Sibship Size, Sibling Cognitive Sensitivity, and Children's Receptive Vocabulary

WHAT'S KNOWN ON THIS SUBJECT: Sibship size has been negatively associated with children's language, cognitive, and academic outcomes. This phenomenon is often explained in terms of resource dilution, wherein more children in the home is associated with fewer parental resources allocated to each child.

WHAT THIS STUDY ADDS: The current study identifies a moderator of this relationship. Specifically, if children's next-in-age older siblings exhibit high levels of cognitive sensitivity then sibship size is not significantly related to children's vocabulary.

abstract

OBJECTIVES: The aim of the current study was to examine the relationship between sibship size and children's vocabulary as a function of quality of sibling interactions. It was hypothesized that coming from a larger sibship (ie, 3+ children) would be related to lower receptive vocabulary in children. However, we expected this association to be moderated by the level of cognitive sensitivity shown by children's next-in-age older siblings.

METHODS: Data on 385 children (mean age = 3.15 years) and their next-in-age older siblings (mean age = 5.57 years) were collected and included demographic questionnaires, direct testing of children's receptive vocabulary, and videos of mother-child and sibling interactions. Sibling dyads were taped engaging in a cooperative building task and tapes were coded for the amount of cognitive sensitivity the older sibling exhibited toward the younger sibling.

RESULTS: Hierarchical regression analyses were conducted and showed an interaction between sibship size and sibling cognitive sensitivity in the prediction of children's receptive vocabulary; children exposed to large sibships whose next-in-age older sibling exhibited higher levels of cognitive sensitivity were less likely to show low vocabulary skills when compared with those children exposed to large sibships whose siblings showed lower levels of cognitive sensitivity.

CONCLUSIONS: Children who show sensitivity to the cognitive needs of their younger siblings provide a rich environment for language development. The negative impact of large sibships on language development is moderated by the presence of an older sibling who shows high cognitive sensitivity. *Pediatrics* 2014;133:e394–e401

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The important influence that social interactions have on children's social and cognitive development is well established.[1–4] Indeed, children's development occurs through active participation in social interactions with the guidance, support, and challenge of their interaction partners.[5] The content of these interactions is more readily internalized when partners operate at a cognitively appropriate level.[6,7] There has been a recent interest in parental sensitivity to children's cognitive and mental states,[8–10] which has been demonstrated to foster children's social and cognitive development.[11–13] Cognitive sensitivity describes the extent to which an individual considers the knowledge and abilities of their interaction partner during a dyadic interaction.[14]

It has been suggested that the interactions a parent has with a particular child suffer with the addition of children into the family. The resource dilution hypothesis posits that as the sibship size increases, the proportion of parental resources accrued by any 1 child decreases.[15,16] The negative influence of sibship size on parental investment in the domains of caregiving, cognitive learning, and interpersonal relations has been demonstrated.[17] Similarly, there is evidence that later-born children receive less language input from their parents compared with firstborn children, and that the quality of input is less supportive of language development.[18] A negative relationship between sibship size and measures of children's attainment has been demonstrated,[15,16,19,20] which appears to persist into adulthood.[21–23] Additionally, later-born children show poorer vocabulary skills in comparison with firstborn children.[24,25] The negative effect of sibship size persists after accounting for the effect of socioeconomic status,[15,19] indicating that the association between socioeconomic status and sibship size does not account for the association between sibship size and educational attainment.

Given that effect sizes in the relationship between sibship size and children's attainment are modest,[26] compensatory processes may be operating.[27–29] In this study, large families can be considered a risk factor, making children vulnerable to poor language development. Protective factors serve to weaken the association between early risk and child outcomes.[30]

It has been suggested that increased attention be given to the role of siblings in children's development because of the extent and intensity of interactions between siblings.[31,32] Having siblings has been associated with enhanced conversational and communicative abilities, social skills, and theory of mind development.[33–37] Although children who have siblings receive relatively less linguistic input from their parents, observations of parent-sibling interactions as well as their own interactions with siblings afford them increased exposure to discourse overall.[10,18] Additionally, children are sensitive to what their siblings understand, adapting teaching behavior as a function of task difficulty, the age of the learners, and the learners' behaviors.[38,39] However, there are variations in preschoolers' abilities to respond to the cognitive needs of their siblings during interactions, which are related to their own sociocognitive skills.[14] Individual differences in siblings' early relationship quality are relatively stable over time.[40] Thus, exploration into early sibling interactions may shed light on protective factors favoring resiliency to adverse yet normative environments during early childhood. Given the individual differences observed in children's sensitivity to their siblings' cognitive needs, this might be an important protective factor to consider when exploring the effect of sibship size on children's development.

The aim of the current study was to examine whether the level of cognitive sensitivity children receive from their next-in-age older sibling moderates the strength of the relationship between sibship size and children's receptive vocabulary. Effects of siblings have been demonstrated for both receptive and expressive language.[41–43] However, as our sample was linguistically diverse, there is evidence that receptive gains are observed before those of expressive gains in English language learners,[44,45] and receptive and expressive vocabulary are highly correlated ($r = 0.83$),[46] we examined receptive vocabulary only. All children in the study had a minimum of 1 older sibling. It was hypothesized that coming from a larger sibship (ie, 3+ children) would be related to lower receptive vocabulary. However, we expected that this would be qualified by an interaction between sibship size and sibling cognitive sensitivity; children from larger sibships will show better receptive vocabulary when exposed to a high versus low cognitively sensitive older sibling. Cognitively sensitive siblings may have a compensatory effect in low resource homes (ie, large sibships). We included a number of covariates based on their demonstrated association with children's receptive language or hypothesized predictor variables: younger sibling gender, older sibling receptive vocabulary, gender composition and age gap of dyad, household income/assets, language spoken in the home, ethnicity, maternal cognitive sensitivity, and education.

METHODS

Sample

The current study is embedded within a larger longitudinal birth-cohort study. The goals of the larger study were to examine genetic and environmental influences on children's socio-emotional development by using

a sibling design. Participants were recruited through *Healthy Babies Healthy Children*, a program responsible for contacting the parents of all newborns within days of the infant's birth. Inclusion criteria for participating in the Intensive component of the Kids, Families and Places study included an English-speaking mother, a newborn >1500 g (the younger sibling) with a sibling <4 years of age (the older sibling), and maternal agreement to be videotaped. Thirty-four percent of families approached in Toronto agreed to take part. At Time 1 (infants were 2 months old), 501 families took part. Families were followed when the newborn was age 18 months (Time 2) and 3 years (Time 3). Observational data and direct testing were carried out on the newborn and the next-in-age older sibling at all waves. The Intensive component of the Kids, Families and Places sample was similar to the general population of Toronto and Hamilton (2006 Canada Census Data) 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.[47]

Current Study

The current study is based on Time 3 data (N = 385 families), as this was the first occasion of measurement for receptive vocabulary and cognitive sensitivity. Attrition from T1 to T3 was 23.2%. Dropout was significantly related to lower income/assets, $t(173) = -4.15$, $P < .001$, lower maternal education, $t(161) = -2.55$, $P < .05$, as well as race (ie, individuals who endorsed being black), χ^2 (1) = 7.27, $P < .05$; these variables are included in the analysis. Consent was obtained at the start of the home visit. Data included demographic questionnaires, direct testing of children, genetic testing (not included in the present report), and videos of mother-child and sibling interactions.

Demographics and participant characteristics are outlined in Table 1.

Measures

Sibling Cognitive Sensitivity

Sibling pairs were filmed engaging in a cooperative building task.[48] Dyads were instructed to sit on a yoga mat and use Duplo building blocks to replicate a design presented in a picture in 5 minutes. Each sibling was only allowed to touch 2 of the 4 colors of Duplo blocks to ensure collaboration for completion. Interviewers were present in the room with the dyads during the task but did not provide instructions beyond protocol. If children finished the design before the end of 5 minutes, they were given a second model to replicate. All children were stopped after 5 minutes, regardless of completion. The majority of dyads were engaged with the task for 80% or more of the 5 minutes.

Videotapes of sibling interactions were coded by using a measure of cognitive sensitivity,[14] defined as the 3 interlinked capacities of mind-reading, mutuality, and communicative clarity. 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 each of the 11 cognitive sensitivity statements. Items started with "This person is…" and examples include: 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. The coding approach presented in the current paper provides comparable reliability and validity to a more time-intensive observational coding method while reducing resources.[14,49] The mean was taken across items, and internal consistency of the composite was high, α = 0.89. Coders included

TABLE 1 Study Characteristics

	Characteristic	%
Maternal ethnicity	Caucasian	57.1
	Black	7.0
	South Asian	14.0
	East and South East Asian	13.0
	Other	8.8
Language spoken in the home	English only	79.2
Immigrant status	Canadian born	55.1
Sibship size	2	60.8
	3 or more	39.2
Gender	Younger (male)	51.7
	Older (male)	52.0
	Same-sex dyad	49.1
Birth order	Younger (youngest)	84.4
	Younger (middle)	15.6
	Older (middle)	27.8
	Older (oldest)	71.9
		Mean (SD; range)
Maternal education, y		15.59 (2.47)
Age, y	Younger	3.15 (0.27; 2.5–4.5)
	Older	5.57 (0.77; 4.0–7.7)
	Age gap	2.42 (0.72)
Household income	Range	$65 000–$74 999
Receptive vocabulary	Younger	94.78 (15.45)
	Older	107.51 (13.42)
Cognitive Sensitivity	Sibling	2.73 (0.71)
	Maternal	3.56 (0.77)

a mix of undergraduates and graduates who were trained by an expert coder. Inter-rater reliability was tested by double-coding 10% of the interactions, and reliability checks were conducted throughout the coding period to minimize drift. Disagreements were resolved by taking the score of the expert coder. Inter-rater reliability on the composite score was acceptable, $\alpha = 0.72$. All coders were blind to the hypotheses of the study.

Receptive Vocabulary

The Peabody Picture Vocabulary Test, a standardized test of receptive vocabulary skills, requires children to point to 1 of 4 pictures indicating a word that is read out loud. The test yields 1 overall standardized summary score representing the child's level of receptive language skills for their age. The test has been shown to have good psychometric properties.[50]

Maternal Cognitive Sensitivity

Maternal cognitive sensitivity toward the younger sibling was measured during the home visit in the same way as the sibling cognitive sensitivity outlined above. The composite showed excellent internal consistency ($\alpha = 0.92$). Inter-rater reliability was tested in the same way as that described for the sibling measure ($\alpha = 0.84$).

Demographics

Younger sibling gender (0 = female; 1 = male), dyad gender composition (0 = mixed; 1 = same-sex), and dyad age gap (age of older sibling – age of younger sibling child) were included as covariates. Income/assets were examined through questions regarding family assets (eg, house size, ownership status, cars) and annual household income. Assets and income items were standardized and a mean was computed, with higher scores indicating higher income/assets. Mothers spoke English as a criterion for study enlistment. However, the extent to which the heritage language was also used in the home was reported by mothers and measured through observation during the mother-child and sibling interactions (0 = English only; heritage language for more than 1 sentence = 1). These 2 indices overlapped ($r = 0.57$) and, given that the latter showed the strongest relationship to child language, this was used in analyses as a covariate. Dummy variables were created for self-reported ethnicity: Black, South Asian, and East/South East Asian (8.9% were categorized as "Other"), with European as a reference. Mothers reported their years of education and the number of children aged 0 to 18 years in the household, which were recoded into small (0 = 2 children) and large sibships (1 = 3+ children).

Data Analysis

Missing Data

Demographic variables and maternal cognitive sensitivity had minimal missing data (<5%), whereas children's receptive vocabulary and sibling cognitive sensitivity had more missing data (range = 5%–21%). Multiple imputation, one of the best techniques for the treatment of missing data,[51] was used. All variables with missing data were imputed. Multiple imputation generates multiple data sets where the missing values are substituted with plausible values based on patterns of non-missing data. Analyses are conducted on each data set and parameter estimates and SEs are pooled across the set of analyses by using Rubin's rule.[52,53] MPLUS 7 was used to generate 25 complete data sets by using the model variables.

Procedure

Regression analyses were conducted using maximum likelihood estimation in MPLUS 7. The model included 12 covariates and 2 predictor variables (ie, sibship size and older sibling cognitive sensitivity). Additionally, exploration into a moderator effect involves an interaction term (older sibling cognitive sensitivity × sibship size). For our hypothesis to be supported, we expect a significant interaction term in which the relationship between sibship size and receptive vocabulary is strong when cognitive sensitivity is low and weak when it is high. Centering of continuous variables was carried out to minimize multicollinearity. Interaction terms were computed by using the centered variables. This was done before imputation and analyses.[54,55]

RESULTS

Preliminary Analyses

Means and SDs are presented in Table 1. Pearson correlations (Φ for binary) revealed small to medium correlations in expected directions (see Table 2). An examination of the study variables indicates that younger siblings' receptive vocabulary is higher when their siblings demonstrate higher cognitive sensitivity and lower when they are from large sibships. Siblings were less sensitive when they came from large sibships.

Main Analyses

Results of the regression analyses can be found in Table 3. With respect to covariates, sibling vocabulary and maternal cognitive sensitivity were significantly predictive of higher receptive vocabulary scores. Additionally, children from families who spoke their heritage language during the home visit had significantly lower vocabulary scores. Large sibship was significantly associated with lower vocabulary scores but sibling cognitive sensitivity was not. Finally, the interaction between sibship size and sibling cognitive sensitivity was a significant predictor of children's receptive vocabulary. The

TABLE 2 Pearson Correlations (Φ for Binary) Between Study Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Income/assets	1															
2. Ethnicity 'Euro'	0.37**	1														
3. Ethnicity 'South Asian'	−0.20**	−0.47**	1													
4. Ethnicity 'Black'	−0.29**	−0.32**	−0.11*	1												
5. Ethnicity 'East/SE Asian'	0.01	−0.45**	−0.16**	−0.11*	1											
6. Ethnicity 'Other'	−0.15**	−0.36**	−0.13*	−0.09	−0.12*	1										
7. Use of heritage language	−0.20**	−0.37**	0.20**	−0.09	0.31**	0.12*	1									
8. Maternal education	0.47**	0.15**	−0.06	−0.15**	−0.02	−0.04	−0.08	1								
9. Maternal cognitive sensitivity	0.37**	0.35**	−0.34**	−0.18**	−0.02	−0.01	−0.13*	0.24**	1							
10. Older receptive vocabulary	0.42**	0.46**	−0.29**	−0.16**	−0.14**	−0.15**	−0.31**	0.23**	0.28**	1						
11. Sibling age gap	0.04	0.01	0.02	−0.08	0.08	−0.05	0.02	−0.01	−0.05	0.01	1					
12. Same-sex gender	0.02	0.06	−0.05	0.10	−0.07	−0.03	−0.05	0.12*	0.05	0.01	0.02	1				
13. Younger male	0.02	−0.01	−0.03	0.10*	−0.03	−0.01	−0.02	0.06	−0.02	−0.05	0.01	0.04	1			
14. Large sibship	−0.11*	0.00	−0.03	0.18**	−0.14**	0.05	−0.10	−0.09	−0.20**	−0.04	−0.12*	0.06	0.02	1		
15. Older cognitive sensitivity	0.20**	0.10	−0.08	−0.11*	0.06	−0.05	−0.01	0.17**	0.15**	0.15**	0.22**	0.09	−0.01	−0.13*	1	
16. Younger receptive vocabulary	0.33**	0.36**	−0.23**	−0.09	−0.09	−0.16**	−0.32**	0.11	0.34**	0.43**	−0.01	0.05	−0.10	−0.16**	0.17**	1

* $P < .05$;
** $P < .01$.

model accounted for a significant amount of the variance of children's receptive vocabulary scores, r^2 = 36.4%.

To probe the nature of the significant interaction, we plotted the association between sibship size (small versus large) and children's receptive vocabulary at different levels of sibling cognitive sensitivity scores (Fig 1).[54] Testing of simple slopes revealed that the association between sibship size and receptive vocabulary was significant at low levels of cognitive sensitivity but not at high levels of sibling cognitive sensitivity. For children who had a less sensitive sibling, coming from a large sibship predicted lower receptive vocabulary scores (β = −0.616, $P < .001$). For children who had a more sensitive sibling, coming from a large sibship was not related to receptive vocabulary (β = 0.043, not significant).

To ensure that covariates and their interactions with sibship size did not account for the interaction of interest, we tested a series of additional interactions (all covariates by sibship size with each entered individually). Given the possibility that the relationship between sibship size and sibling cognitive sensitivity may have varied by the covariates, we also tested these 3-way interactions. None of the 3-way interactions were significant and none of the additional 2-way interactions substantially reduced the moderation effect between sibship size and siblings' cognitive sensitivity.

DISCUSSION

Although there is evidence for dilution of parental resources in larger families,[15–18] the effect is modest in size, which suggests that other factors may act as protective factors. We hypothesized that 1 such factor is sibling cognitive sensitivity.

TABLE 3 Summary of Regression Analysis Examining the Role of Sibship Size and Sibling Cognitive Sensitivity in Predicting Receptive Vocabulary

Younger Receptive Vocabulary	*b*	SE	β	2-Tailed *P* Value
Covariates				
Income/assets	1.932	1.423	0.100	.17
Ethnicity 'Other'	−4.274	2.808	−0.275	.13
Ethnicity 'Black'	−2.846	2.495	−0.182	.25
Ethnicity 'South Asian'	−0.248	3.196	−0.015	.94
Ethnicity 'East and South East Asian'	−2.041	2.640	−0.131	.44
Use of heritage language at home	−7.256	2.017	−0.466	<.001
Maternal education	−0.313	0.379	−0.051	.41
Maternal cognitive sensitivity	3.646	1.098	0.181	.001
Older receptive vocabulary	0.266	0.069	0.229	<.001
Age gap	−1.380	1.006	−0.064	.17
Same-sex dyad	0.467	1.456	0.030	.75
Younger male	−1.726	1.465	−0.111	.24
Predictors				
Large sibship	−4.428	1.595	−0.284	.006
Older cognitive sensitivity	−1.253	1.528	−0.056	.41
Interaction				
Sibship size * sibling cognitive sensitivity	7.241	2.298	0.215	.002

The goal of the current study was to examine the protective effect of older siblings' cognitive sensitivity on younger children's receptive vocabulary for children in large sibships. Children from larger sibships who received higher levels of cognitive sensitivity from their older siblings were less likely to show poor receptive vocabulary when compared with those children whose siblings exhibited lower levels of cognitive sensitivity. Children from large sibships whose older siblings demonstrated higher levels of cognitive sensitivity did not differ significantly from children from smaller sibships (high or low cognitive sensitivity). Thus, our hypothesis that older sibling cognitive sensitivity would buffer younger children from the negative role of large sibships was supported. Notably, this pattern was robust after controlling for covariates often predictive of children's vocabulary: language spoken in the home, maternal cognitive sensitivity and education, ethnicity, and income/assets. The observed protective effect is in line with past research that has shown that non-parental adults can buffer children from the adverse effects of large sibships.[56]

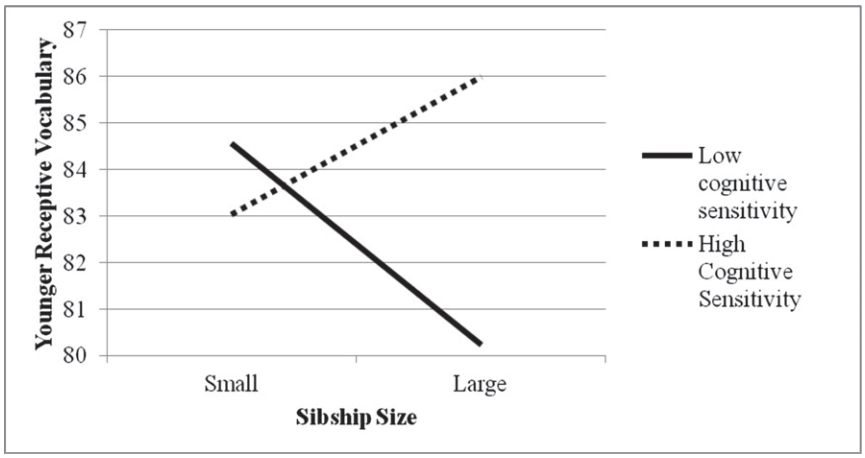

FIGURE 1
Younger siblings' receptive vocabulary (mean) as a function of sibship size and older sibling cognitive sensitivity. Note: Regression lines for relations between sibship size and children's receptive vocabulary as moderated by cognitive sensitivity (1 SD above and below the mean; 2-way interaction). Slope of low cognitive sensitivity line is significant, $\beta = -0.616$, $P < .001$; slope of high cognitive sensitivity line is not $\beta = 0.043$, not significant.

The current study adds to growing research highlighting the importance of partner attunement to children's cognitive states, extending it to siblings. Cognitively sensitive older siblings, who provided positively valenced feedback and promoted turn-taking (ie, mutuality), were sensitive and responsive to partner's abilities (ie, mind-reading), and promoted a mutual understanding of the goals of the task (ie, communicative clarity), were effective partners.

There are several clinical implications of these findings. First, although research has concentrated more on the importance of parents in early language development, older siblings play a central role. The majority of children spend more time with siblings than with parents.[32] Children who have siblings are afforded heightened exposure to certain contexts that are associated with social and cognitive development, including pretend play, conflict, and conversation.[10,57–60] In these and other contexts, siblings provide one another with varying levels of stimulation,[31,32,61] which are important for understanding development. Second, being raised in a large sibship is not a risk factor for poor language development if children receive the appropriate stimulation from an older sibling. Third, early developmental outcomes are best understood by thinking about the ways in which environmental experiences combine. Thus children who are raised in less than optimal conditions (large families) show resilience in the presence

of compensatory experiences (sensitive siblings). Understanding the combinations of risk and protective processes in children's lives is central to our ability to improve population health.[62]

The present findings should be considered in light of several limitations. First, the cross-sectional design of the current study limits the conclusions we can make regarding direction of association between the protective factor studied and child vocabulary. Second, the sample was similar to the general population on some but not all indices. Third, given that younger children may differentially elicit sensitivity from their partners,[63] these partner effects are important to consider in future work. Fourth, the inter-rater reliability of the sibling cognitive sensitivity variable was acceptable but not high, which might result in an underestimation of the true effect. Fifth, we were only able to investigate the cognitive sensitivity received from the next-in-age older sibling as opposed to all siblings in the home. Finally, to limit burden on respondents, children's expressive vocabulary was not assessed.

CONCLUSIONS

Children who demonstrate sensitivity to their siblings' cognitive needs offer them a rich context for language development. Delineating the beneficial interactions that are inherent to sibling relationships can help us understand the family processes influencing children's development.[64]

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