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The Effect of Older Siblings on Language Development as a Function of Age Difference and Sex

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Abstract

The number of older siblings a child has is negatively correlated with the child's verbal skills, perhaps because of competition for parents' attention. In the current study, we examined the role of siblings' sex and age gap as moderating factors, reasoning that they affect older siblings' tendency to compensate for reduced parental attention. We hypothesized that children with an older sister have better language abilities than children with an older brother, especially when there is a large age gap between the two siblings. We reanalyzed data from the EDEN cohort (N = 1,154) and found that children with an older sister had better language skills than those with an older brother. Contrary to predictions, results showed that the age gap between siblings was not associated with language skills and did not interact with sex. Results suggest that the negative effect of older siblings on language development may be entirely due to the role of older brothers. Our findings invite further research on the mechanisms involved in this effect.

Keywords

language, language development, siblings, sex differences, preregistered

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The number of older siblings a child has is negatively correlated with that child's verbal skills, including verbal intelligence, language-development measures, and educational attainment (e.g., Black, Devereux, & Salvanes, 2005; Peyre, Bernard, et al., 2016). According to the *resource-dilution model* (Blake, 1981), a family has limited resources to distribute among siblings, and the more children the family has, the less resources are allocated to each child. These resources can be material (e.g., buying books and games) or personal (e.g., providing attention or teaching). The *confluence model* (Zajonc & Markus, 1975) considers siblings to be not only consumers of the family's resources but also part of this pool of resources. According to this theory, the child's intellectual environment is made up of the mean intellectual ability in the family; children, who have lower intellectual abilities than adults, bring this mean down. Thus, having more siblings is almost always detrimental, but the older the siblings, the less detrimental their effect.

Verbal intelligence is more affected by birth order than is nonverbal intelligence (Peyre, Bernard, et al., 2016), suggesting that the effect of older siblings is greater for language development. One possible reason for this may be that language development is more affected by the quantity and quality of input the child receives than is nonverbal intelligence. Child-directed

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speech from adults, especially in one-on-one interactions, has been found to promote language learning (e.g., Hart & Risley, 1995; Ramírez-Esparza, García-Sierra, & Kuhl, 2014). The relationship between the number of older siblings and language development may relate to a decrease in parents' ability to spend one-on-one time with each child separately. For example, when both siblings are present, parents may be more responsive to the older child, at the expense of providing (quality) language input to the younger child (Huttenlocher, Vasilyeva, Waterfall, Vevea, & Hedges, 2007; see also Hoff-Ginsberg, 1998).

But can siblings themselves make up for some of the lost parental resources by providing their own input and interactions? Though children may not be as adept as adults at adapting their speech to younger children (Mannle, Barton, & Tomasello, 1992), siblings are able to adjust their teaching strategies to their younger siblings' ages (Dunn & Kendrick, 1982). Indeed, having older siblings positively affects children's social-communicative skills (Hoff, 2006), the ability to join in conversations (Dunn & Shatz, 1989), and some aspects of syntactic development, such as pronoun use (*me–you*; Oshima-Takane, Goodz, & Derevensky, 1996). In addition, in research on bilingual families, older siblings are found to be effective second-language models; their second-language skills can be better than the parents', and they tend to use the second language with their younger siblings (e.g., Bridges & Hoff, 2014; Duncan, 2017). This suggests that input and interactions with siblings can be beneficial, at least when input from the parents is of lesser quality. Conversely, other studies have found that input from siblings does not contribute to vocabulary development of the target child and generally accounts for a very small percentage of input to children in some cultures (Shneidman, Arroyo, Levine, & Goldin-Meadow, 2013). How can these discrepancies be resolved?

We suggest that there are two main routes by which siblings may affect language development. By competing for parents' attention, older siblings might be depriving their younger sibling of personally tailored child-directed input. By providing their own input, however, siblings may partly make up for some lost stimulation. Finding a negative effect of older siblings on language development could mean that, on average, the effect of competition is larger than the effect of compensation, or it could mean that older siblings are unable to compensate at all.

To tease apart these two scenarios, we looked into two different characteristics of older siblings—namely, age gap and sex. As we describe below, there is reason to believe that older siblings' characteristics affect their ability and inclination to provide their younger siblings with their own quality input. If children whose older siblings are more likely to compensate for lost input have better language skills than children whose older siblings are less likely to do so, then this would suggest that some older siblings do contribute to their younger siblings' language development—in other words, that compensation exists.

Age gap might have an effect on parents' ability to provide linguistic simulation. More narrowly spaced siblings might present greater competition for parental resources because of their own level of demands (as they become older, they require less care and supervision). Age gap might also have an effect on the likelihood that the sibling can compensate for the loss of parental linguistic simulation (Hoff-Ginsberg & Krueger, 1991). The older the siblings are, the more likely they are to have more developed social and linguistic skills, thus providing better input. Indeed, one study found that more narrowly spaced siblings had a larger negative effect on verbal test scores in high school than more widely spaced siblings did (Powell & Steelman Carr, 1990). As mentioned above, the confluence theory also makes this prediction. This leads us to predict that the larger the age gap between target child and sibling, the less detrimental the effect of having a sibling.

A second variable of interest is gender. Older sisters are more likely to engage in positive and nurturing behavior than older brothers are (e.g., Tucker, McHale, & Crouter, 2001). Additionally, at early ages, girls tend to have more advanced language skills than boys (e.g., Eriksson et al., 2012). This advantage seems to last until 5 to 6 years of age (Peyre et al., 2019), though it is possible that a small advantage in language-related tasks remains throughout life (e.g., Ullman, Miranda, & Travers, 2008). Consequently, sisters might contribute better-quality input than brothers. All this leads to the prediction that having an older sister is better for one's language development than having an older brother (i.e., an effect of the older sibling's sex). Additionally, when an older sister is slightly older than the target child, she is relatively young and likely not very good at providing compensatory input. In contrast, much older sisters should be better able to provide such stimulation; they also might be more likely to be delegated some of the caretaking of the target child and thus be in a position to provide that stimulation. We therefore predicted that the age-gap effect would be greater for older sisters than for older brothers.

To test these predictions, we reanalyzed data from the EDEN cohort, a large population-based sample of French children. Among children who have only one older sibling, we predicted better language scores for those who have an older sister than an older brother. We predicted worse language outcomes for children who were closer in age to their preceding sibling. We also predicted a steeper slope of language scores on age gap when the older sibling was a sister (i.e., a larger difference between the language scores of children with an older sister and the language scores of children with an older brother when the age gap was large than when it was small).

Method

Study design

We used data from the EDEN mother-child cohort study (Heude et al., 2016), the primary aim of which is to identify prenatal and early postnatal nutritional, environmental, and social determinants of children's health and development. This is a longitudinal study, tracking children's development from before birth to the age of 11 years (so far). Participants were recruited between 2003 and 2006 from two university hospitals' maternity units, both in France (in Poitiers and Nancy). Exclusion criteria included history of diabetes, twin pregnancies, intention to deliver outside the university hospital, intention to move out of the study region within the next 3 years, and inability to speak French. The study was approved by the Bicêtre Hospital Ethical Research Committee and by the French data-protection authority (Commission Nationale de l'Informatique et des Libertés). Written informed consent was obtained from parents—for themselves at the time of enrollment and for the newborn after delivery. For the current study, we used language measures taken at 2, 3, and 5 to 6 years of age (see Table 1 for details). The EDEN cohort study also contains many other cognitive measures that are nonlinguistic and were thus not part of the current analyses.

Participants

There were 1,276 eligible children with language-skills data available at 2, 3, or 5 to 6 years.[1] There were 1,154 children (483 with one older sibling) with language-skills data available at 2 years; for some children (n = 122), language-skills data were available at 3 or 5 to 6 years but not at 2 years. There were 996 children (416 with one older sibling) with language-skills data available at 3 years, and 898 children (381 with one older sibling) with language-skills data available at 5 to 6 years. About 46% of the older siblings were girls, and 6.88% of families were single-parent families.

Although it is difficult to accurately estimate statistical power, given that the effect size of interest was unknown, that we had multiple hypotheses, and that we had unequal sample sizes at the different ages, we estimated that this sample size was large enough to allow us to detect effects similar to those found in prior work. For example, with a minimum of 381 participants per group (the smallest sample in any cell), we could detect an effect size (d) of 0.2 (the effect size of birth order in previous studies, e.g., Kristensen & Bjerkedal, 2007) with 80% power.

Materials

Predictors of language skills. Gestational age and birth weight were collected from obstetrical records, and the older sibling's sex and age were reported by the mother at the birth of the child included in the EDEN cohort. Smoking status and alcohol consumption during pregnancy (units per week) were determined from the questionnaires filled out by the mothers during pregnancy and at delivery. Mothers completed questionnaires on partial or exclusive breastfeeding (breastfeeding initiation; Bernard et al., 2017). Both parents completed questionnaires on their age at the child's birth, family income, and education level. For level of parental education at birth of the child and household income (in thousands of euros per month) at each age of testing, the averages for both parents were used in the analyses (see the Statistical Analysis section). At each follow-up visit, parents completed questionnaires providing information on the sex and age of children born into the family after the study started.

Language skills (outcome variables). All tests and questionnaires described below were combined to create a single score at each age, except at age 2, when only one test was conducted. Using the same data set, Peyre and colleagues (2016) found that a single latent factor provided an excellent fit to the data at both 3 years and 5 to 6 years of age, thus providing a general index of language skills.

Statistical analysis

All analyses were preregistered on the Open Science Framework before they were performed (https://osf.io/pgtyx/). They were performed as preregistered, except that in the adjusted models (introduced below), we added a control factor for the effect of having a younger sibling (results without controlling for this effect were similar; see the Supplemental Material available online). Additional exploratory analyses can be found in the Supplemental Material as well.

Language scores representing language skills at 3 years and at 5 to 6 years were calculated as the mean of the scores at each time point (each score was first converted into a z score in order for each test to have the same weight).

There were a few missing data points on language tests at 3 years of age and at 5 to 6 years of age (age 3: 5.9% in our total sample and 5.3% in the subsample of children with an older sibling only; ages 5–6: 1.9% in our total sample and 1.8% of children with an older

Table 1. Language Tests Used to Assess Children at the Three Time Points in the Present Study

Age group	Type of measure	Test
Two-year-olds (*M* = 24 months, *SD* = 1)	Parental questionnaire	French version of the CDI-2. Parents were asked to indicate which words from a list of 100 their child could say spontaneously (expressive vocabulary). The score is the sum of the words produced by the child. The CDI-2 has high test-retest reliability and strong associations with the corresponding scores from the longer version (Kern et al., 2010).
Three-year-olds (*M* = 38 months, *SD* = 1)	Assessment by trained psychologists	Items from the ELOLA battery, a European oral-language test battery: • Semantic Fluency, scored as the sum of the number of animals retrieved spontaneously in 1 min plus the number of objects named in 1 min • Word and Nonword Repetition, scored as the number of words (6 items) and nonwords (6 items) repeated correctly • Picture Naming, scored as the number of pictures named correctly (10 items, e.g., "cheval" [horse]) Items from the NEPSY battery, a developmental neuropsychological assessment: • Sentence Repetition, scored as the number of sentences of increasing complexity and length repeated correctly (17 items, e.g., "dors bien" [sleep well]) Comprehension of Instructions, a sentence-comprehension task scored as the number of correct answers by pointing at one of eight pictures (13 items, e.g., "montre moi un grand lapin" [show me a large rabbit])
Five- to six-year-olds (*M* = 68 months, *SD* = 2)	Assessment by trained psychologists	Tests from the NEPSY battery: • Nonword Repetition, scored as the number of syllables repeated correctly (out of 46 syllables in 13 nonwords—e.g., "kiutsa," a nonword with two syllables) • Sentence Repetition Items from the WPPSI-III battery, a developmental neuropsychological assessment: • Information, scored as the number of correct answers (speaking or pointing) to questions that address a broad range of general-knowledge topics (34 items) • Vocabulary, scored as the number of words correctly defined (25 items) • Word Reasoning, scored as the number of concepts correctly identified from a series of clues (28 items)

Note: CDI-2 = MacArthur-Bates Communicative Development Inventory (Kern, Langue, Zesiger, & Bovet, 2010); ELOLA = Batterie d'Évaluation du Langage Oral de l'Enfant Aphasique (De Agostini et al., 1998); NEPSY = NEPSY Bilan Neuropsychologique de l'Enfant (Kemp, Kirk, & Korkman, 2001; Korkman, Kirk, & Kemp, 2003); WPPSI-III = Wechsler Preschool and Primary Scale of Intelligence–3rd edition (Wechsler, 1967).

sibling only). For predictors of language skills, fewer than 1% of the data points were missing in both analysis samples. Missing data on predictors of language skills were determined using multiple imputation (n = 50), assuming that missing data were probably not missing at random (Donders, van der Heijden, Stijnen, & Moons, 2006). All analyses were performed using SAS software (Version 9.4). Multiple imputations were implemented using the SAS PROC MI procedure with the fully conditional specification statement.

Analysis 1: having a sibling versus having no sibling. Before looking into the mediating role of sex and age gap, we checked that having an older sibling (either a brother or a sister) was indeed detrimental for language outcomes, as found in previous research (e.g., Black et al., 2005) and by Peyre, Bernard, et al. (2016), when analyzing 5- to 6-year-olds' data in the same cohort.

In our sample (N = 1,276), we ran a linear mixed regression model with language skills as the dependent variable, testing age (2, 3, and 5–6 years of age) as a repeated measure, and the presence of one older sibling as the independent variable (participant was entered as a random effect). A second model was adjusted for exact age at time of evaluation (continuous) and other predictors of language skills—sex, gestational age (weeks), birth weight (kg), maternal age at delivery (years), paternal age at delivery (years), breastfeeding initiation (%), alcohol use during pregnancy (units per week), tobacco use during pregnancy (%), parental education (years), household income (in thousands of euros per month), and presence of younger siblings at the time of evaluation. These are the main factors suspected of influencing cognitive development that were available in the EDEN cohort study (Peyre, Galera, et al., 2016).

We adjusted the model for these control variables by fitting three linear models, one for each testing age, with the child's precise age at testing as well as the control variables (but not with our hypothesized predictors). We then extracted the residuals from these fitted models and combined them into one data set, which served as the outcome for the mixed-effects regression analysis mentioned above. The reason the adjustment was done this way was to enable us to control for exact age at time of evaluation, which would not be possible if the adjustments were done directly within the main model.

Analysis 2: sex, age gap, and interaction. Next, we tested our prediction of a positive effect of older sisters on language development (compared with older brothers), a positive effect of a larger age gap, and a stronger age-gap effect for older sisters.

In the subsample of children with only one older sibling (n = 547), we performed a linear mixed-effects regression model with language skills as the dependent variable, testing age as a repeated measure, sex of the older sibling and age gap (i.e., age difference between the two siblings) as independent variables, and the interaction between the older sibling's sex and the age gap. Participant was entered as a random effect. In a second model, we adjusted for exact age at time of evaluation and the other predictors of language skills, as described above.

Preregistered follow-up analyses. We compared children who had no sibling with children who had either an older sister or an older brother (unlike in Analysis 1, in which the gender of the older sibling was not specified). We did this in order to estimate the effects of older brothers and sisters, respectively, relative to the baseline of having no older sibling. We ran a linear mixed-effects regression model with language skills as the dependent variable and with testing age and presence and sex of the older sibling as independent variables (categorical with three levels—no sibling, brother, and sister—and with no sibling as the reference). Participant was entered as a random effect. A second model was adjusted for exact age at time of evaluation and the other predictors of language skills, as described above.

Results

Characteristics of participants in the samples of analysis are presented in Table 2. As predicted, Analysis 1 showed that language skills of children with one older sibling were lower than those of children without an older sibling (Cohen's d = −0.14 and −0.17 in the unadjusted and adjusted models, respectively; see Table 3 and Fig. 1). Also as predicted, Analysis 2 showed that language skills of children with an older sister were higher than those of children with an older brother (d = 0.26 and 0.22 in the unadjusted and adjusted models, respectively; see Table 4 and Figs. 2 and 3). Contrary to our prediction, results of Analysis 2 showed that language skills were negatively associated with age gap in the unadjusted model (d = −0.05, p = .003). This association was not significant in the model adjusted for the other predictors of language skills (d = −0.04, p = .071). No significant interaction between the sex of the older sibling and age gap was found (see Fig. 2).

Finally, in the follow-up analyses, children with an older sister had similar language skills to children without an older sibling, while children with an older brother had significantly worse language skills (see Table 5 and Fig. 3).

Discussion

Having an older sibling is associated with lower verbal skills compared with having no older sibling (e.g., Black et al., 2005). We reanalyzed data from the EDEN cohort to examine the effect of the sex of the older sibling and the age gap between siblings on the younger child's language development, reasoning that some older siblings are more likely to compensate for parental resources than others.

Our hypothesis that children with older sisters would have higher language scores than children with older brothers was confirmed. The size of the effect of sibling sex, d = 0.22, although small, is not negligible in epidemiological studies of cognitive development. It would be the equivalent of 3 IQ points and is similar to the birth-order effect in Kristensen and Bjerkedal's (2007) seminal study. In a follow-up comparison separating siblings by sex, we found that although children with an older brother exhibited lower language skills than children with no older sibling, children who had an older sister scored comparably with children with no older sibling. It thus might be more accurate to think of the well-established negative older-sibling effect as an *older-brother effect*.

It is unclear whether older sisters help language development—or just hinder it less than older brothers do. Indeed, there are two possible reasons for this effect. First, as argued in the introduction, older sisters may themselves contribute to their younger sibling's language development. Older sisters may be more predisposed or better trained to act as caregivers than older brothers (e.g., Tucker et al., 2001)—or even simply more talkative or more willing playmates. Young girls are also more linguistically advanced than young boys until at least age 5 to 6 (Peyre et al., 2019), and thus they may be better able to provide quality input. An alternative explanation suggested by our results is that an older brother may be more demanding for parents than an older sister, at the expense of the younger sibling. Mothers of baby boys experience more stress than mothers of baby girls (Scher & Sharabany, 2010), and later on, boys show more externalizing behavior and tend to be more irritable (Leaper, 2002). This could

Table 2. Characteristics of Children in the Analysis Sample With No Older Sibling or One Older Sibling

Variable	Children with no sibling or one older sibling (n = 1,276)	Children without an older sibling (n = 729)	Children with one older sibling (n = 547)
Children with one older sibling	43.3%	0%	100%
Sex of the older sibling (male)	—	—	53.9%
Age gap (years)	—	—	M = 3.7 (SD = 2.2)
Language skills at 2 years	n = 1,154	n = 671	n = 483
CDI-2 score	M = 62.1 (SD = 29.2)	M = 64.5 (SD = 28.6)	M = 58.7 (SD = 29.6)
Age of the child at the time of CDI-2 (months)	M = 24.3 (SD = 1.1)	M = 24.4 (SD = 1.8)	M = 24.3 (SD = 0.7)
Language skills at 3 years	n = 996	n = 580	n = 416
Semantic Fluency[a]	M = 0.0 (SD = 0.8)	M = 0.1 (SD = 0.8)	M = 0.0 (SD = 0.8)
Word and Nonword Repetition[a]	M = 0.0 (SD = 0.9)	M = 0.1 (SD = 0.9)	M = 0.0 (SD = 1.0)
Sentence Repetition	M = 7.2 (SD = 3.3)	M = 7.2 (SD = 3.1)	M = 7.2 (SD = 3.5)
Picture Naming	M = 7.0 (SD = 1.8)	M = 7.2 (SD = 1.8)	M = 6.9 (SD = 1.9)
Comprehension of Instructions	M = 8.6 (SD = 2.9)	M = 8.8 (SD = 2.9)	M = 8.4 (SD = 3.0)
Age of the child at the time of tests (in months)	M = 38.0 (SD = 0.8)	M = 38.0 (SD = 0.8)	M = 38.0 (SD = 0.8)
Language skills at 5–6 years	n = 898	n = 517	n = 381
Nonword Repetition	M = 21.0 (SD = 4.9)	M = 21.0 (SD = 4.9)	M = 21.0 (SD = 5.0)
Sentence Repetition	M = 15.6 (SD = 4.0)	M = 15.8 (SD = 3.9)	M = 15.2 (SD = 4.1)
Information	M = 25.1 (SD = 2.9)	M = 25.4 (SD = 2.9)	M = 24.7 (SD = 2.8)
Vocabulary	M = 23.8 (SD = 5.6)	M = 24.3 (SD = 5.6)	M = 23.2 (SD = 5.6)
Word Reasoning	M = 16.3 (SD = 4.7)	M = 16.6 (SD = 4.6)	M = 15.8 (SD = 4.8)
Age of the child at the time of tests (in months)	M = 67.9 (SD = 1.8)	M = 67.9 (SD = 1.7)	M = 68.0 (SD = 1.9)
Predictor of cognitive skills			
Sex (male)	51.7%	51.5%	52.1%
Gestational age (in weeks)	M = 39.2 (SD = 1.7)	M = 39.3 (SD = 1.8)	M = 39.2 (SD = 1.6)
Birth weight (kg)	M = 3.26 (SD = 0.51)	M = 3.22 (SD = 0.51)	M = 3.30 (SD = 0.50)
Mother's age at delivery (years)	M = 28.5 (SD = 4.5)	M = 27.3 (SD = 4.4)	M = 29.9 (SD = 4.3)
Father's age at delivery (years)	M = 31.3 (SD = 5.6)	M = 30.1 (SD = 5.5)	M = 32.9 (SD = 5.2)
Breastfeeding initiation	73.1%	75.6%	69.8%
Alcohol during pregnancy (drinks per week)	M = 0.56 (SD = 1.60)	M = 0.52 (SD = 1.61)	M = 0.62 (SD = 1.61)
Maternal smoking during pregnancy	24.8%	26.3%	23.0%
Parental education (years)	M = 13.6 (SD = 2.3)	M = 13.6 (SD = 2.3)	M = 13.6 (SD = 2.4)
Household income at 2 years (k€)	M = 2.61 (SD = 1.01)	M = 2.53 (SD = 1.00)	M = 2.71 (SD = 1.01)
Younger siblings at 2 years	8.4%	13.1%	2.6%
Younger siblings at 3 years	20.1%	28.4%	9.5%
Younger siblings at 5–6 years	35.2%	47.1%	19.7%
Center (Nancy, France)	50.1%	46.9%	54.3%

Note: CDI-2 = MacArthur-Bates Communicative Development Inventory (Kern, Langue, Zesiger, & Bovet, 2010). [a]Scores have been standardized in the whole data set.

mean that there is less competition for parental resources from an older sister than from an older brother. Although our results cannot help us discriminate between these two explanations, both focus on the linguistic environment available to children and the types of linguistic experiences and input they are exposed to in their early years of life. Our results thus join a vast literature on the effect of the quantity and quality of input on language development (e.g., Ramírez-Esparza et al., 2014).

We additionally hypothesized that the age gap between siblings would be positively correlated with language scores. This hypothesis was not supported. If anything, we found a trend in the opposite direction: The more closely spaced the siblings were, the higher the language scores of the target child. Thus, although the present study was well powered, the age-gap effect remains uncertain. An even larger study would be necessary to determine whether or not there is a genuine negative age-gap effect. This result fails to support the confluence model discussed in the introduction, which states that the older the siblings, the higher their intellectual abilities and the less disruptive they are to their younger siblings' development (Zajonc & Markus, 1975).

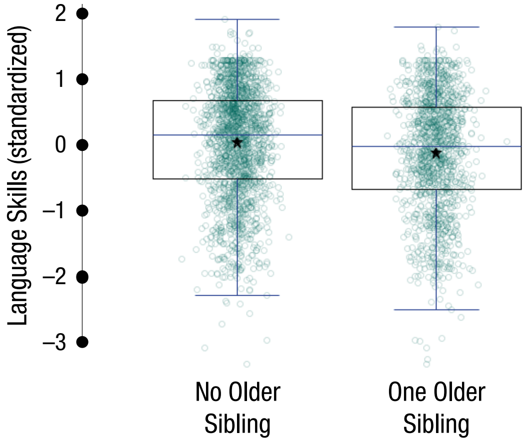

Fig. 1. Language skills of children with no older siblings compared with those who had one older sibling. The boxes encompass interquartile ranges, the black stars represents means, and the error bars represent ±2 *SD*. Open circles represent individual data points. Because the model included children's scores at each age separately, children have between one and three data points apiece, depending on whether data were missing.

A limitation of the current study is that demographic characteristics of the older siblings were used as a proxy for the level of stimulation the older sibling would provide the younger sibling, as well as for the level of competition. We have no direct evidence that the interactions between children and their older sisters were different from children's interactions with their older brothers, or that the interactions between the caregiver and the key child differed in the presence of an older brother compared with an older sister. Moreover, our sample drew from the French population, and the results may not generalize to other cultures. Indeed, Frank, Braginsky, Marchman, and Yurovsky (2019; see also Steelman, Powell, Werum, & Carter, 2002) found large variability in the birth-order effects across different countries, compared with, for example, stability in the female advantage in early language development. Another limitation is that our sample of children with and without an older sibling differed in their demographic characteristics (e.g., children with no older

Table 3. Results of Linear Mixed Regression Models With Language Skills as the Dependent Variable and the Presence of an Older Sibling as the Independent Variable (N = 1,276)

Model and predictor	β	*SD*	*p*
Unadjusted model: older sibling (reference: without an older sibling)	−0.141	0.030	< .0001
Model 1 (adjusted): older sibling (reference: without an older sibling)	−0.168	0.037	< .0001

Note: For this analysis, language scores were available for 1,154 two-year-olds (483 of whom had an older sibling), 996 three-year-olds (416 of whom had an older sibling), and 898 five- to six-year-olds (381 of whom had an older sibling). Adjusted Model 1 was adjusted for exact age at time of evaluation and other predictors of cognitive development—sex, gestational age (weeks), birth weight (kg), maternal age at delivery (years), paternal age at delivery (years), breastfeeding initiation (%), alcohol use during pregnancy (units per week), tobacco use during pregnancy (%), parental education (years), household income (thousands of euros per month), and presence of younger siblings at the time of evaluation.

Table 4. Results of Linear Mixed Regression Models With Language Skills as the Dependent Variable and Sex of the Older Sibling, Age Gap Between the Two Siblings, and the Interaction Between Sex and Age Gap as the Independent Variables (N = 547)

Model and predictor	β	*SD*	*p*
Unadjusted model			
Sex of older sibling (male; reference: female)	−0.259	0.091	.0045
Age gap (years)	−0.048	0.016	.0031
Age Gap × Sex of Older Sibling	0.020	0.021	.3543
Model 1 (adjusted)			
Sex of older sibling (male; reference: female)	−0.218	0.108	.0433
Age gap (years)	−0.035	0.019	.0708
Age Gap × Sex of Older Sibling	0.008	0.025	.7411

Note: For this analysis, language scores were available for 483 two-year-olds (222 of whom had an older sister), 416 three-year-olds (187 of whom had an older sister), and 381 five- to six-year-olds (177 of whom had an older sister). Adjusted Model 1 was adjusted for exact age at time of evaluation and other predictors of cognitive development—sex, gestational age (weeks), birth weight (kg), maternal age at delivery (years), paternal age at delivery (years), breastfeeding initiation (%), alcohol use during pregnancy (units per week), tobacco use during pregnancy (%), parental education (years), household income (thousands of euros per month), and presence of younger siblings at the time of evaluation.

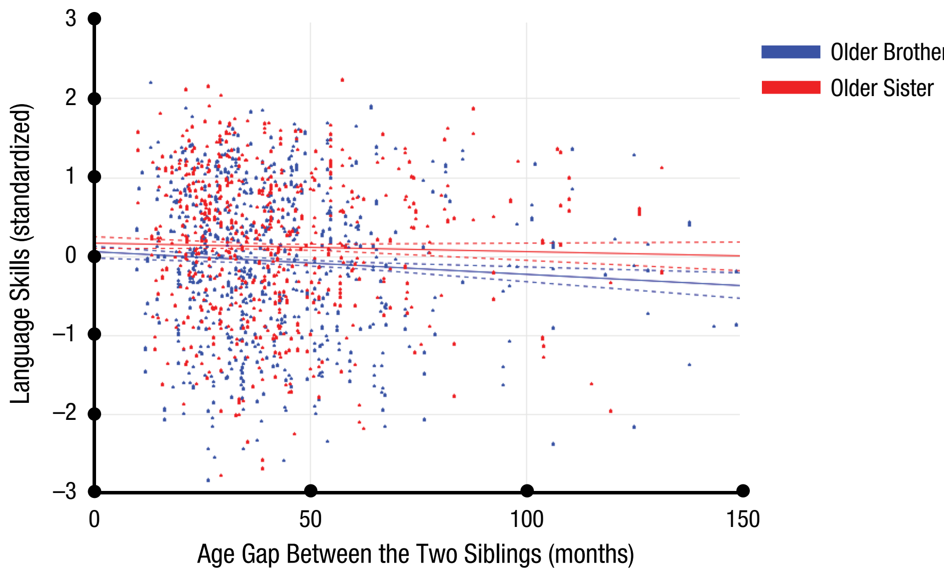

Fig. 2. Scatterplot showing the relationship between language skills and age gap between participants and their siblings, separately for children with an older brother and an older sister. Solid lines indicate best-fitting regressions, and dotted lines represent 95% confidence intervals.

sibling tended to also have more younger siblings). Although we adjusted for these factors statistically, it would be helpful for future studies to use a more balanced sample.

To conclude, the current study found that having an older sister was associated with higher language scores than having an older brother. Children who had an older sister scored similarly to children with no older

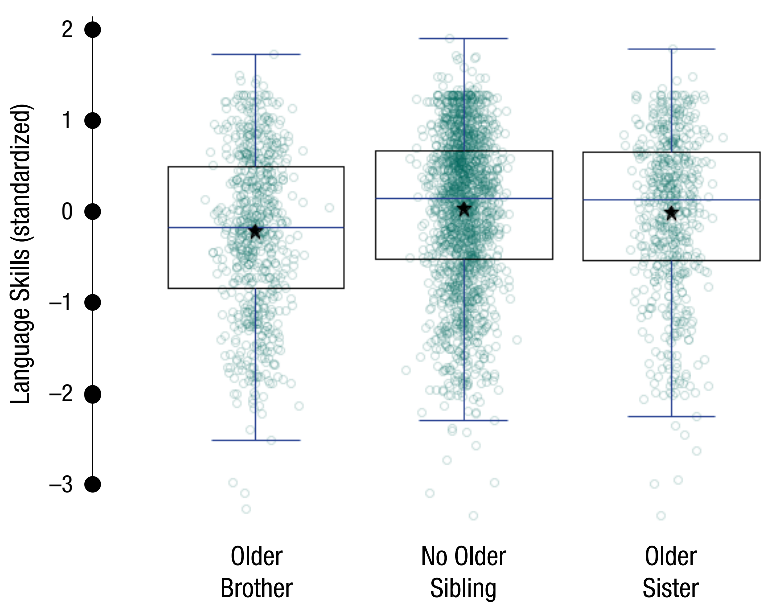

Fig. 3. Language skills of children with no older siblings compared with those who had one older brother or one older sister. The boxes encompass within-quartile ranges, the black stars represents means, and the error bars represent ±2 *SD*. Open circles represent individual data points. Because the model included children's scores at each age separately, children have between one and three data points apiece, depending on whether data were missing.

Table 5. Results of Linear Mixed Regression Models With Language Skills as the Dependent Variable and the Presence and Sex of the Older Sibling as the Independent Variables (*N* = 1,276)

Model and predictor	β	*SD*	*p*
Unadjusted model			
Older brother (reference: without an older sibling)	−0.234	0.037	< .0001
Older sister (reference: without an older sibling)	−0.042	0.040	.2969
Model 1 (adjusted)			
Older brother (reference: without an older sibling)	−0.267	0.045	< .0001
Older sister (reference: without an older sibling)	−0.060	0.047	.2085

Note: For this analysis, language scores were available for 1,154 two-year-olds (483 of whom had an older sibling), 996 three-year-olds (416 of whom had an older sibling), and 898 five- to six-year-olds (381 of whom had an older sibling). Adjusted Model 1 was adjusted for exact age at time of evaluation and other predictors of cognitive development—sex, gestational age (weeks), birth weight (kg), maternal age at delivery (years), paternal age at delivery (years), breastfeeding initiation (%), alcohol use during pregnancy (units per week), tobacco use during pregnancy (%), parental education (years), household income (thousands of euros per month), and presence of younger siblings at the time of evaluation.

sibling, whereas children who had an older brother scored significantly lower. We found no evidence that a larger age gap between siblings was beneficial for the language development of the younger child.

Action Editor

Rebecca Treiman served as action editor for this article.

Author Contributions

N. Havron developed the study concept and wrote the first draft of the manuscript. F. Ramus, A. Cristia, H. Peyre, B. Heude, and A. Forhan commented on drafts of the manuscript. B. Heude and A. Forhan collected the original data on which the study was based. N. Havron, F. Ramus, A. Cristia, and H. Peyre constructed the data-analysis plan; H. Peyre analyzed the data. All authors approved the final version of the manuscript for submission.

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Declaration of Conflicting Interests

The author(s) declared that there were no conflicts of interest with respect to the authorship or the publication of this article.

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Supplemental Material

Additional supporting information can be found at http://journals.sagepub.com/doi/suppl/10.1177/0956797619861436

Open Practices

The design and analysis plans for the experiments were preregistered at https://osf.io/pgtyx/. Changes made to the preregistration after data collection are described in the main text. The data used in this study can be accessed through the EDEN Mother-Child Cohort Study Group website (http://eden.vjf.inserm.fr/index.php/fr/) after completion of a request or registration form. The complete Open Practices Disclosure for this article can be found at http://journals.sagepub.com/doi/suppl/10.1177/0956797619861436. This article has received the badge for Preregistration. More information about the Open Practices badges can be found at http://www.psychologicalscience.org/publications/badges.

Note

1. We analyzed a subsample of the EDEN cohort full sample consisting only of children with one older sibling or no older siblings. Children with more than one older sibling (n = 354) were excluded because additional older siblings may obscure the effects of age gap and sex of the immediately preceding older sibling. The EDEN cohort full sample included 1,907 liveborn children, as described in detail by Heude et al. (2016). The attrition rate of children at age 5 years was 41%, both for the overall sample in the cohort and for our analysis sample.

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