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Older sibling contribution to younger children's working memory and cognitive flexibility

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Abstract

We used structural equation modeling in the Early Childhood Longitudinal Study—Kindergarten Cohort (*N* = 17,020) to explore the influence of having an older sibling on kindergarten-age focal children's cognitive self-regulation. In model 1, we tested how having a sibling who is generally older than the focal child contributes to the focal child's working memory (WM) and cognitive flexibility (CF) upon entering kindergarten. In model 2, we assessed the contribution to the focal child's kindergarten WM and CF of having an older sibling in a non-proximal age range (age 12–18) or not having siblings relative to having an older sibling in a proximal age range to the focal child (up to age 11). In model 3, we considered the contribution of having an older sister, an older brother, or both an older sister and an older brother of any age. Having an older sibling in general was associated with increased kindergarten WM, whereas having an older sister was related to increased WM and CF. Compared to having a proximal older sibling, having no siblings and having a non-proximal older sibling were related to decreased WM and CF. Findings have implications for involving siblings in family interventions in early childhood.

KEYWORDS
cognitive flexibility, self-regulation, siblings, sisters, working memory

1 | INTRODUCTION

Developing self-regulation in early childhood prepares children to learn upon entering formal school environments (Blair & Razza, 2007; Fitzpatrick & Pagani, 2011; Fuchs et al., 2010; Ponitz, McClelland, Matthews, & Morrison, 2009; Rimm-Kauffman, Curby, Grimm, Nathanson, & Brock, 2009). Children develop cognitive self-regulation skills such as planning and controlling attention in the home environment (Baker, 2013; Bernier, Carlson, Deschênes, & Matte-Gagné, 2012; Engelhardt et al., 2016; Segers, Damhuis, van de Sande, & Verhoeven, 2016). Parents are viewed in research and policy as primary caretakers and thus primary contributors to children's cognitive development and subsequent school readiness (Ayoub, 2018; Eisenberg et al., 2005; Hill, 2001; McWayne, Fantuzzo, Cohen, & Sekino, 2004; U.S. Department of Education, 2018). However, such research neglects the roles of other family members such as siblings who spend significant if not greater periods of time with children (Dunn, 2015).

1.1 | Significance of cognitive self-regulation in kindergarten

Self-regulation encompasses a network of competencies necessary for managing behaviors, thoughts, and emotions in response to environmental inputs (McClelland & Cameron, 2011). The cognitive skills of controlling attention and memory, combined with children's ability to reflect on and respond to emotions and behaviors in a demanding social environment, contribute to children's overall ability to self-regulate (Raver & Blair, 2016). Working memory (WM) and cognitive flexibility (CF) are widely acknowledged as executive functioning skills, those cognitive skills integral to "the broader construct" (Raver & Blair, 2016, p. 4) of self-regulation. WM is the ability to store information in memory that is immediately needed for brief time periods, and CF entails switching attention between tasks (McClelland & Cameron, 2011).

Both WM and CF are pertinent to children's school readiness (Ponitz et al., 2009; Rimm-Kauffman et al., 2009). WM is associated positively with early academic outcomes such as receptive vocabulary, classroom engagement, number knowledge (Fitzpatrick & Pagani, 2011), and word problem skills (Fuchs et al., 2010). CF also is pivotal for its association with kindergarten math and reading outcomes such as phonemic awareness, letter knowledge, and math knowledge (Blair & Razza, 2007). Given that WM and CF are essential cognitive self-regulation skills for preparing children for school (Blair & Razza, 2007; Fitzpatrick & Pagani, 2011; Ponitz et al., 2009), it is necessary to examine the primary context for developing WM and CF prior to school—the home (Baker, 2013; Segers, Damhuis, Sande, & Verhoeven, 2016).

1.2 | Sibling scaffolding and collaboration in promotion of self-regulation

Humans uniquely are able to learn through social interaction (Vygotsky, 1978), and the home is the first setting in which children practice social behavior. At early ages, children's social context is dominated by direct interactions with parents and siblings in the microsystem (Bronfenbrenner, 1977; Eisenberg et al., 2005; Hill, 2001; McWayne et al., 2004; Reynolds, Dorner, & Faulstich-Orellana, 2011). Siblings may be a particularly salient sociocultural influence in the home, spending as much or more time with children as parents (Dunn, 2015), and supplying additional supports when parents are less involved (White & Hughes, 2017). Based on Vygotsky's (1978) theory of learning through social interaction, knowledge is most likely to be internalized in the context of interaction between focal children and more knowledgeable others. Children learn not just from social interactions with parents in the home context but from interactions with older siblings, as older siblings scaffold focal children by providing access to understanding of psychological tools, presenting a level of challenge that allows focal children to pursue their developmental potential. Successful scaffolding requires certain conditions and behaviors, which siblings provide (White & Hughes, 2017). Combined with differing levels of knowledge and skills, and a democratic power

dynamic, older siblings establish environmental resources and opportunities for teaching and learning. The older sibling's suitability as teacher spurs from supportive scaffolding practices and parallel interests to the focal child (Howe & Recchia, 2009; White & Hughes, 2017). Moreover, the teaching strategies typically exhibited by older siblings include guidance techniques such as explaining or hinting in addition to scaffolding, which place demands on the younger child's WM and CF (Howe & Recchia, 2009). Also, focal children are equipped to benefit from sibling teaching as indicated by active learner behaviors (Howe, Brody, & Recchia, 2006). The sibling relationship straddles horizontal relationships, in which levels of authority and knowledge are equivalent, and vertical relationships, characterized by contrasting levels of authority and knowledge (Brownell & Carriger, 1998; Hartup, 1989). Furthermore, sibling relationships are distinct from horizontal peer relationships, in part due to the consistency of interaction and influence on younger siblings (White & Hughes, 2017).

Collaborative interactions between older and younger siblings involve older siblings contributing challenging knowledge, being responsive to younger siblings' level of understanding, and allowing for younger siblings' contributions of their developmentally appropriate knowledge and eagerness to learn (Brownell & Carriger, 1998). Collaboration is inherently cognitive due to the demands placed on self-regulation strategies of "goal recognition or definition, planning of behavior around the goal, adopting effective goal-related strategies, and monitoring and changing goal-directed behavior" (Brownell & Carriger, 1998, p. 198). Moreover, these goal-oriented, cognitive self-regulatory behaviors are reciprocated by child collaborators such as the older and younger sibling, in order to achieve a shared objective. Therefore, the sibling relationship, and collaboration between siblings, make contributions to the younger child's development that are distinct from vertical parent–child interactions in early childhood and particularly relevant for cognitive self-regulation (Brownell & Carriger, 1998).

It is also evident that siblings play a role in development of perspective taking, emotional and cognitive regulation (McAlister & Peterson, 2007), particularly in approaching conflict and pretend play (Dunn, 2015). However, very few studies focusing on siblings and self-regulation consider CF and WM as outcomes (Kennedy, Lagattuta, & Sayfan, 2015), with those that have examined these processes demonstrating conflicting findings. Kennedy et al. (2015) examined the association between having older siblings and executive functions defined as inhibitory control and verbal WM, finding a negative correlation between number of older siblings and verbal WM (Kennedy et al., 2015). However, the association of older siblings to other cognitive self-regulation competencies such as CF remains less understood.

1.3 | Influence of sibling age range and gender in promoting cognitive self-regulation

1.3.1 | Age range

Though relationships between older and younger siblings might be viewed as vertical (Hartup, 1989), the relationship could be more horizontal depending on proximity in age and development of the older sibling to the younger sibling. The older sibling has a higher propensity to demonstrate teaching practices including scaffolding, physical demonstrations, and corrective feedback that are responsive to the age of the younger sibling and the level of challenge of the task when the older sibling is in middle childhood (Howe et al., 2006). Older siblings in the age group of middle childhood may execute cognitive self-regulation skills with greater organization and synchronization, also enhanced by self-monitoring (Welsh, Friedman, & Spieker, 2008). Thus, the period of middle childhood may present a window for older siblings to model more sophisticated levels of cognitive self-regulation while supporting younger children's progression from more rudimentary levels of cognitive self-regulation in ways that are appropriate for younger siblings. As older siblings surpass age 11, the age gap with younger siblings entering kindergarten may be too large, particularly given shifts in cognitive ability in early adolescence (Welsh et al., 2008). It may be that having a more proximally aged sibling (i.e., up to age 11) is more beneficial to a kindergarten-age child than having an adolescent older sibling, because older siblings' experiences in middle childhood and preadolescence are more pertinent to those of children in kindergarten. Bryant (1982) stated that "we would expect

children in [middle childhood] to be actively engaged with their siblings" and "struggling to better manage sibling interaction" (p. 88), also noting that older siblings help children of this age range to define their social standing in the immediate family context and the broader school context. In contrast, older siblings entering adolescence (i.e., 12 and older) may have greater agency paired with fewer overlapping social experiences with younger siblings (White & Hughes, 2017), which reduce opportunities to scaffold and teach younger siblings.

Given the potential for older siblings in middle childhood to demonstrate more cognitive self-regulation and serve as scaffolding models for their younger siblings, and the increased likelihood for meaningful engagement between older siblings in middle childhood and younger siblings, it is possible that older siblings in middle childhood are particularly well suited for facilitating younger siblings' cognitive development. Furthermore, through middle childhood, the sibling style of interaction and the affective nature of the sibling relationship does not change significantly (White & Hughes, 2017). In fact, the older sibling and the younger sibling can leverage the established power dynamic and emotional inputs, and teaching supports from the older sibling to scaffold cognitive self-regulation development through consistent inputs to the relationship (Brownell & Carriger, 1998; Dunn, Slomkowski, & Beardsall, 1994). Correlational findings regarding older sibling age range suggest that having a higher number of older siblings who were 11 years of age and up was associated with improved inhibitory control response time in 4–11–year-old focal children, and the number of siblings between 6 and 10 years old was associated with higher inhibitory control performance of the focal children in the regression model (Kennedy et al., 2015). Furthermore, sibling dyads of 7-year-old focal children and 9-year-old older siblings demonstrated higher frequencies of discussing cognitions at Time 2 than at Time 1, when older siblings were not yet in middle childhood (Leach, Howe, & Dehart, 2017). The authors attributed these findings to advancements in sociocognitive development in middle childhood (Leach et al., 2017), but findings also could be indicative of the effective strategies older siblings in middle childhood used in order to scaffold discussing cognitions. Therefore, we hope to build on this finding by determining the influence on cognitive self-regulation of having an older sibling with particular characteristics (age range, gender) that may be developmentally adaptive for the younger sibling compared to having no siblings or having siblings with less adaptive characteristics. Once we establish the benefit of having an older sibling, we will have a better understanding of whether an increase in siblings with similar characteristics augments or reduces the benefits.

1.3.2 | Gender

Gender of older siblings also may influence their tendency to serve as teachers (Brownell & Carriger, 1998). Due to socialization patterns that prepare females to exhibit caretaking behavior, females may function in their role as older sisters to support younger children's development (Leaper, 1991; Leaper & Friedman, 2007; Leaper & Smith, 2004; Leaper, Tenenbaum, & Shaffer, 1999). In comparison to brothers, older sisters may foster a nurturing teaching environment through greater affection, prosocial behavior, and intimacy based on children's reports of sibling relationships in middle childhood and adolescence (Buhrmester & Furman, 1990). Moreover, children may be more receptive to older sisters' teaching than that of older brothers', as indicated by greater neutral acceptance (Howe et al., 2006). Furthermore, regulatory competencies such as younger siblings' theory of mind (ToM) are associated positively with number of female siblings (Kennedy et al., 2015), and there is a negative association between sisters and younger siblings' internalizing behavior (Padilla-Walker, Harper, & Jensen, 2010). Despite evidence of the importance of sibling gender in family socialization and the association between sibling gender and broader cognitive outcomes, limited research exists examining the association between sibling gender and WM and CF.

1.4 | The present study

The importance of siblings for scaffolding younger children's development, and our limited understanding of how sibling age and gender relate to children's cognitive self-regulation, highlight the need for exploratory research that examines how these factors relate to kindergarten age children's WM and CF. The present study addressed

these initial research questions: (a) Is having an *older sibling* associated with the younger child's WM and CF in fall of kindergarten? (b) Is having an *older sibling in the proximal age range of up to age 11 (proximal older sibling)* related to the younger child's WM and CF in fall of kindergarten? (c) Is the *gender of older siblings of any age* associated with the younger child's WM and CF in fall of kindergarten? Moreover, this study will contribute to our understanding of WM and CF as coactive processes in managing attention by accounting for interrelatedness of these self-regulation outcomes rather than modeling them separately.

Based on the established evidence of older siblings' role in younger children's cognitive development (Dunn, 2015; White & Hughes, 2017), we predicted that having an older sibling would contribute positively to the younger focal child's WM and CF performance. Moreover, given the increased benefits of interactions between focal children in early childhood and older siblings in middle childhood (Kennedy et al., 2015; Leach et al., 2017; Welsh et al., 2008), we predicted that having proximal older siblings would facilitate kindergarten WM and CF more effectively. In investigating older sibling gender, we hypothesized that having older sisters of any age would support WM and CF based on patterns of socializing girls to support caretaking (Leaper, 1991; Leaper & Friedman, 2007; Leaper & Smith, 2004; Leaper et al., 1999) as well as interaction styles of older sisters in engaging and teaching younger children (Buhrmester & Furman, 1990; Padilla-Walker et al., 2010). We predicted that having older brothers of any age would not contribute significantly to outcomes. Lastly, our investigation of the influence of having an older sister and an older brother was exploratory, such that findings could reflect that older sisters and brothers of any age either cooperatively support the focal child's development or demonstrate inputs that neutralize each other.

2 | METHOD

2.1 | Participants

We utilized the Early Childhood Longitudinal Study: 2011 Kindergarten cohort (ECLS-K:2011) restricted-use data, a nationally representative dataset from the National Center for Education Statistics, which is part of a continuing study of children entering kindergarten in the fall of 2010 (Tourangeau et al., 2015). For each child, the dataset provides information on family characteristics, children's cognitive and socioemotional development, academic achievement, and other demographic information. Our study focused on direct assessments of children's self-regulation, including WM and CF assessed in fall of kindergarten. Our key predictors focused on family composition, particularly on the presence of older siblings in the household in fall of kindergarten.

The ECLS-K:2011 sample population consisted of 17,020 kindergarten-age children, with ages between 44.81 months (~4 years old) and 93.90 months (~8 years old; M = 67.45 months, SD = 4.48). The sample was ethnically diverse, with 49.9% of children identified as White on the school roster, and the other half of the children identified as Black (14.1%), Hispanic (26.9%), or Asian (9.1%). The highest level of parental education in the majority of focal children households was above high school but not including college, with the remainder of the sample also demonstrating low levels of parental education. A slight majority of the families of focal children reported an income at or above 200% of the U.S. Census Bureau poverty threshold, which varied depending on the size of the household (Tourangeau et al., 2015). The remainder of families reported income at or above the poverty threshold but below 200% of the poverty threshold, or below the poverty threshold. Regarding family composition, focal children in the sample had between one and two siblings on average (see Table 1 for descriptive sample statistics).

2.2 | Measures

2.2.1 | Older sibling

A dichotomous variable indicating whether the focal child had at least one older sibling was created from the household roster variables indicating each household member's age and relationship to the focal child. All

TABLE 1 Sample descriptives

	M (*SD*)	Percent	Range
Working memory	432.7 (30.2)		393–572
Cognitive flexibility	14.2 (3.3)		0–18
# of siblings	1.5 (1.1)		0–12
Has at least one sibling		86.6%	0–1
# older siblings	0.9 (1.0)		0–10
Has at least one older sibling		58.9%	0–1
# proximal older siblings up to 11 years of age	0.7 (0.7)		0–6
# non-proximal older siblings 12 to 18 years of age	0.3 (0.6)		0–6
Older sibling age range			
Has no siblings		22.2%	0–1
Has at least one proximal older sibling up to 11 years old		63.1%	0–1
Has at least one non-proximal older sibling 12–18 years old		14.7%	0–1
Older sibling gender			
Has at least one older sister		22.5%	0–1
Has at least one older brother		23.6%	0–1
Has at least one older sister and one older brother		12.9%	0–1
Gender (Male = 1)		51.1%	0–1
Age (months)	67.5 (4.5)		44.8–93.9
Race and ethnicity			
White		49.9%	0–1
Black		14.1%	0–1
Hispanic		26.9%	0–1
Asian		9.1%	0–1
Disability status (Yes)		19.7%	0–1
Poverty status			
Below poverty threshold		25.7%	0–1
At or above poverty threshold but below 200%		22.1%	0–1
At or above 200% of poverty threshold		52.2%	0–1
Parental education (Highest level)			
Completed college or above		25.1%	0–1
Above high school but no college		55.4%	0–1
Less than high school degree		19.5%	0–1
Both foreign-born parents		26.3%	0–1
English home		79.6%	0–1
Childcare			
Parental care		21.7%	0–1
Center care		57.2%	0–1
Relative care		15.0%	0–1
Non-relative care		6.1%	0–1

(Continues)

TABLE 1 (Continued)

	M (*SD*)	Percent	Range
Full day kindergarten		82.6%	0–1
First year of kindergarten		94.7%	0–1

Notes: Percentages are rounded to the nearest tenth and may not sum to 100%. In compliance with the license agreement, all sample sizes are rounded to the nearest 10. The control variables White, At or above 200% of poverty threshold, Highest parental education: completed college or above, and Center care were omitted from analyses and treated as reference groups.

individuals coded as "brother" or "sister," who were older than the focal child were identified as older siblings. If the focal child had at least one sibling who met these criteria, they were identified as having an older sibling (0 = had no siblings (older/younger); 1 = had older sibling).

2.2.2 | Older sibling age range

To identify those older siblings who ranged in proximity in age to the focal child, we created dichotomous indicators for the following: the focal child had no siblings (0 = all others; 1 = had no siblings); focal child had a non-proximal older sibling between 12 and 18 years old (0 = all others; 1 = had at least one non-proximal older sibling); focal child had a proximal older sibling up to 11 years old (0 = all others; 1 = had at least one proximal older sibling [reference group]).

2.2.3 | Older sibling gender

We created the following dichotomous indicators of older sibling gender: the focal child had an older sister (0 = all others; 1 = had at least one older sister); focal child had an older brother (0 = all others; 1 = had at least one older brother); focal child had an older sister *and* an older brother (0 = all others; 1 = had at least one older sister and at least one older brother); focal child had no siblings (0 = all others; 1 = had no siblings [reference group]).

2.2.4 | Working memory (WM)

WM was measured using the Numbers Reversed subtest of the Woodcock–Johnson III tests of Cognitive Abilities (Woodcock, McGrew, & Mather, 2001) administered in fall of kindergarten in 2010. The subtest consisted of introducing a sequence of numbers and instructing the child to recite the numbers in the opposite order. The sequences increased in difficulty, ranging from five two-number sequences to five eight-number sequences. The child was required to complete three of the same length sequences in a row successfully in order to progress to the next level of difficulty. The outcome variable for WM was defined by the Numbers Reversed W-Ability Score (Range: 393–603). The average score based on a 10-year-old child is 500 (*SD* = 100) (Mather & Woodcock, 2001; Tourangeau et al., 2015).

2.2.5 | Cognitive flexibility (CF)

The Dimension Change Card Sort Task was administered in fall of kindergarten 2010 as a measurement of CF and inhibitory control (DCCS; Zelazo, 2006). The task involved sorting 22 cards with images on them into the correct tray based on sorting criteria determined by varying sets of rules ranging in difficulty. Rules included: sorting by the color of the image on the card in the Color Game, sorting by shape in the Shape Game, and sorting by shape or color based on the presence or absence of a border in the Border Game. Advancing to the Border Game depended on the child's ability to sort four out of six cards in the Shape Game, which required flexibly adjusting to new rules

and inhibiting the response patterns established with previous rules. The outcome variable for CF was defined by the Card Sort Combined Score (Range: 0–18; Tourangeau et al., 2015).

2.2.6 | Control variables

Additional variables were included in the models as control or auxiliary variables. These variables include focal child gender (0 = Female; 1 = Male), age measured in months, child race (1 = White [reference group], 2 = Black, 3 = Hispanic, 4 = Asian), disability status (0 = child does not have diagnosed disability; 1 = child has disability diagnosed by professional), family poverty level (1 = below poverty threshold, 2 = at or above poverty threshold but below 200%, 3 = at or above 200% of poverty threshold [reference group]), highest level of parental education attained (1 = completed college or above [reference group], 2 = above high school but no college, 3 = less than high school degree), foreign-born status of parents (0 = at least one U.S.-born parent; 1 = both foreign-born parents), English was the primary language spoken at home (0 = primary language other; 1 = primary language), childcare type in preschool (1 = parental care, 2 = center care [reference group], 3 = relative, 4 = non-relative care), full day kindergarten (0 = part-time kindergarten; 1 = full-time kindergarten), and first-time kindergartener (0 = not first time in kindergarten; 1 = first time in kindergarten).

3 | RESULTS

3.1 | Descriptive statistics

WM (M = 432.7, SD = 30.2) and CF (M = 14.2, SD = 3.3) were distributed normally. Nearly 59% of the sample had at least one older sibling, with 63.1% of the sample having at least one older sibling up to 11 years old. The percentage of the sample who had at least one older sister (22.5%) was similar to that which had at least one older brother (23.6%). Only 12.9% of the sample had at least one older sister *and* one older brother (see Table 1).

We utilized structural equation modeling in Stata 14.0 (Acock, 2013; StataCorp, 2014) to test three separate models examining different aspects of the association between having older siblings and our two outcomes of interest, WM and CF. Importantly, both outcomes were incorporated into the model simultaneously, accounting for the shared variance between these cognitive self-regulatory processes (Miyake et al., 2000). The first model examined the association between having at least one older sibling and WM and CF. The second model examined the association between having no siblings and having a non-proximal older sibling and our key outcomes relative to that of having a proximal older sibling. Therefore, we entered the indicator for having no siblings and the indicator for having a non-proximal older sibling as predictors into model 2, and the indicator for having a proximal older sibling was omitted as the reference group. Finally, the third model examined the association between older sibling gender and our key outcomes, tested by entering the indicators for having an older sister of any age, having an older brother of any age, and having both an older brother and sister of any age, as predictors into model 3 and omitting the indicator for having no siblings as the reference group.

3.1.1 | Missing data

Approximately 14% of CF and WM data were missing at kindergarten entry. Our older sibling variable was missing for 29% of the sample. We verified that data were missing at random, conditional on additional covariates. Full information maximum likelihood, which utilizes all available data and increases the statistical power of estimated parameters, was used to address missing data concerns (Enders & Bandalos, 2001). We used race, child disability status, family poverty level, parental education, whether or not English primarily was spoken at home, foreign-born status of the parents, childcare indicator variables, and whether the child attended full day kindergarten, as auxiliary variables (Collins, Schafer, & Kam, 2001; Enders, 2010).

3.2 | Siblings and cognitive self-regulation

3.2.1 | Older siblings (Model 1)

We partially confirmed our hypothesis that having an older sibling would be associated positively with children's cognitive self-regulation at kindergarten entry (see Table 2). Accounting for all controls, having an older sibling was associated with a 1.46 point increase in children's WM (β = .02, p < .01). However, having an older sibling was not associated significantly with CF (β = .02, p = .07).

3.2.2 | Proximal older siblings (Model 2)

We confirmed the hypothesis that having an older sibling, particularly in a proximal age range (up to age 11) to the kindergarten-age focal child would be related positively to children's cognitive self-regulation at kindergarten entry (see Table 2). Accounting for all controls, relative to having a proximal older sibling up to age 11, having no siblings was associated with a 2.30 point decrease in focal children's WM (β = −.03, p < .01) and a 0.38 point decrease in CF (β = −.05, p < .001). Having a non-proximal older sibling between 12 and 18 was associated with a 3.07 point decrease in focal children's WM (β = −.04, p = .001) and a 0.26 point decrease in CF in fall of kindergarten (β = −.03, p < .05). Therefore, only having an older sibling in the proximal age range promoted cognitive self-regulation.

However, there appeared to be no cumulative benefit to having more than one proximal older sibling. In supplementary analyses, we examined differences in WM and CF between children who had one proximal older sibling, more than one proximal older sibling, and no proximal older siblings (reference group). We found that having one proximal older sibling was still associated significantly and positively with focal child outcomes compared to having no proximal older siblings (WM: β = .03, p = .001; CF: β = .02, p < .05). Yet, no differences were found between children who had more than one proximal older sibling and no proximal older siblings.

3.2.3 | Older sibling gender (Model 3)

Our findings confirm the hypothesis that having an older sister, of any age, would be associated positively with WM and CF. Having an older sister of any age was associated significantly with WM (a 2.69 point increase in WM; β = .04, p < .001) and CF (a 0.19 point increase in CF; β = .02, p < .05) in fall of kindergarten. In contrast, having an older brother, or having an older sister and an older brother, of any age were not associated with WM and CF.

4 | DISCUSSION

Having older siblings as well as characteristics of those siblings such as their age and gender are relevant for focal children's cognitive self-regulation skills of WM and CF at kindergarten entry. Analyses revealed that having an older sibling was associated positively with kindergarten WM but only associated marginally with kindergarten CF. Having an older sister was associated positively with both WM and CF, and having no siblings and having a non-proximal older sibling were associated negatively with outcomes.

4.1 | Older siblings

The positive association between having an older sibling and WM in a national sample seems to illustrate the importance of non-parental family members for developing cognitive self-regulation at kindergarten entry. Specifically, our findings highlight the potential for older siblings to support younger children's development of WM. Thus, findings reinforce research on the significance of social interactions with siblings for scaffolding

TABLE 2 Standardized associations between sibling variables and working memory and cognitive flexibility in fall of kindergarten

Working memory	Model 1	Model 2	Model 3
Has at least one older sibling	0.02**	–	–
Older sibling age range			
Has no siblings	–	−0.03**	–
Has at least one non-proximal older sibling	–	−0.04***	–
Older sibling gender			
Has at least one older sister	–	–	0.04***
Has at least one older brother	–	–	0.01
Has at least one older sister and at least one older brother	–	–	0.00
Gender (male)	−0.04***	−0.04***	−0.04***
Black	−0.12***	−0.11***	−0.12***
Hispanic	−0.10***	−0.09***	−0.10***
Asian	0.03*	0.03**	0.03*
Age (in months)	0.14***	0.14***	0.14***
Disability status (yes)	−0.11***	−0.11***	−0.11***
Below poverty threshold	−0.11***	−0.11***	−0.10***
At or above poverty threshold below 200%	−0.06***	−0.06***	−0.06***
Highest parental education: above high school but no college	−0.15***	−0.14***	−0.15***
Highest parental education: less than high school degree	−0.22***	−0.21***	−0.22***
Both foreign-born parents	−0.03	−0.03	−0.03
English home	0.04*	0.04*	0.04*
Parental care	−0.04***	−0.04***	−0.04***
Relative care	−0.03***	−0.03***	−0.03***
Non-relative care	−0.00	−0.00	−0.00
Full day kindergarten	−0.00	−0.00	−0.00
First time in kindergarten	0.04***	0.04***	0.04***
Cognitive flexibility			
Has at least one older sibling	0.02+		
Older sibling age range			
Has no siblings		−0.05***	
Has at least one non-proximal older sibling		−0.03*	
Older sibling gender			
Has at least one older sister		–	0.02*
Has at least one older brother		–	0.02
Has at least one older sister and at least one older brother		–	−0.01
Gender (male)	−0.04***	−0.04***	−0.04***
Black	−0.11***	−0.11***	−0.11***
Hispanic	−0.07***	−0.06***	−0.07***
Asian	0.01	0.01	0.01
Age(in months)	0.11***	0.11***	0.11***

(Continues)

TABLE 2 (Continued)

Working memory	Model 1	Model 2	Model 3
Disability status (yes)	−0.10***	−0.10***	−0.10***
Below poverty threshold	−0.05***	−0.06***	−0.05***
At or above poverty threshold below 200%	−0.02+	−0.02*	−0.02+
Highest parental education above high school but no college	−0.06***	−0.05***	−0.06***
Highest parental education less than high school degree	−0.10***	−0.09***	−0.10***
Both foreign-born parents	−0.08***	−0.08***	−0.08***
English home	0.02	0.02	0.02
Parental care	−0.03***	−0.04***	−0.03***
Relative care	−0.01	−0.01	−0.01
Non-relative care	0.00	0.00	0.00
Full day kindergarten	0.03**	0.03***	0.03**
First time in kindergarten	0.04***	0.04***	0.04***

+marginally significant defined as $p \leq .07$; *$p \leq .05$; **$p \leq .01$; ***$p \leq .001$.

cognitive self-regulation development (Dunn, 2015; White & Hughes, 2017). However, the association between having an older sibling and CF was marginal, suggesting that sibling interactions may not play the same role in shaping all aspects of cognitive self-regulation. Research on the neuropsychological mechanisms driving WM and CF suggests that WM is a key process that plays a control function in attentional and inhibitory processes (Baddeley, 1996). It may be that through teaching practices, older siblings contribute to shaping development of younger siblings' WM capacity, which may have positive long-term implications for attentional and inhibitory processes. Additional research is needed to examine whether it is indeed older siblings' unique linguistic inputs that drive WM capacity in the short term, having implications for attentional and inhibitory processes in the longer term.

4.2 | Older sibling age range

Our findings also suggest that having an older sibling proximal in age to the focal child could benefit younger children's cognitive self-regulation at kindergarten entry. It may be that older siblings use scaffolding practices effectively to teach cognitive self-regulation, whereas younger siblings have the capacity to learn and develop cognitive self-regulation in kindergarten (Howe & Recchia, 2009; Welsh et al., 2008). Older children who straddle a vertical and horizontal relationship with younger siblings may be positioned better to provide scaffolds for learning through shared interests, balanced power dynamics, and well-established relationships (White & Hughes, 2017) with their younger siblings. However, additional testing of the influence of having multiple proximal older siblings revealed that having one proximal older sibling was related positively to focal child outcomes, but having more than one proximal older sibling was not related. It could be that having multiple proximal older siblings detracts from the quality of individual relationships between proximal older siblings and younger siblings.

Some evidence suggests that having siblings up to about age 12 is a positive predictor of inhibitory control and subtypes of ToM (Kennedy et al., 2015; McAlister & Peterson, 2007, 2013). As for the one finding pointing to age 11 and up as an age range in which older siblings promote inhibitory control (Kennedy et al., 2015), this potentially could be a beneficial age range to support a focal child's development if the child is closer to age 11 than to age 4. Focal children in kindergarten may view proximal older siblings up to age 11 as models for their behavior more so than older siblings in other age ranges. By being relatively close in age, the older sibling may still be interested in engaging their younger sibling in play and teaching in support of younger siblings' development of WM and CF.

Older siblings in middle childhood also exhibit a level of organization of cognitive self-regulatory processes that is a useful reference point for younger siblings with emerging cognitive self-regulation skills (Welsh et al., 2008). Although additional research is needed to establish the type and quality of interactions that occur between proximal siblings that support the WM and CF of younger siblings, our study provides initial support that having an older sibling close in age has positive implications for cognitive self-regulation at school entry.

4.3 | Older sibling gender

We found that having an older sister of any age was associated with WM and CF at kindergarten entry. However, having an older brother of any age or having both an older sister and an older brother of any age was not associated with kindergarten WM and CF. The finding favoring older sisters may be indicative of gender differences in the cognitive self-regulation competencies of older siblings. Such gender differences are consistent with Matthews, Ponitz, and Morrison's (2009) findings that girls demonstrated higher levels of behavioral self-regulation. These gender differences in kindergarten children potentially could persist in older sisters, thus allowing them to be better at scaffolding younger siblings' cognitive self-regulation.

Other studies demonstrate that males have been socialized by their families differently from females, potentially resulting in older sisters valuing and cultivating more nurturing skills than older brothers (Leaper & Friedman, 2007). In other words, sisters may be socialized to be more affiliative and build connections with younger siblings (Leaper, 1991; Leaper & Friedman, 2007; Leaper & Smith, 2004; Leaper et al., 1999), enabling them to be effective teachers. Conversely, older brothers may be socialized to be more assertive rather than oriented to the learning needs of younger siblings. Moreover, research on socialization of males and females has shown that females demonstrate greater responsiveness than males (Leaper & Friedman, 2007; Leaper & Smith, 2004). Hence, older sisters may be more likely to foster environments conducive to scaffolding cognitive self-regulation in younger children (Leaper & Friedman, 2007).

Drawing from our findings, socialization differences may allow older sisters to foster more nurturing environments for younger siblings only when older brothers are not part of the family. Additional research on the shared impact of older sisters and older brothers on younger siblings' development of cognitive self-regulation should be conducted to determine whether the positive influence that sisters have on children's WM and CF is neutralized when at least one older brother is also present in the home. Further research also should examine the intersection of older sibling age range and gender to determine a potential link between the non-significant finding for having both an older sister and an older brother and the non-significant supplementary finding for having more than one proximal older sibling. It may be that an older sister in a proximal age range is able to provide responsive and developmentally appropriate supports for the younger sibling, but additional older siblings who are male and also in a proximal age range may reduce quality and attention to individual relationships with younger siblings.

4.4 | Limitations and future directions

Although our study established an association between older siblings, sibling characteristics, and WM and CF, causal relations cannot be assumed. Moreover, we had limited information on siblings, and were primarily reliant on demographic characteristics such as age range and gender. Also, the manner in which variables were coded resulted in exclusion from analyses of children with only younger siblings and no older siblings. Furthermore, the analytical approach to model 2 cannot inform inferences about the contribution of having both a sibling in a proximal age range *and* a sibling in a non-proximal age range in the focal child household. Future research might recode demographic variables to investigate these outcomes. The present study findings provide an initial step in expanding current definitions of family engagement and inputs promoted in current educational policy and practice by suggesting that older siblings should be considered as valuable influences on children's school readiness. However, future studies might augment the current findings not only by providing further evidence for the role of

older siblings in children's cognitive self-regulation development but also by identifying the mechanisms through which older siblings promote WM and CF. Although not tested, it is possible that the association between having older siblings and cognitive aspects of self-regulation such as WM and CF could function through other regulatory competencies such as ToM or emotion regulation, given the previous evidence for older siblings' contribution to these skills (Garner, 1995) and the role of emotionality in cognitive self-regulation (Blair, 2002).

Additionally, researchers must explore other unique characteristics of sibling relationships (e.g., step-siblings, half-sibling, foster siblings, and adopted siblings). Finally, home environment and the role of older siblings may be influenced by race or ethnicity and overall culture. In fact, much of the qualitative research on older siblings' role in younger children's development reflects patterns of sibling interactions in populations characterized by diverse and often underrepresented ethnicities and cultures (Kibler, Palacios, Simpson-Baird, Bergey, & Yoder, 2016; Maynard, 2002; Rabain-Jamin, Maynard, & Greenfield, 2003; Rogoff, 1990). Future quantitative research should examine whether the nature of this relationship changes for different racial or ethnic groups, as there may be potential differences in the role of siblings across different racial and ethnic groups.

Building on efforts of the current study to highlight sibling roles in development, future research on interventions designed to promote cognitive aspects of self-regulation such as WM and CF in early childhood might focus on leveraging sibling interactions in home contexts. Proximal older siblings should be emphasized as resources who may supplement parents' contributions to self-regulation, ultimately helping children to navigate academic and social domains in kindergarten. Investigating how older sisters' interactions with younger children differ from those of older brothers might reveal those practices and environments that are most conducive to improvements in WM and CF.

5 | CONCLUSION

The degree to which families invest in forming rich environments for children contributes directly to children's attainment of school readiness skills such as self-regulation (Bronson, 2000). Our findings highlight the potential for older siblings to support children's cognitive self-regulation at the start of formal schooling. More importantly, we identify sibling age and gender as key factors that may influence younger siblings' WM and CF. By identifying the relation of having older siblings to younger children's cognitive self-regulation in kindergarten, we can work toward explaining the mechanisms through which older siblings enhance these environments. Particularly, when siblings are close enough in age to engage frequently with each other, older siblings may acclimate children to informal learning environments comparable to school, or otherwise create opportunities to practice cognitive self-regulation (Bronson, 2000). When developing early childhood interventions, it may be important to consider older sibling age and gender, particular in the home context, as well as other learning environments in which children are paired to work with older children.

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CONFLICT OF INTEREST

Neither I nor my coauthor have interests that may be viewed as influencing or conflicting with the research.

DATA AVAILABILITY STATEMENT

The data for this study were made available through a restricted-use license with the National Center for Education Statistics. Information for obtaining the public-use data file and a restricted-use license may be found at https://nces.ed.gov/pubsearch/getpubcats.asp?sid=024.

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