“Because If You Don’t Put the Top on, It Will Spill”: A Longitudinal Study of Sibling Teaching in Early Childhood

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Naturalistic dyadic sequences of teaching and learning involving older and younger siblings were investigated in 39 middle-class dyads over a 2-year period in early childhood. Siblings were observed during ongoing interactions in the home setting for 6 90-min sessions at both Time 1 (older sibling M age = 4.4 years; younger sibling M age = 2.4 years) and Time 2 (older sibling M age = 6.3 years; younger sibling M age = 4.4 years). Sequences of sibling-directed teaching (T1 n = 353; T2 n = 1,039) were identified from the observation transcripts and coded for teacher/learner roles, initiation of teaching, teaching strategies, and learner response. Older siblings were more likely to engage in teaching at both time points, but the proportion of younger sibling teaching increased significantly from T1 to T2, partially because older siblings requested teaching more often from their younger siblings at T2. Siblings’ use of teaching strategies varied across time points, while both older and younger sibling learners generally accepted or complied with the teaching. A final set of analyses examined birth-order effects while controlling for age by comparing older sibling teachers at age 4 (T1) to younger sibling teachers at age 4 (T2). At T1 firstborn older siblings (age 4) engaged in a wider range and more sophisticated teaching strategies than secondborn younger siblings (age 4) at T2. Findings highlight the bidirectional nature of teacher–learner interactions and are discussed in light of recent theory and research indicating that the sibling relationship is a rich context for children’s learning and development.

Keywords: siblings, teaching, learning, early childhood, naturalistic observation

Children’s social–cognitive development is facilitated within the context of close, intimate relationships with significant others (Carpendale & Lewis, 2004, 2006; Palincsar, 1998). The sibling relationship is a key context in which children reveal their social understanding during naturalistic interactions and family conversations (Dunn, 2002; Howe, Ross, & Recchia, 2011; Hughes & de Rosnay, 2006). An important, but understudied, relational process is how young siblings coconstruct shared meanings during conversations that the sibling relationship is a rich context for children’s learning and development. Nature of teacher–learner interactions and are discussed in light of recent theory and research indicating that the sibling relationship is a rich context for children’s learning and development.

Teaching and Learning

Piaget (1950) and Vygotsky (1978) argued that teaching depends on knowledge differences between the teacher and learner and not on authority or status differences (Tudge & Rogoff, 1989). Thus, in Rogoff’s (1990, 1998) collaborative model of teaching, the knowledgeable teacher intentionally guides the less informed learner via strategies that construct bridges between known and unknown information, promote and structure learner involvement, and allow the learner to assume responsibility for solving a prob-
Older Sibling and Younger Sibling Teaching/learning

Older siblings are typically assigned the teaching role in semi-structured paradigms where they are taught a task by an adult and then asked to teach their younger siblings (Azmithia & Hesser, 1993; Klein et al., 2002). In middle childhood, first-born siblings’ teaching strategies may reflect a learner-centered approach (e.g., encouraging, guiding) that facilitates the younger learner’s involvement and self-correction of their own errors (Howe & Recchia, 2005, 2009; Howe et al., 2012; Pérez-Granados & Callanan, 1997; Rogoff, 1998). Furthermore, school-age first-born teachers demonstrate sensitivity to the learner’s abilities during increasingly difficult tasks by appropriately adjusting their strategies (Howe et al., 2006). Thus, as they develop, first-born teachers become capable of constructing bridges between known and unknown information for learners and also engage learners so that they can take control of their own learning (Azmithia & Hesser, 1993; Howe et al., 2009). School-age first-born siblings’ greater social–cognitive skills may partly account for these developmental differences (Howe et al., 2012). Yet, studies that focus solely on the teacher do not provide a full analysis of the relevant processes.

Given the bidirectional nature of teaching, it is also important to consider the learner’s contributions; with age, learners are more involved during teaching (e.g., asking questions), which is associated with better task performance, perhaps by focusing the teacher on where the learner needs assistance (Azmithia & Hesser, 1993; Howe & Recchia, 2009; Howe et al., 2012). When second-born children were also asked to teach their siblings, they were more likely to give positive feedback and use learner-centered strategies (e.g., greater learner involvement, opportunities to correct their own errors) than first-born teachers, thereby creating a more collaborative learning process (Howe & Recchia, 2005, 2009; Recchia et al., 2009). Perhaps the second-born teacher deferred to the older child’s (i.e., learner’s) expected level of greater knowledge and involved him or her in the task due to their unfamiliarity or discomfort with the teaching role. In the same vein, the first-born learner may have been active by asking questions, being engaged, and attempting to structure the learning. Whether these patterns would be evident in observations of naturalistic sibling-directed teaching is not known.

In terms of sibling gender and teaching, some studies find no differences (e.g., Azmithia & Hesser, 1993; Recchia et al., 2009), whereas others reported that older brothers provided feedback and identified task features more when teaching younger brothers, but female teachers gave more positive feedback (Howe et al., 2009; Klein et al., 2002). In middle childhood, sisters also taught more frequently than brothers especially with younger sisters who were more likely to be active learners (Minnett, Vandell, & Santrock, 1983; Stoneman, Brody, & McKinnon, 1986).

Naturalistic Sibling Teaching

Few studies have examined naturalistic sibling teaching and learning. In an early study, Stoneman et al. (1986) reported that first-born school-age sisters in female dyads engaged in the most naturalistic teaching at home. Maynard (2002, 2004) and Rabain-Jamin, Maynard, and Greenfield (2003) observed Mayan children teaching younger siblings about cultural and domestic tasks (e.g., making food) during play contexts. Teachers used a range of sophisticated strategies such as scaffolding, explanations, and

The Sibling Relationship as a Context for Teaching and Learning

Given their long and intense history, siblings are in a unique position to develop a shared understanding regarding one another’s knowledge and ability (Dunn, 2002; Howe & Recchia, 2014; Howe et al., 2011). Siblings act as socializing agents for one another due to both reciprocal and complementary relationship characteristics of their relationships (Dunn, 1983, 2002; Hinde, 1979). In the present case, complementary (i.e., hierarchical) features, as evident in teaching, highlight the unequal distribution of power and knowledge disparity between siblings (Howe, Brody, & Recchia, 2006; Perez-Granados & Callanan, 1997; Recchia, Howe, & Alexander, 2009). Older siblings have inherent developmental advantages enabling them to direct and control interactions with younger siblings (Perlman, Siddiqui, Ram, & Ross, 2000), who in turn may benefit developmentally from interacting with more knowledgeable older siblings (Ruffman, Perner, Naito, Parkin, & Clements, 1998); however, preliminary evidence suggests that sometimes younger siblings do teach (Howe et al., 2015). Investigating naturalistic teaching and learning at home affords an opportunity for a more balanced view of these behaviors and the contribution of both siblings as active agents in their own learning and socialization, as well as how they apply their social–cognitive skills in real-life situations.

Sibling Teaching During Semistructured Tasks

Older siblings are typically assigned the teaching role in semistructured paradigms where they are taught a task by an adult and then asked to teach their younger siblings (Azmithia & Hesser, 1993; Klein, Feldman, & Zarur, 2002; Recchia et al., 2009). These studies reveal developmental differences in children’s teaching; by age 3, children demonstrate some teaching skills that become more sophisticated with age (Howe & Recchia, 2005). Preschoolers are more likely to demonstrate while teaching, while older children focus increasingly on verbal instruction, scaffolding techniques (e.g., explanations, hints), and structuring the task for the learner (Howe & Recchia, 2009; Maynard, 2002; Strauss & Ziv, 2012). In middle childhood, first-born siblings’ teaching strategies may reflect a learner-centered approach (e.g., encouraging, guiding) that facilitates the younger learner’s involvement and self-correction of their own errors (Howe & Recchia, 2005, 2009; Howe et al., 2012; Pérez-Granados & Callanan, 1997; Rogoff, 1998). Furthermore, school-age first-born teachers demonstrate sensitivity to the learner’s abilities during increasingly difficult tasks by appropriately adjusting their strategies (Howe et al., 2006). Thus, as they develop, first-born teachers become capable of constructing bridges between known and unknown information for learners and also engage learners so that they can take control of their own learning (Azmithia & Hesser, 1993; Howe et al., 2009). School-age first-born siblings’ greater social–cognitive skills may partly account for these developmental differences (Howe et al., 2012). Yet, studies that focus solely on the teacher do not provide a full analysis of the relevant processes.

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et al. (2014) have argued, teaching is a natural cognitive activity that varies across time. Our study highlights one process through development during naturalistic teaching and learning and how another in this critical relationship.

This also provides a more balanced perspective of how the characteristics and strategies associated with sibling teaching and learning may evolve over the preschool years. We know even less about younger siblings’ teaching of their older counterparts, including how older and younger siblings’ teaching evolves in similar or distinct ways across development. Specifically, do younger siblings initiate teaching in the same ways as older siblings and do they use a similar or different range of strategies, depending on the age of the learner? Are the exchanges in which younger siblings teach more collaborative, and if so, what strategies and responses of both teacher and learner indicate collaboration? Investigating these questions regarding the teaching and learning of older and younger siblings will allow for a deeper understanding of the significance of this intentional activity for development. The focus on both older and younger siblings as teachers and learners, provides an opportunity to consider how children demonstrate their agency as individuals within a dyadic and dynamic context. This also provides a more balanced perspective on the ongoing nature of children’s interactions over time and further insight into what and how they transmit knowledge to one another in this critical relationship.

Therefore, our central goal was to illuminate the bidirectional nature of how young siblings socialize and influence one another’s development during naturalistic teaching and learning and how this varies across time. Our study highlights one process through which young siblings may gain an understanding of their social and physical worlds (Piaget, 1950; Vygotsky, 1978). If, as Strauss et al. (2014) have argued, teaching is a natural cognitive activity that children engage in spontaneously and without explicit instruction by others about how to teach, the sibling relationship appears to be a rich context for studying this process. As the literature indicates, there are strong theoretical and empirical reasons to investigate the bidirectional process of teaching and learning.

**The Present Study**

The purpose of the present longitudinal study was to investigate sibling teaching frequency, teaching strategies, and learner involvement during early childhood, starting when the siblings were ages 2 and 4 years (T1: Time 1) and 2 years later (T2: Time 2). Given that both siblings can assume the roles of teacher or learner (Howe et al., 2015), we also compared the teaching of first- and second-born siblings over both time points. In addition, we investigated the effects of birth order on teaching strategies when both children were age 4 (i.e., first-borns at T1 and second-borns at T2), so as to disentangle birth order and developmental differences. While we control the teacher’s age for this comparison, learners were either 2-year-old younger or 6-year-old older siblings, which allowed us to examine the influence of important learner characteristics on the nature of sibling teaching.

Howe et al. (2015) reported that first-born siblings engaged in teaching and assumed the teaching role compared to second-born learners who were more likely to request teaching when children were ages 4 and 6 (T2 in the present study). The current study built on these findings by using the T2 and also the T1 data when the children were 2 years younger (ages 2 and 4) so as to examine the variability in the naturally occurring teaching/learning process of both younger and older siblings over time. In our study, teachers and learners were generally younger than in previous investigations (e.g., Stoneman et al., 1986) and we also controlled for sibling age gap in contrast to other studies (e.g., Maynard, 2002, 2004). We expected that the same pattern would be revealed for birth order and teaching roles at T1 as reported at T2 (Howe et al., 2015). However, given developmental changes and greater experiences over early childhood, we predicted second-born siblings would be proportionally more likely to engage in teaching at T2 than T1 relative to first-borns, but both children would also increase in overall frequency of teaching. Based on the findings of Strauss and Ziv (2012) and Howe and Recchia (2005, 2009), we expected that first-born teachers would be proportionately more likely to engage in direct instruction, demonstration, planning; Howe et al., 2015). Furthermore, based on studies that used a similar comparison but with a semistructured task (Howe & Recchia, 2005, 2009; Recchia et al., 2009), we predicted that second-born 4-year-old teachers would provide more positive feedback compared to first-born 4-year-old teachers. Given the active role of learners, we examined how both first- and second-born 4-year-old learners responded to teaching.
Method

Participants

At T1, participants included 40 middle-class Caucasian families (two siblings; two parents) living in a mid-sized Canadian city, who were representative of the local population. One family (mixed-gender dyad) moved by T2. At T1, older siblings’ M age = 4.4 years (SD = .31) and younger siblings’ M age = 2.4 years (SD = .13); the T2 observations were intentionally scheduled for 2 years later, when older siblings’ M age = 6.3 years (SD = .42) and younger siblings’ M age = 4.4 years (SD = .21). Mean age gap = 1.94 years. Dyadic gender composition (T1) was balanced across all four configurations. At T1, parents’ ages (mothers’ M = 32.8 years; fathers’ M = 34.6 years; range = 23–48 years) and education included university = 29%, community college = 15%, high school = 41%, and no high school diploma = 15%.

Procedure

At each time point, families were observed for six 90-min sessions at home for a total of 9 hr per family (T1 + T2 = 18 hr; Ross, Filyer, Lollis, Perlman, & Martin, 1994). In a few cases, sessions were cut short for various reasons and a seventh session was conducted (data were prorated to equal 9 hr at each time point). Two observers were assigned to each family for preliminary reliability sessions, but only one observer was present for the actual data collection. Reliability sessions were brief (20 min) with both observers present; these were conducted to allow the children to become familiar with the observers, to adjust to being observed, and to establish interrater reliability as described below. Observers were instructed not to interact with families so that children would be less likely to be distracted by their presence and to record behavior quietly and unobtrusively. Children were asked to pretend the observer was not present, and allowed to play with their own toys in as natural a way as possible. Although being observed, however unobtrusively, might influence children’s interactions, they rarely talked to or appeared to notice the observer. Furthermore, the observer sometimes recorded ongoing negative parent-child or sibling interactions (e.g., conflict, whining) but never interacted with the participants, which provides further evidence that the family members were not overly affected by the observer’s presence.

A dual track audio-recorder was used to record the data; an omnidirectional microphone held by the observer recorded family speech onto one track while the observer quietly dictated the actions of family members into a second lapel microphone so as to provide descriptions of sibling and parent interaction. All audio-recordings of family members’ actions were coded into 96 possible behaviors (e.g., laugh, smile, hit, grab) along with verbatim transcriptions of speech and observers’ descriptions (Ross et al., 1994). To determine interrater reliability on the coding of observed behaviors, at T1 seventeen 20-min sessions and at T2 ten 20-min sessions were conducted by the two trained, but naïve observers for each family prior to the actual data sessions; reliability assessed for percent of agreement for the presence of each coded behavioral action (T1 = 92%, range = 79%–100%; T2 = 86%, range = 70%–100%).

Measures

Sibling teaching. For the current study, the original transcripts were first reviewed to identify naturalistic sequences of sibling-directed teaching; 353 teaching sequences were identified at T1 and 1,039 at T2 (see Tables 1 and 2 for examples of the coding). We coded teaching sequences based on a child’s clear intention to teach (Howe et al., 2015) defined as direct (e.g., “I will show you how to make a nose”) or indirect (e.g., “This is the letter x”) statements to teach. Sometimes learners also made requests for teaching (e.g., “How do you spell Dorothy?”). Sequences terminated when the teaching clearly ended or there was a topic change. More implicit forms of teaching were not included nor sequences when parents taught or entered into the sibling-directed teaching. Interrater reliability for identifying teaching sequences was conducted on 21% of the transcripts by two naive research assistants. Reliability was calculated on the coders’ agreement that the line was part of the teaching sequence (κ = .78, p < .001); specifically, agreements were counted when both coders agreed the line was part of the sequence and disagreements were counted when one coder missed a line or an entire sequence. As described next we identified teacher and learner roles, initiation of teaching, teaching strategies and learner response (see also Howe et al., 2015), which

Table 1

Example of Teaching Sequence: First-Born Sibling at Time 1 (4-Year-Old) Teaching Second-Born (2-Year-Old) Sibling How to Use Utensils

<table>
<thead>
<tr>
<th>Line no.</th>
<th>Actor</th>
<th>Nonverbal/verbal activity</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>94</td>
<td>O</td>
<td>I’ll show you which ones to use</td>
<td>Initiation: O assumed role Strategy: planning</td>
</tr>
<tr>
<td>95</td>
<td>O</td>
<td>(Hands utensils to Y)</td>
<td></td>
</tr>
<tr>
<td>96</td>
<td>Y</td>
<td>(Accepts utensils from O)</td>
<td>Learner response: active involvement</td>
</tr>
<tr>
<td>97</td>
<td>Y</td>
<td>Open your mouth</td>
<td>Learner response: active involvement</td>
</tr>
<tr>
<td>98</td>
<td>O</td>
<td>(Plays utensil in his own mouth)</td>
<td>Strategy: demonstration</td>
</tr>
<tr>
<td>99</td>
<td>O</td>
<td>You’re supposed to do this</td>
<td>Strategy: direct instruction</td>
</tr>
<tr>
<td>100</td>
<td>O</td>
<td>(Shows Y how to put a fork and spoon in her mouth)</td>
<td>Strategy: demonstration</td>
</tr>
<tr>
<td>101</td>
<td>Y</td>
<td>(Reaches for utensils)</td>
<td>Learner response: active involvement</td>
</tr>
</tbody>
</table>

Note. The teaching strategy of demonstration occurred twice and was coded only once because each strategy was only coded as present or absent. In addition, learner response was coded as active involvement based on the learner’s involvement throughout the sequence (i.e., including lines 97 and 101). O = older sibling; Y = younger sibling.
became actively involved, the latter was coded. The level of involvement was coded, for example, if the learner initiated and built on the teacher’s instruction (e.g., teacher: “This is its nose”; learner: “Okay, and its nose can go here”). Since more than one learner response was possible during a sequence, the four responses were considered in terms of degree of involvement (i.e., no response to active involvement). For each sequence, the highest level of involvement was coded, for example, if the learner initially complied with a teaching behavior, but later in the sequence became actively involved, the latter was coded.

were the variables of conceptual interest that reflect the bidirectional interaction between teacher and learner (Howe et al., 2006; Howe & Recchia, 2009; Recchia et al., 2009).

Initiation of teaching and teacher/learner roles. The initiation of teaching was assessed using two mutually exclusive and exhaustive codes: (a) initiation when one sibling proposed to teach something (e.g., “You wanna learn how to make an onion?”) or simply assumed the teacher role (e.g., “I’ll show you how to write ‘AT’”) or (b) one child requested teaching from their sibling by asking for information, how to do something, or a directly asked to be taught (e.g., “How do you make ABC?”).

Teaching strategies. The presence or absence of each of the seven jointly exhaustive teaching strategies was coded within each teaching sequence: (a) direct instruction, referring to labeling, describing, or sharing information in a direct way (e.g., “that piece goes there”; “this is batman”), (b) demonstration, involving showing the learner how to do something (e.g., pointing to the right shape; teacher performs dance steps), (c) explanation, including justifications or reasons to explain how or why (e.g., “because if you don’t put the top on, it will spill”), (d) planning, defined as outlining the steps required to learn something (e.g., “I’m going to get you all lined up and I’m going to see who can do it good”), (e) clarification, referring to checking learner understanding (e.g., “now do you see how to do it?”; “Ok?”), (f) positive feedback, including praise and affirmation (e.g., “good”; “that’s right”), and (g) negative feedback or correction (e.g., “you don’t turn, no, not like that”).

Learner response. The learner’s response to teaching was determined using four jointly exhaustive codes: (a) no response, in which the learner did not act or respond in any way to the teaching; (b) rejection, when the learner explicitly disagreed with the teacher’s actions or statements (e.g., teacher: “This puzzle piece goes right here”; learner: “No, it goes there”); (c) compliance, when the learner accepted the teacher’s actions or statements by agreeing or following instructions (e.g., teacher: “Jump over it”; learner jumps over obstacle); or (d) active involvement, when the learner accepted and built on the teacher’s instruction (e.g., teacher: “This is its nose”; learner: “Okay, and its nose can go here”). Since more than one learner response was possible during a sequence, the four responses were considered in terms of degree of involvement (i.e., no response to active involvement). For each sequence, the highest level of involvement was coded, for example, if the learner initially complied with a teaching behavior, but later in the sequence became actively involved, the latter was coded.

Reliability for Teaching/Learning Codes

First, two assistants (one naïve to the current study) established interrater reliability for the coding of sibling teaching on 82/353 (23%) sequences at T1 and 229/1,039 (22%) sequences at T2. Cohen’s kappas (all ps < .001) were (a) who was teaching = .97; (b) initiation of teaching = .98; and teaching strategies: (a) direct instruction = .82; (b) demonstration = .89; (c) explanation = .78; (d) planning = .63; (e) clarification = .79; (f) positive feedback = .88; (g) negative feedback = .89; and learner response = .74. Discrepancies were resolved by discussion.

Results

First we compare older and younger sibling teaching across time points and second we present a cross-sectional comparison of 4-year-olds’ teaching (i.e., first-born 4-year-olds at T1 and second-born 4-year-olds at T2) and learner responses. The range of teaching sequences identified per family at T1 = 2–25 (M = 8.82; SD = 5.43) and at T2 range = 6–96 (M = 26.67; SD = 17.97); the amount of sibling teaching increased significantly from T1 to T2, t(38) = −6.87, p < .001. Considering the range across dyads at T1 and T2, proportion scores for each analysis were calculated to control for the number of sequences per family. Repeated-measures analyses of variance (ANOVAs) were utilized with the Bonferroni correction for post hoc comparisons. When violations of sphericity occurred, degrees of freedom were adjusted with the Greenhouse-Geisser correction.

Descriptive Statistics

Age and gender. A series of one-way ANOVAs were conducted to test for the effects of gender and gender composition (i.e., mixed-sex vs. same-sex dyads) in initiation of teaching, teaching strategy, and learner response variables. Pearson correlations were used to test for associations between sibling age gap and teaching initiation, teaching strategy, and learner response. Results revealed no significant effects for gender, gender composition, or age gap in either set of analyses.

First- and second-born teaching. To compare first- and second-born sibling teaching across both time points, proportion scores were calculated, for example by dividing the total number of first-born sibling teaching sequences at each time point by the total number of older and younger sibling teaching sequences at each time point (e.g., first-born sibling teaching sequences at...
T1/total number of first plus second-born teaching sequences at T1). A 2 (first-, second-born) × 2 (time) repeated-measures ANOVA revealed a significant main effect of sibling teaching, \(F(1, 38) = 403.04, p < .001, \eta^2 = .91\), qualified by an interaction, \(F(1, 38) = 46.58, p < .001, \eta^2 = .55\). Although first-born siblings taught more than their younger counterparts at both T1 (\(M = .92, SE = .02\)) and T2 (\(M = .75; SE = .03\), pairwise post hoc comparisons indicated that second-borns taught proportionately more often at T2 (\(M = .25; SE = .03\)) compared to T1 (\(M = .08; SE = .02\), relative to their older siblings.

**First- and Second-Born Sibling Teaching Across Time Points**

Initiation of teaching (teacher assumes role vs. learner requests). Proportion scores were calculated to compare how each sibling initiated teaching over time either by assuming the teaching role or responding to a learner request for teaching (e.g., number of T1 sequences in which a child assumed the teacher role/total number of T1 sequences taught by that child).

**First-born sibling teaching.** A 2 (initiating teacher role) × 2 (time) repeated-measures ANOVA revealed a main effect of initiation, \(F(1, 38) = 282.59, p < .001, \eta^2 = .88\); first-born siblings were more likely to initiate teaching by assuming the teacher role (\(M = .83; SE = .02\)) than to teach in response to their younger sibling’s request for teaching (\(M = .17; SE = .20\)). This effect was qualified by an interaction, \(F(1, 38) = 20.96, p < .001, \eta^2 = .36\). First-born siblings were more likely to assume the teaching role (\(M = .91; SE = .03\)) at T1 than T2 (\(M = .74; SE = .03\)), whereas they were more likely to engage in teaching following the younger sibling’s request for teaching at T2 (\(M = .26; SE = .03\)) than T1 (\(M = .09; SE = .03\)).

**Second-born sibling teaching.** A 2 (initiating teacher role) × 2 (time) repeated-measures ANOVA revealed only a main effect of initiation, \(F(1, 20) = 52.50, p < .001, \eta^2 = .72\). Specifically, across both time points, second-born siblings were more likely to teach by assuming the teacher role (\(M = .79; SE = .04\)) than in response to their older siblings’ request for teaching (\(M = .21; SE = .04\)).

**Teaching strategies.** The presence or absence of each teaching strategy was identified for each sequence and more than one teaching strategy may have occurred per sequence. An exploratory 2 (sibling) × 2 (time) repeated-measures ANOVA determined if the number of teaching strategies per sequence used by each sibling differed over time. Results indicated a main effect of sibling, \(F(1, 18) = 8.81, p < .01, \eta^2 = .33\); first-born siblings used more strategies on average per sequence (\(M = 2.05; SE = .07\)) than second-born siblings (\(M = 1.6; SE = .11\)). For the next analyses, proportion scores were calculated by dividing the frequency of each strategy by the total frequency of teaching by each sibling at T1 and T2 (e.g., first-born sibling use of direct instruction at T1/total number of T1 first-born sibling teaching sequences).

**First-born sibling teaching.** A 7 (teaching strategy) × 2 (time) repeated-measures ANOVA indicated a main effect of strategy, \(F(4.06, 10.44) = 320.22, p < .001, \eta^2 = .89\); first-born siblings were most likely to utilize direct instruction (\(M = .90; SE = .01\)) and demonstration (\(M = .46; SE = .02\)) than any other strategy. Furthermore, negative feedback (\(M = .27; SE = .02\)) was more likely to be utilized than explanation (\(M = .12; SE = .02\)), planning (\(M = .14; SE = .02\)), clarification (\(M = .07; SE = .01\)), and positive feedback (\(M = .08; SE = .01\)). There was also a significant interaction, \(F(3.59, 136.45) = 2.99, p < .05, \eta^2 = .07\). Simple-effects tests indicated that planning was more likely to be used by first-born siblings at T1 than T2, while positive feedback was more likely to be used at T2 than T1 (see Table 3).

**Second-born sibling teaching.** For younger sibling teaching, a 7 (strategy) × 2 (time) repeated-measures ANOVA revealed only a main effect of strategy, \(F(5.53, 55.61) = 61.71, p < .001, \eta^2 = .77\); second-born siblings were more likely to use direct instruction (\(M = .88; SE = .04\)) than any other strategy. Demonstration (\(M = .35; SE = .06\)) was the second-most frequent strategy and was utilized more than explanation (\(M = .09; SE = .03\)), planning (\(M = .05; SE = .02\)), and clarification (\(M = .05; SE = .03\)), but not more than positive (\(M = .07; SE = .04\)) or negative feedback (\(M = .13; SE = .04\)). These patterns were not significantly different across time for second-born learners’ teaching strategies (see Table 3).

**Learner response.** Learner response codes were proportionally by dividing the frequency of each response by each child by the total number of responses by that child to teaching sequences at T1 and at T2 (e.g., first-born learner no response at T1/total number of T1 sequences when first-born was the learner).

**First-born sibling learner response.** A 4 (learner response) × 2 (time) repeated-measures ANOVA comparing first-born learners’ response to teaching indicated a main effect of learner response, \(F(3, 16) = 4.28, p < .05, \eta^2 = .44\). Specifically, first-born

<table>
<thead>
<tr>
<th>Teaching strategy</th>
<th>First-born sibling (n = 39)</th>
<th>Second-born sibling (n = 19)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T1 (age 4) M (SE)</td>
<td>T2 (age 6) M (SE)</td>
</tr>
<tr>
<td>Direct instruction</td>
<td>.91 (.02)</td>
<td>.88 (.02)</td>
</tr>
<tr>
<td>Demonstration</td>
<td>.50 (.04)</td>
<td>.42 (.03)</td>
</tr>
<tr>
<td>Explanation</td>
<td>.10 (.03)</td>
<td>.13 (.02)</td>
</tr>
<tr>
<td>Planning</td>
<td>.19 (.03)**</td>
<td>.09 (.01)**</td>
</tr>
<tr>
<td>Clarification</td>
<td>.08 (.02)</td>
<td>.06 (.01)</td>
</tr>
<tr>
<td>Positive feedback</td>
<td>.05 (.01)*</td>
<td>.10 (.02)*</td>
</tr>
<tr>
<td>Negative feedback</td>
<td>.26 (.03)</td>
<td>.28 (.02)</td>
</tr>
</tbody>
</table>

*Note. Comparisons of T1 and T2 are significant for first- or second-born siblings. T1 = Time 1; T2 = Time 2.

\*p < .05. \**p < .01.
siblings were more likely not to respond to their second-born siblings’ teaching \((M = .37; SE = .07)\) or to comply \((M = .33; SE = .06)\) rather than to reject \((M = .15; SE = .04)\) or be actively involved \((M = .15; SE = .03)\). Pairwise comparisons show no significant differences across time for first-born learners’ responses to teaching (see Table 4).

**Second-born sibling learner response.** A 4 (learner response) × 2 (time) repeated-measures ANOVA revealed a significant main effect of response, \(F(3, 36) = 33.36, p < .001, \eta^2 = .73\). Second-born siblings were more likely not to respond to their first-born siblings’ teaching \((M = .35; SE = .02)\) and to comply \((M = .34; SE = .02)\) compared to the other two responses. Active involvement \((M = .21; SE = .02)\) was also more likely to occur than rejecting the teaching \((M = .10; SE = .02)\). This effect was qualified by an interaction with time, \(F(3, 36) = 4.65, p < .01, \eta^2 = .28\). Simple-effects tests indicated that second-born learners were more likely not to respond to their older sibling teacher at T1 than T2, while they were more likely to be actively involved at T2 than T1 (see Table 4).

**Cross-Sectional Birth-Order Comparison**

The final analyses compared both children at age 4, specifically the older sibling’s teaching and learning at T1 (i.e., 4-year-old first-borns teaching a 2-year-old younger sibling) compared to the younger sibling’s teaching at T2 (i.e., 4-year-old second-borns teaching a 6-year-old older sibling) to examine birth-order effects while holding age constant.

**Initiating teaching (teacher assumes role vs. learner requests).** To test the difference between 4-year-old’s initiation of teaching at T1 (i.e., first-borns) and T2 (i.e., second-borns), proportion scores were calculated by dividing each 4-year-old’s initiation of the teaching role (i.e., assuming teaching role or in response to the learner’s request) by the total number of sequences in which each 4-year-old taught (e.g., number of sequences in which the 4-year-old first-born assumed the teaching role at T1/total number of teaching sequences of first-born 4-year-old at T1). A 2 (teacher role initiation) × 2 (first-, second-born 4-year-olds) repeated-measures ANOVA indicated a significant main effect of initiation, \(F(1, 37) = 188.59, p < .001, \eta^2 = .84\). Both first- and second-born 4-year-olds were more likely to assume the teaching role \((M = .81; SE = .02)\) than to teach in response to their sibling’s request for teaching \((M = .19; SE = .02)\). This effect was qualified by a birth-order interaction, \(F(1, 37) = 13.39, p < .01, \eta^2 = .27\); simple effects tests indicated that first-born 4-year-olds at T1 were more likely to initiate teaching by assuming the role \((M = .91; SE = .03)\) than second-born 4-year-olds at T2 \((M = .71; SE = .04)\); while second-born 4-year-olds were more likely to teach in response to their 6-year-old sibling’s request for teaching at T2 \((M = .29; SE = .04)\) than first-born 4-year-olds in response to their 2-year-old younger sibling’s request for teaching at T1 \((M = .09; SE = .03)\).

**Teaching strategies.** An exploratory one-way repeated-measures ANOVA comparing the number of strategies used per sequence indicated a main effect, \(F(1, 37) = 13.99, p < .01, \eta^2 = .27\). Namely, first-born 4-year-olds at T1 used a greater number of strategies per teaching sequence \((M = 2.11; SE = .08)\) compared to second-born 4-year-olds at T2 \((M = 1.63; SE = .07)\).

Teaching strategy scores were calculated by taking the proportional use of each strategy in relation to the total teaching sequences by the target child at T1 or T2 (e.g., first-borns’ use of direct instruction at T1/total number of first-born sibling teaching sequences at T1). A 7 (teaching strategies) × 2 (first-, second-born 4-year-olds) repeated-measures ANOVA indicated a significant main effect of strategy, \(F(3.63, 134.17) = 218.60, p < .001, \eta^2 = .86\). Direct instruction \((M = .89; SE = .02)\) was most frequent, followed by demonstration \((M = .39; SE = .03)\), negative feedback \((M = .21; SE = .02)\), planning \((M = .15; SE = .02)\), and explanation \((M = .11; SE = .02)\), which were used more than clarification \((M = .06; SE = .01)\) and positive feedback \((M = .05; SE = .01)\). A main effect of birth order was also revealed, \(F(1, 37) = 14.53, p < .01, \eta^2 = .28\); first-born 4-year-olds at T1 were more likely to use teaching strategies \((M = .30; SE = .01)\) than second-born 4-year-olds at T2 \((M = .23; SE = .01)\). There was also an interaction, \(F(4.08, 150.95) = 3.61, p < .01, \eta^2 = .09\). Simple effects tests showed that first-born 4-year-olds at T1 had a greater likelihood of utilizing demonstration, planning, and negative feedback than second-born 4-year-old teachers at T2 (see Table 5).

**Learner response of 4-year-olds.** Proportion scores for the learner response codes were calculated by the total number of teaching sequences by the other child at T1 and T2 (e.g., first-born sibling no response at T1/total number of first-born sibling teaching sequences when first-born was the learner). A 4 (learner response) × 2 (first-, second-born 4-year-olds) repeated-measures ANOVA revealed a main effect of learner response, \(F(2.36, 87.31) = 18.98, p < .001, \eta^2 = .34\). Post hoc pairwise comparisons indicated that both first- and second-born learners at age 4 were more likely not to respond to teaching \((M = .40; SE = .03)\) or to comply \((M = .32; SE = .03)\) than to reject \((M = .11; SE = .03)\) or be actively involved \((M = .18; SE = .02)\).

### Table 4

**Older and Younger Sibling Learner Response at T1 and T2**

<table>
<thead>
<tr>
<th>Learner response</th>
<th>First-born sibling ((n = 19))</th>
<th>Second-born sibling ((n = 39))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T1 (age 4) (M (SE))</td>
<td>T2 (age 6) (M (SE))</td>
</tr>
<tr>
<td>No response</td>
<td>.37 (.11)</td>
<td>.37 (.05)</td>
</tr>
<tr>
<td>Rejection</td>
<td>.18 (.08)</td>
<td>.12 (.03)</td>
</tr>
<tr>
<td>Compliance</td>
<td>.34 (.10)</td>
<td>.32 (.06)</td>
</tr>
<tr>
<td>Active involvement</td>
<td>.11 (.07)</td>
<td>.19 (.04)</td>
</tr>
</tbody>
</table>

*Note.* Comparisons of T1 and T2 are significant for first- or second-born siblings. T1 = Time 1; T2 = Time 2.

* \(p < .05\). ** \(p < .01\).
### Table 5

<table>
<thead>
<tr>
<th>Teaching Strategy</th>
<th>4-year-old first-born sibling (teaching a 2-year-old at T1) M (SE)</th>
<th>4-year-old second-born sibling (teaching a 6-year-old at T2) M (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct instruction</td>
<td>.91 (.02)</td>
<td>.86 (.04)</td>
</tr>
<tr>
<td>Demonstration</td>
<td>.51 (.04)**</td>
<td>.28 (.04)**</td>
</tr>
<tr>
<td>Explanation</td>
<td>.11 (.03)</td>
<td>.12 (.03)</td>
</tr>
<tr>
<td>Planning</td>
<td>.19 (.03)*</td>
<td>.10 (.03)*</td>
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</tr>
<tr>
<td>Negative feedback</td>
<td>.26 (.03)*</td>
<td>.16 (.03)*</td>
</tr>
</tbody>
</table>

**Note.** T1 = Time 1; T2 = Time 2.

*p < .05, **p < .001.

## Discussion

Our findings provide insight into the dynamics of sibling teaching and learning taking account of a number of factors. We first address the differences in older and younger sibling teaching and learning across time and then birth-order influences after accounting for age. These findings allow for new insights into one process of young siblings’ socialization of one another during ongoing bidirectional home interactions (Dunn, 2002; Hinde, 1979).

### The Dynamics of Sibling-Directed Teaching at Home

The frequency of naturalistic sibling-directed teaching during ongoing family interactions was quite striking, even at ages 2 and 4. Two years later, children were engaged in teaching three times more often as they shared their knowledge about the social and physical world. Interestingly, although older siblings taught significantly more than younger siblings at both time points, younger siblings taught proportionately more over time, suggesting that developmental changes were occurring regarding the breadth of their knowledge and motivation to engage in teaching. Moreover, younger siblings were more active participants during ongoing interaction at home; this shift suggests a developing trend toward a more balanced and reciprocal set of exchanges between the children, at least regarding teaching and learning (LeBlanc & Bearison, 2004; Rogoff, 1998), although clearly older siblings were still primarily responsible for teaching. By age 4, younger siblings apparently recognized that they were capable of teaching or imparting knowledge to a less-informed older sibling (Abuhatoum, Howe, Della Porta, & Ross, 2016; Ziv & Frye, 2004), a point addressed below. Overall, sibling teaching occurred spontaneously and without adult prompting or involvement, supporting the contention that teaching is a natural human activity (Strauss et al., 2014). Ongoing naturalistic interactions are a rich context in which to examine how developmentally young children socialize of one another during ongoing bidirectional home interactions (Dunn, 2002; Hinde, 1979).

In terms of specific teaching strategies, both older and younger siblings were most likely to use direct instruction and demonstration. Older siblings consistently used a greater number of teaching strategies per sequence than younger siblings, after accounting for the mixed findings.

### Initiation of Teaching

In terms of the initiation of teaching sequences, both older and younger children were more likely to launch directly into teaching by assuming the role (e.g., “I’ll show you how to do the dance step”) or sometimes by asking the learner if she or he wanted instruction (e.g., “Want me to show you how to write ‘AT’?”) rather than responding to the learner’s request for teaching. The issue of how youngsters initiate naturalistic teaching sequences has received little attention in the literature; thus our findings illuminate the spontaneous and seamless nature of these interactions. Given that at T1 older siblings apparently felt comfortable initiating teaching, this finding also suggests a belief in their own understanding of the required knowledge and how to transfer it to their less informed 2-year-old sibling via a variety of teaching strategies (Abuhatoum et al., 2016; Rogoff, 1998; Strauss & Ziv, 2012; Ziv & Frye, 2004; Ziv, Solomon, & Frye, 2008), as discussed below. In contrast, over time older sibling teachers responded more to their younger siblings’ requests for teaching, which may indicate that younger siblings increasingly recognized their lack of knowledge and their older sibling’s expertise in conveying the desired knowledge or information (Strauss & Ziv, 2012). Furthermore, these findings illuminate another development in children’s relationships, namely the younger sibling as an active participant in ongoing bidirectional exchanges who can influence the direction of interactions (Howe et al., 2011).

These patterns of findings provide support for the arguments of Piaget (1950) and Vygotsky (1978) that teaching depends on knowledge differences between teacher and learner and not on authority or status and that both teacher and learner are active agents in the process. Moreover, it suggests that research using semistructured teaching tasks that train only older siblings as teachers may have underestimated the ability of younger siblings to teach and older siblings to engage in the learner role. If teaching and learning is a collaborative process (Palinscar, 1998; Rogoff, 1998) as our findings demonstrate, it is critical to assess the behavior of both participants and to account for possible sibling birth order differences (LeBlanc & Bearison, 2004; Strauss et al., 2014).

### Teaching Strategies: Relative Use Over Time

The literature on sibling teaching demonstrates that children have a wide variety of strategies available to promote learning such as direct instruction, demonstration, explanation, and feedback, which increase with age (Azmitia & Hesser, 1993; Howe et al., 2015; Howe & Recchia, 2005, 2009; Klein et al., 2002; Strauss & Ziv, 2012). In our study, developmental differences were apparent in both the number and type of teaching strategies siblings used. Older siblings consistently used a greater number of teaching strategies per sequence than younger siblings, after accounting for age. Presumably the first-born 4-year-old siblings were more cognitively sophisticated than the second-born 4-year-old younger siblings, suggesting the first-borns were sensitive to the abilities of the younger learner.

In terms of specific teaching strategies, both older and younger siblings were most likely to use direct instruction and demonstration...
tion teaching strategies. Certainly, direct instruction and physical demonstration are straightforward and concrete strategies, for example, saying “do it like that,” “hold these ends with one hand each,” or showing how to draw circles and lines in a coloring book. Strauss and Ziv (2012) argued that there may be several kinds of demonstration skills some of which may include learner involvement, verbal explanation, or both; however, our investigation did not include this level of specificity and this is a question for future research. Older siblings were next most likely to use negative feedback, perhaps as a way of correcting the learner and attempting to point out the right information or steps to ensure learning, followed by explanations, planning, clarifications, and positive feedback. Younger siblings’ use of teaching strategies followed a similar pattern as their older sibling, perhaps suggesting that they were modeling the older sibling’s preferred use of particular strategies.

Interestingly, although not frequent in terms of overall use, older siblings used planning more at T1 than T2 (e.g., “Jake, you see, I’ll show you how,” referring how to put a crayon in the box), but provided more positive feedback at T2 than T1 (e.g., “Ya, that’s right,” “Yup, that’s what you do”). Greater planning may reflect the older sibling’s perception that their 2-year-old younger sibling required more information regarding the steps involved in learning either procedural or conceptual knowledge than 2 years later at age 4. Planning requires metacognitive and expanded verbal skills to explain the order of steps clearly to the learner, a strategy used more frequently in the later preschool years (Davis-Unger & Carlson, 2008; Strauss et al., 2002). Furthermore, planning requires the teacher to be aware of how well the learner understands the steps for teaching to be successful, which also depends on understanding the learner’s mental states, beliefs, and knowledge so as to intentionally facilitate the acquisition of new learning or knowledge (Strauss & Ziv, 2012). Unfortunately, this existing longitudinal dataset did not include measures of children’s cognitive skills, which is a question for future research. However, the use of planning strategies suggests that at T1 older sibling teachers were scaffolding the younger sibling learner’s understanding of the task or information to support successful transfer of knowledge (LeBlanc & Bearison, 2004; Rogoff, 1998). In contrast, at T2 older siblings may have used positive feedback as a possible way to motivate the learner. These findings are in line with the literature indicating older sibling teachers adjusted their teaching strategies during naturalistic teaching at home depending on who initiated the teaching and whether they were teaching conceptual or procedural knowledge (Howe et al., 2015).

Learner Response to Teaching

Given that teaching and learning are bidirectional processes, it is critical to determine the response of the learner (Palincsar, 1998; Rogoff, 1998), although less attention has been devoted to this issue in the literature (Strauss et al., 2014). We differentiated the learner’s response by who was teaching and findings are generally in line with literature indicating that learners are active participants who ask questions, demonstrate understanding, and become involved (Howe et al., 2009, 2015; Howe & Recchia, 2006).

Both older and younger learners responded to teaching most often by either not responding or complying more than being actively involved or rejecting the teaching. The more prominent responses suggest that overall, siblings were accepting of instruction from their sibling and may support the notion that their compliant responses perhaps facilitated opportunities for the co-constructed meanings. Furthermore, findings revealed changes in second-born learner responses over time; specifically they were more likely not to respond to teaching by older siblings at T1 than T2, but were more actively involved in the process at T2 compared to T1 in line with Howe et al. (2009, 2015). This pattern provides insight into the changing dynamics of the relationship in early childhood as younger siblings (age 4) became more active agents in the teaching and learning process, which may have motivated or drawn older sibling teachers (age 6) into the collaborative process. It may also suggest that the increasing cognitive sophistication of the younger sibling learner at T2 afforded greater flexibility in their thinking and ability to adjust to the older sibling’s teaching style. Again, the shifting patterns suggest a move toward greater coherence and balance in the nature of sibling interactions over time regarding teaching and learning, although the issue of birth-order differences further illuminated the process.

Comparing Older and Younger Sibling Teachers at Age 4

The present data allowed for a unique comparison of the behavior of both children when they were age 4 to investigate birth-order differences while controlling for age. The theoretical literature (e.g., Dunn, 1983; Hinde, 1979) argues that sibling birth-order differences are associated with hierarchical roles. Specifically, the older sibling is viewed as the leader or teacher due to their presumed greater experience and knowledge, whereas the younger sibling is assigned the complementary role of follower or learner. This premise may account for assigning the teaching role to older siblings during semistructured paradigms (Azmitia & Hesser, 1993; Howe & Recchia, 2006; Klein et al., 2002).

In the present study, as reported above, overall both first- and second-born 4-year-olds were more likely to assume the teaching role than to do so in response to a learner request; however, at age 4 first-born siblings were proportionally more likely to initiate teaching by assuming the role compared to second-born 4-year-olds, suggesting a birth-order effect. Interestingly, at age 4, second-borns were more likely to respond to the older sibling’s (age 6) request for teaching than first-borns were to respond to their younger sibling’s (age 2) request for teaching. These findings provide support for the argument that older siblings most likely take the lead in complementary interactions (Hinde, 1979; Dunn, 1983; Howe et al., 2011), even when they are learners. Furthermore, at age 4, first-borns used a greater number and variety of teaching strategies per sequence than second-born 4-year-olds, again perhaps reflecting the abilities of the learner in the process. Specifically, older siblings were significantly more likely to demonstrate, plan, and use negative feedback when teaching 2-year-old younger siblings. Perhaps the more straightforward, concrete strategies of demonstration, planning by helping the younger sibling to understand the steps involved in a task and correcting errors, may be effective approaches to teaching 2-year-olds, in line with the literature (Strauss & Ziv, 2012). In general, it seems that the 4-year-old first-born teaching sequences were more elaborated and extended than 4-year-old secondborn sequences, given the relative frequencies and range of strategies.
Based on literature on teaching during semistructured teaching paradigms (Howe et al., 2009; Recchia, Howe, & Alexander, 2009), we had predicted that second-born teachers would be more likely to provide positive feedback, but did not find this. Perhaps constraints imposed by a semistructured task prompted teachers to use positive feedback to enhance task completion, whereas teaching in a more naturalistic, less-constrained context did not. Future research could investigate if children use positive feedback selectively given the task.

Finally, in terms of learner response, only main effects were evident. Although siblings often failed to respond actively to the others’ teaching, it was often the case that no response was required (e.g., older sibling is teaching younger rules of a board game: “You can’t go backwards” and moves own piece; learner does not respond). Conversely, siblings also complied or actively built upon the teaching they received (e.g., older sibling demonstrates how to feed baby doll with a cup, asks younger sibling to try it, who then takes cup and feeds doll), suggesting that they were participating in coconstructing shared meanings regarding the transfer of knowledge (LeBlanc & Bearson, 2004; Rogoff, 1998). The lack of rejection suggests that siblings were generally receptive to being taught and in fact, often complied with the teaching. A number of the teaching episodes were fairly short and, thus, may not have facilitated the sibling’s active involvement. Perhaps a more nuanced examination of learner responses to specific teaching strategies is warranted to take account of the learner’s age and the range of possible responses.

Limitations and Conclusions

Our study has a number of limitations including the relatively small sample of families of European background; however, they were representative of the local population and there were extensive observations of each family. Relying on transcripts of the language and behaviors sometimes made it difficult to determine some nuanced details of the teaching and the learner’s response. Nevertheless, the audio-recording was less intrusive for capturing naturalistic interaction in the home setting than video-recording and still provided rich data. The lack of information about parental teaching styles before and after the birth of the second child and their influence on siblings’ approaches to teaching would allow for a broader understanding of family dynamics and the role of shared and nonshared environmental experiences. Finally, there are likely long-term implications of sibling teaching and learning perhaps in reference to children’s engagement in the more academic environment of school; while these associations are not explored here, our descriptive work provides the basis for future research.

There are a number of developmental implications of our study. Parents should recognize and appreciate the knowledge and expertise of both children and that their sophistication increases with age by facilitating opportunities for siblings to teach and learn from one another. During children’s ongoing play (without adult interference) there are many opportunities for teaching and learning, thus providing a rich array of play materials in less structured, naturalistic contexts may be important for siblings’ social and cognitive development. Furthermore, the evidence for cross-age teaching/learning suggests that such groupings might be encouraged in child care and school settings rather than restricting classes by age. Taken together, the implications of this study suggest a number of possible future questions regarding associations between siblings’ teaching and learning strategies, their relationship quality, adjustment outcomes (e.g., psychological well-being, social competence with peers and friends, and academic success), as well as associations between parents’ and siblings’ approaches to teaching.

In conclusion, we have provided important insights into the developmental trajectory of sibling teaching in early childhood. Young children appear to launch into teaching one another in seemingly effortless ways, using a variety of quite sophisticated strategies that develop over time, and to respond positively to teaching as well as to request teaching from one another as a means to gain knowledge about their world. Young children are sensitive to the knowledge or lack thereof of their siblings and our findings highlight the mutual, bidirectional exchanges where both teacher and learner are active agents of influence. Clearly, the sibling relationship is a rich context for socialization and for facilitating one another’s social and cognitive development in collaborative and rich ways.

References


Howe, N., & Recchia, H. (2006). Sibling relations and their impact on...