in sensitivity (Prime, Pauker, Plamondon, Perlman, & Jenkins, 2014). We would expect a similar pattern in ToM development, given the significant behavioural overlap between ToM and other measures of cognitive development, including language (Wade, Browne, Plamondon, Daniel, & Jenkins, 2015). That is, children with more siblings may be at risk for poor development of ToM, by way of diluted parental resources, if they do not have older siblings who themselves engage in ToM-promoting (i.e., sensitive) behaviours. Older siblings, in particular, are better able to respond sensitively to their preschool sibling's inferred mental states than younger siblings. This is likely related to their older age and, thus, heightened skill-set (Prime, Perlman et al., 2014), and/or the power differential inherent to sibling dyads (Perlman, Siddiqui, Ram, & Ross, 2000). Thus, we were interested in looking at older, as opposed to younger, siblings' cognitive sensitivity as a potential moderating factor.

It was hypothesized that coming from a larger sibship (i.e., 3+ children) would be associated with lower ToM. However, we expected that this would be qualified by an interaction between sibship size and older sibling cognitive sensitivity; children from larger sibships will show enhanced ToM when they have older siblings with high versus low levels of cognitive sensitivity. That is, siblings with high levels of cognitive sensitivity will play a compensatory role in large sibships.

1. Current study

The current study utilized a longitudinal design to investigate older sibling cognitive sensitivity as a moderator of the relationship between sibship size and preschool children's ToM development. Previous studies on siblings and theory of mind have been primarily cross-sectional (with some exceptions; McAlister & Peterson, 2007, 2013). A longitudinal design was used to allow for the direction of effect between predictors and the outcome to be disambiguated. This facilitates a stronger conclusion about causality than is possible using a cross-sectional design.

A number of further considerations informed the study design. First, past studies exploring sibship size and ToM have exclusively compared only children to varying sibship sizes. Given that the large majority of individuals grow up with one or more siblings, and that our question related to sibling interactions, the current study explored the phenomenon in children that had at least one older sibling. Thus, we compared children from 2-child families ("small sibships") to those from families with 3+ children ("large sibships"). Second, we only observed interactions between target children and their next in age older siblings, as opposed to all older siblings in the home, to reduce burden on families. The next in age older sibling was chosen as a way to standardize across small and large sibships (i.e., children from small sibships *only* have a next in age older sibling). Third, in defining sibship size, we sought to capture the parental resource dilution process that has been documented with increasing family size (Lawson & Mace, 2009). To do this, we included all children in the home less than 18 years old to index all sources of potential resource dilution. This is in line with the majority of previous studies examining the relationship between sibship size and cognitive, linguistic and/or ToM outcomes (e.g., Harrison & McLeod, 2010; Tompkins et al., 2013; Wright & Mahfoud, 2012). Supplemental analyses were conducted controlling for the number of child-aged siblings (i.e., 12 months–12 years), as some studies have found this to be an important indicator in the relationship between sibship size and children's ToM (Cassidy et al., 2005; McAlister & Peterson, 2007; Peterson, 2000).

Data from two home visits were used in the current study. Specifically, in the first visit, we videotaped 385 preschool children interacting with their next in age older siblings during a collaboration task and subsequently coded the interactions for the level of cognitive sensitivity displayed by the older siblings. Additionally, children were directly assessed on a previously validated assessment of ToM (Wellman & Liu, 2004) at both home visits. Standard regression analyses were used to explore the associations of sibship size and sibling cognitive sensitivity to later ToM, controlling for earlier levels of ToM.

A number of additional measures were obtained during the home visits and were included in the analysis as covariates for theoretical and methodological reasons. First, we controlled for socioeconomic status as this has been shown to be associated with ToM (Cutting & Dunn, 1999). Child gender was included, as females have been previously documented as outperforming males on ToM (Charman, Ruffman, & Clements, 2002; Cutting & Dunn, 1999). Further, families varied in the age spacing of target children to their next in age older siblings, as well as the age spread of the entire sibship, and thus sibling age-related factors were included to standardize across diverse family structures. Maternal sensitivity to children's internal states has previously been linked to children's ToM (Meins et al., 2002). A measure of maternal sensitivity, based on videotaped observations of mother-child interactions, was included to allow us to isolate the relationship between sibling behavior and children's ToM. Further, given that children's development of language and ToM are intricately connected (Astington & Baird, 2005), we included a measure of children's language skills (i.e., receptive vocabulary) and controlled for the ethnic diversity in the sample (as a proxy for home language exposure). Finally, we controlled for older sibling ToM scores so that we could isolate the effect of older sibling behaviour from that associated with older sibling ToM. Inclusion of these covariates allowed us to draw conclusions about the specific processes occurring between siblings and their relationship to theory of mind.

2. Methods

2.1. Original sample

The sample used in the current study is a subset of the Kids, Families, and Places (KFP) study, which is a longitudinal birth cohort study examining biological and social influences on early socio-emotional development using a within-family design. Recruitment occurred through the *Healthy Babies Healthy Children* program (Toronto and Hamilton Public Health), which contacts the parents of all newborn babies within days of the newborn's birth. Inclusion criteria included families having a newborn singleton (termed 'target child') > 1500 g, with an older sibling within four years of the newborn (termed 'next in age older sibling'). Additional criteria included English-speaking mothers who agreed to be videotaped. Five-hundred and one families were enlisted into the KFP study (reasons for non-enlistment included inability to contact families, families not meeting criteria and refusals). Children were approximately 2 months old at Wave 1 and these families were followed up at ages 18 months, 3 years and 4.5 years. All data were collected during home visits. Observational data and direct testing were carried out on the target child and the next in age older sibling at all waves. The KFP sample was similar to the general population of Toronto and Hamilton in terms of number of persons in the household and personal income, but had a lower proportion of non-intact families, fewer immigrants and more educated mothers (Meunier, Boyle, O'Connor, & Jenkins, 2013).

2.2. Current study

Data came from the third and fourth waves of the larger study. Attrition from the first to third wave was 23.2%. Dropout was significantly related to indices of social disadvantage, which is typical for longitudinal studies (Stouthamer-Loeber & Van Kammen, 1995): lower income/assets, $t(470) = -2.69$, $p < 0.001$, lower maternal education, $t(498) = -2.88$, $p < 0.05$, younger maternal age of first pregnancy, $t(494) = -3.89$, $p < 0.001$, and ethnicity, $\chi^2\ (1) = 7.27$, $p < 0.05$. These variables were included in the data analysis as covariates or auxiliary variables. Henceforth, the third and fourth wave will be referred to as Time 1 and Time 2, respectively, for the purposes of the current study. Data included demographic questionnaire measures from mothers, child testing of receptive vocabulary and theory of mind, and videos of mother-child and sibling interactions during the home visit. The full sample at Time 1 consisted of 385 children and their older siblings. Of the participating families, 60.8% had two children living in the home; the remainder had three or more children in the home. For the purposes of this study, sibship size (i.e., the number of children aged 0 < 18 in the household) was recoded as a dummy variable with small sibships as the reference category (0 = 2 children in the home; 1 = 3+ children). The mean age of target children was 3.15 years (*SD* = 0.27; range = 2.5–4.5) and 51.7% were male. The mean age of their next in age older siblings was 5.57 years (*SD* = 0.77; range = 4.0–7.67) and 51.2% were male. Children were on average 1.65 years older at Time 2. The sample was diverse; 57.1% of mothers were European, 13.0% were East/South East Asian, 14.0% were South Asian, and 7.0% were Black (8.8% were classified as 'Other'). Families reported their income based on predetermined ranges; the mean family income was in the range of $65,000–$74,999.

2.3. Measures

2.3.1. Older sibling cognitive sensitivity (T1)

Sibling pairs were filmed engaging in a cooperative building task (Aguilar et al., 2001Aguilar, O'Brien, August, Aoun, & Hektner, 2001). Dyads were instructed to sit on a yoga mat and use Duplo building blocks to replicate a design presented in a picture in five minutes. Each sibling was only allowed to touch two of the four colours of Duplo blocks to promote collaboration for completion. If children finished the design before the end of five minutes, they were given a second model to replicate. All children were stopped after five minutes, regardless of completion.

Videotapes of sibling interactions were coded using a measure of cognitive sensitivity, defined as the three inter-linked capacities of mind-reading, mutuality, and communicative clarity (Prime, Perlman et al., 2014). Individuals who score higher on the scale are considered to be more adept at providing cognitively-attuned input to their partners; that is, picking up on the cues of the child and adjusting their own verbal and nonverbal behavior to accommodate the child's cognitive needs. In addition to this cognitive attunement, individuals who score high on the scale demonstrate a positively valenced interaction style. An emphasis was placed on both the affective quality and cognitive attunement of partners' behaviours, as such qualities promote cooperative interactions that facilitate socio-cognitive growth (Carpendale & Lewis, 2004). Coders watched the 5-minute film clip in its entirety and then rated the older sibling on a 5-point likert scale, ranging from 'Not at all true' (1) to 'Very true' (5) on eleven cognitive sensitivity statements. Items started with 'This person is...' and examples included: sensitive to what his/her partner knows and/or understands; good at rephrasing what his/her partner does not understand; gives positive feedback to reinforce his/her partner; clear in his/her requests for help (a full list is available from Prime, Perlman et al., 2014). The mean was taken across items and internal consistency of the composite was $\alpha = 0.89$ (item–total correlations ranged from 0.43 to 0.79). The cognitive sensitivity scale has been previously demonstrated to have good convergent validity (Prime, Perlman et al., 2014). The coding approach presented in the current paper provides comparable psychometric properties to a more time intensive observational coding method while reducing resources (Ambady, 2010; Prime, Perlman et al., 2014).

An expert coder (first author) trained two coders to criterion with the expert ($\alpha > 0.80$), at which point they coded all remaining videos independently. Inter-rater reliability with the expert coder was checked regularly to prevent coder drift. Inter-rater reliability was tested using Cronbach's alpha (Cronbach, Rajaratnman, & Gleser, 1963), with a final estimate (based on 10% overlap in videotapes independently coded) of $\alpha = 0.72$. All coders were blind to the hypotheses of the study.

2.3.2. Target child and older sibling theory of mind

At Time 1, target children's and older siblings' ToM scores were included in the model as covariates. At Time 2, target children's ToM was used as the dependent variable. The scale described by Wellman and Liu (2004) was used to measure ToM. This scale presents a series of ToM tasks ordered in terms of difficulty: diverse desires and beliefs, knowledge access, contents false-belief, explicit false belief, belief-based emotion, and real-apparent emotion. For all ToM tasks, stories were enacted for children with the use of toy figures and picture cards. For the diverse desires task, children answered a target question that required them to distinguish between their own desires (e.g., cookies) and that of a toy doll (e.g., carrots). On the belief-based emotion task, children answered a target question that required them to understand that a toy doll's emotions stem from their beliefs; that is, that the toy will be happy when they get their favourite snack (i.e., a box of cereal) and sad when they see that it's not really cereal (i.e., a cereal box full of rocks). For descriptions of other items, see Wellman and Liu (2004). For each of the tasks, the child was given a score of 0 (fail) or 1 (pass). Testing was discontinued and final scores were calculated once children failed two consecutive tasks, based on the Guttman scaling analysis presented by Wellman and Liu (2004) for the ToM measure used in the current study. A mean was taken across tasks at each of Time 1 and Time 2 for target children, and at Time 1 for next in age older siblings. To carefully control for children's age in the calculation of their ToM scores at each time point, the mean ToM score was regressed on age and the standardized residuals were saved and used as the final ToM score.[1]

[1] Analyses were conducted both with the age-residualized ToM scores as well as with the raw ToM scores (with and without age as a covariate). Results went unchanged and the age-residualized scores were used for the final analysis.

Table 1
Descriptive statistics and bivariate correlations for study variables and selected covariates.

Variable (scale)	2.	3.	4.	5.	6.	n	Mean (SD)
1. Child ToM T1 (0–7)	.18***	0.02	.15***	.26***	.12**	356	1.39 (0.90)
2. Child ToM T2 (0–7)		.22***	.23***	.35***	.15**	268	3.62 (1.53)
3. Sibling ToM (0–7)			.19***	.23***	.21***	335	4.44 (1.93)
4. Maternal sensitivity (0–7)				.35***	.28***	369	4.11 (0.82)
5. Child vocabulary (SS)					.11*	278	103.91 (13.65)
6. Sib cognitive sensitivity (0–5)						349	2.73 (0.71)

Note: n = Number of participants with valid scores; *SD* = Standard deviation; *SS* = Standardized Score; T1 = Time 1; T2 = Time 2.
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

Internal consistency of the scales was good (α = 0.76 for target children and α = 0.80 for next in age older siblings). The original scale was developed with children ranging from 2 years 11 months to 6 years 6 months (Wellman & Liu, 2004). Given that a small group of children in our sample (∼10%) fell outside of this age range at their point of ToM measurement, additional analyses were conducted to demonstrate the validity of the scales in our sample's age range (available from authors upon request).

2.3.3. Additional covariates

In addition to target children's and older siblings' ToM at Time 1, a number of other covariates were included in the regression model. *Demographic* covariates included dyad age gap (age of next in age older sibling – age of target child), and sibship age spread (standard deviation of age across all siblings in the home). Child gender was entered as a dummy variable with girls as the reference category (girls = 0, boys = 1). Income/assets were examined through questions regarding family assets and annual household income (items were standardized and a mean was computed). Dummy variables were created for mother-reported ethnicity: European, Black, South Asian, East/South East Asian, and Other. *Child receptive vocabulary (Time 2)* was measured using the Peabody Picture Vocabulary Test, which yields a standardized summary score (Dunn & Dunn, 1997). *Maternal sensitivity (Time 1)* was measured through mother-child interactions during the home visit using two observational tasks: free-play and cooperative building (same as described above for siblings). Interactions were coded for maternal sensitivity (e.g., awareness of child's needs, sensitivity to child's signals, autonomy support), positive control (i.e., use of open-ended questions, explanations and praise) and mother-child mutuality (e.g., affect sharing, reciprocity in conversation, joint engagement) using the Coding of Attachment-Related Parenting (Matias, Scott, & O'Connor, 2006) and Parent-Child Interaction System (Deater-Deckard, Pylas, & Petrill, 1997). All scales were coded on a 7-point-scale and a mean of the three scales across the two tasks was computed (internal consistency α = 0.79). Coders were trained similarly to that described above for older sibling cognitive sensitivity. Notably, coders were different than those who rated cognitive sensitivity. Inter-rater reliability was similarly assessed and the final estimate was α = 0.90.

2.4. Data analysis

2.4.1. Procedure

Multiple regression analyses were conducted using Mplus 7.0 (Muthén & Muthén, 2010) to examine the relationship between sibship size and sibling cognitive sensitivity in the prediction of children's ToM at Time 2, controlling for ToM at Time 1. Covariates, predictor variables, and the interaction of interest were included in the analysis model. Prior to conducting the analyses, continuous variables were centered to reduce multicollinearity and allow for testing of simple slopes (Aiken & West, 1991; Holmbeck, 2002). Interaction terms were computed using the centered variables.

2.4.2. Missing data

Demographic variables, maternal sensitivity and children's receptive vocabulary had minimal missing data (<5%). Children's ToM and sibling cognitive sensitivity and ToM were also low (<15%). Excluding cases with missing data from the analyses can reduce the statistical power and bias the estimates of parameters (Allison, 2003). Full Information Maximum Likelihood Estimation (FIML), which estimates model parameters and standard errors using all available information, was utilized for handling missing data. FIML estimates yield superior performance to traditional ad hoc methods in regression analyses (i.e., listwise deletion, pairwise deletion, and multiple imputation), both in terms of bias and efficiency (Enders & Bandalos, 2001). Auxiliary variables that were correlated with variables in our analysis model and with variables that predicted attrition were included in our FIML to yield more accurate and stable estimates (Acock, 2005; Collins, Schafer, & Kam, 2001; Graham, 2003).

Table 2
Summary of regression analysis examining the role of sibship size and older sibling sensitivity in predicting Theory of Mind.

Child ToM (T2)	*b*	S.E.	β
Covariates			
Ethnicity 'South Asian'[a]	0.051	0.184	0.051
Ethnicity 'Black'	−0.126	0.279	−0.125
Ethnicity 'East/SE Asian'	−0.213	0.171	−0.211
Ethnicity 'Other'	−0.091	0.201	−0.089
Income/Assets	−0.058	0.082	−0.046
Maternal sensitivity (T1)	0.148	0.080	0.119*
Sibship age spread (SD)	0.083	0.084	0.086
Dyad age gap	−0.227	0.098	−0.162**
Older sibling ToM (T1)	0.116	0.062	0.114*
Child gender (boys)[b]	−0.300	0.111	−0.296***
Child vocabulary (T2)	0.017	0.005	0.232***
Child ToM (T1)	0.106	0.062	0.105*
Predictors			
Large sibship	−0.197	0.158	−0.157
Older cognitive sensitivity	0.011	0.109	0.008
Interaction			
Sibsize × cognitive sensitivity	0.344	0.170	0.157**

[a] Reference group for all ethnicity variables was European.
[b] Reference group was girls.
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

3. Results

Table 1 presents descriptive statistics for non-demographic covariates (demographics are described in the methods section), older sibling cognitive sensitivity, and child ToM at Time 1 and Time 2, as well as the bivariate correlations between these variables. Associations were in the small to medium range, in the expected directions. An examination of the bivariate relationships between main study variables indicates that children's later ToM was higher when their siblings demonstrated higher levels of cognitive sensitivity and was not significantly related to the size of the sibship ($r = -0.05$, *ns*).

Table 2 presents the results of the regression analyses in the prediction of later ToM. The overall regression, including covariates, predictors and the interaction term, was statistically significant, $R^2 = 0.240$, $p < 0.001$. Children's Time 2 ToM scores could be predicted from this set of variables, with approximately 24.0% of the variance in ToM scores accounted for by the regression. Neither sibship size nor sibling cognitive sensitivity were significantly related to children's ToM as independent predictors, after controlling for covariates, but the hypothesized interaction was significant, $\beta = 0.157$, $p < 0.05$. The majority of the variance was accounted for by model covariates, with 3.4% of the variance attributable to the main predictors (sibship size and sibling cognitive sensitivity) and their interaction. Specifically, being a girl, a smaller age gap between the target child and older sibling, and higher concurrent receptive vocabulary were significantly predictive of higher ToM scores. Higher levels of maternal sensitivity, and Time 1 child and sibling ToM were marginally significant predictors of children's later ToM scores.[2]

Supplementary analyses were conducted controlling for child-age siblings (i.e., number of siblings in the home aged 12 months–12 years), as some previous studies have found this to be an important indicator in the relationship between sibship size and children's ToM. This variable was not a significant predictor of children's ToM and its inclusion did not affect the pattern of results (results not presented).

To probe the nature of the significant interaction, we plotted the association between sibship size (small vs. large) and children's later ToM scores as a function of sibling cognitive sensitivity scores. This was done at one standard deviation above and below the mean following normal practice for plotting continuous variables (Holmbeck, 2002). Fig. 1 shows that sibship size is more strongly associated with ToM when siblings show low levels of cognitive sensitivity. Testing of simple slopes revealed that the association between sibship size and ToM was significant at low levels of cognitive sensitivity, $\beta = -0.430$, $p < 0.05$, but not at high levels of sibling cognitive sensitivity, $\beta = 0.046$, *ns*. Thus, coming from a large sibship is associated with poor ToM development in the absence of cognitively sensitive siblings.

[2] Additional regression analyses were conducted including only those covariates in Table 2 that were significant or marginally significant to allow for greater parsimony. The pattern of findings went unchanged and the predictors accounted for 22.0% of the variance in later ToM scores.

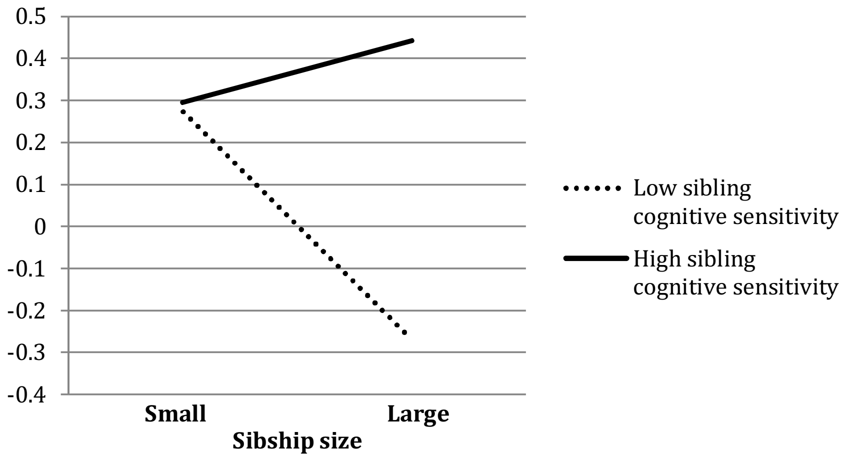

Fig. 1. Children's theory of mind as a function of sibship size and older sibling cognitive sensitivity.
Note: Regression lines for relations between sibship size and children's ToM as moderated by sibling cognitive sensitivity (one standard deviation above and below the mean). Slope of low cognitive sensitivity line is significant, $\beta = -0.430$, $p < 0.05$, high cognitive sensitivity line is not $\beta = 0.046$, *ns*.

4. Discussion

The relationship between sibship size and ToM development in preschool children has been found to be inconsistent, suggesting the presence of a moderator. This study tested the hypothesis that this association is moderated by the processes occurring within sibling dyads, specifically, older siblings' cognitive sensitivity. Sibship size, alone, did not predict children's ToM. However, a small but significant portion of variance was accounted for by the interaction between sibship size and older sibling cognitive sensitivity. The relationship between sibship size and children's ToM abilities was dependent on the older siblings' cognitive sensitivity. Children from larger sibships showed poorer ToM than those from smaller sibships, but only if their older siblings demonstrated low levels of cognitive sensitivity. The largest portion of variance accounted for in children's ToM scores came from our covariates, speaking to the social and developmental processes that have been previously linked to children's ToM development. By using a longitudinal design wherein we controlled for earlier levels of ToM, the results suggest that earlier sibling process contributes to the development of ToM when children are in large sibships. As the study is observational rather than experimental, such a finding is, of course, only suggestive. To our knowledge, this is the first study to longitudinally examine sibling interaction quality as a moderator of the relationship between sibship size and ToM.

The differential effect of sibship size on ToM indicates that it is not the mere exposure to more interactions that is important for promoting ToM (Jenkins & Astington, 1996; Perner et al., 1994). Rather, these findings support the notion of a social constructivist explanation wherein older siblings scaffold younger into learning about others' mental states (Lewis et al., 1996). This adds to previous literature demonstrating the importance of partner attunement to children's cognitive states in the facilitation of their socio-cognitive abilities. Children's integration of self-other perspective differences has been described as the process through which children's interpersonal experiences foster their understanding of minds (Fernyhough, 2008; Moore, 2006; Tomasello, Carpenter, Call, Behne, & Moll, 2005). Responsiveness to children's needs and abilities and provision of input that is cognitively appropriate allows for children to more readily internalize their social interactions. For instance, mothers' mind-mindedness (i.e., their abilities to read and understand the internal states of their children) has been shown to be an important contributor to social understanding in both infants and children (Laranjo et al., 2010; Meins et al., 2002; Meins et al., 2003). Another example is parental mental state talk, which refers to how much and in what ways parents and siblings talk about the mind to children (Jenkins et al., 2003). Parents adjust children's exposure to mental state talk in a developmentally-appropriate fashion and this scaffolding process facilitates children's understanding of the mind and emotions (Taumoepeau & Ruffman, 2006, 2008). Although sibling behaviour (i.e., reference to mental states, pretend play) has been related to ToM in the past, this is the first study to demonstrate that older siblings' cognitive sensitivity can positively influence children's ToM development.

Notably, siblings' cognitive sensitivity was only important when children came from large sibships. One way to understand these findings is through the lens of a resource dilution model. There is evidence that parent-child interactions suffer as the size of a sibship increases. For example, using a multilevel longitudinal design, Lawson and Mace (2009) found that, as sibship size increases, a cost is incurred to the quality of care provided to each individual child in social (i.e., playing, cuddling), caregiving (i.e., feeding, bathing) and cognitive (i.e., reading) domains. This dilution of resources has been proposed as the mechanism through which children from large sibships are disadvantaged in terms of cognitive, academic, and intellectual measures (Downey, 1995; Downey, 2001). It may be, then, that children from larger sibships are receiving less of the necessary parental scaffolding that is instrumental in the development of ToM. There does not appear to be a detrimental effect of sibship size on children's ToM when older siblings are able to identify their younger siblings' needs, respond to their cues and provide cognitively-attuned input during social interactions. In this way, older siblings may be playing a compensatory role for children in low-resource homes (i.e., large sibships). Sibling cognitive sensitivity is not related to children's ToM development under circumstances of high resource (i.e., small sibships).

Importantly, the current study's sample was socioeconomically and ethnically diverse. Previous studies demonstrating a sibling advantage have primarily used samples made up of middle/upper income families. The current findings are in line with previous studies using socioeconomically diverse samples that did not demonstrate a sibling advantage (Hughes & Ensor, 2005; Tompkins et al., 2013). It may be that there is greater variability in the quality of sibling interactions in socioeconomically diverse samples. For example, in less educated families there is less talk about beliefs than in higher educated families (Degotardi & Torr, 2007), suggesting that the types of interactions involving siblings may vary between these families. In the current study, sibship size alone was not predictive of children's ToM, owing to the range in quality of interactions found in our sample.

Further, the current study differed from previous studies in that all children in the sample had at least one older sibling. There is evidence that the largest contribution of the "sibling advantage" lies in the shift from only children to those with at least one sibling (Peterson, 2000). As such, the current sample might be considered advantaged, in that all children had at least one sibling. Having 2 or more siblings in the current sample, however, was related to lower ToM scores for those children with less sensitive siblings. It may be that it is most beneficial to have one sibling, at which point a threshold is reached (Downey & Condron, 2004). At this point, the (dis)advantage of additional siblings may depend more on the quality of interactions occurring (e.g., older sibling sensitivity). We could not test this in the current study, as we did not have any only children for this analysis.

4.1. Limitations and future directions

The current findings should be considered in light of limitations. First, to reduce burden on families we only collected observational data on the next in age older sibling. In future work, it would be valuable to examine the cognitive sensitivity of all children in the home. This would allow for an understanding of different sibling processes: the effect of mean levels of sibship cognitive sensitivity as well as the role of different dyads varying on characteristics such as age gap. Second, as discussed, our participants all had at least one sibling so our sibship size variable pertained to one versus more than one sibling. Given that this strays from previous designs in the literature (e.g., Jenkins & Astington, 1996; Perner et al., 1994; Peterson, 2000), we are not able to directly compare the role of sibship size across studies. Finally, it should be noted that although the hypothesized interaction of sibling cognitive sensitivity and sibship size was significant, it only explained a small amount of the variance in children's ToM. As others have described, a large number of genetic and environmental processes, as well as their interaction, contribute to complex human skills (Blair & Raver, 2012; Cicchetti & Rogosch, 1996).

Together with the growing literature demonstrating the protective role of positive sibling relationships (Conger, Stocker, & McGuire, 2009, Gass, Jenkins, & Dunn, 2007), this study highlights the potential role of intervention studies targeting the sibling relationship. Specifically, family-based interventions designed for vulnerable children may include interactive elements of the sibling relationship as a target for change. To date, interventions for siblings have been utilized to target affective behaviour (e.g., relationship quality; Feinberg, Sakuma, Hostetler, & McHale, 2013; Kennedy & Kramer, 2008) and conflict resolution skills (Siddiqui & Ross, 2004). However, there have not been reported interventions designed to engage siblings in behaviour that may enhance one another's cognitive abilities. This will be an important area for future investigation.

The present findings highlight the need to explore both process-based and structural components of sibships in order to gain an understanding of the dynamics within the home and, thus, the impact on individual children. It is evident that mere sibship size is not explanatory of children's development of ToM but rather how this interacts with the quality of siblings' behavior. Continued investigation into the processes by which siblings confer advantage or disadvantage to one another's ToM is important to our understanding of environmental contributions to children's socio-cognitive development.

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