"You didn’t teach me, you showed me": Variations in Sibling Teaching Strategies in Early and Middle Childhood

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This study examined siblings’ teaching strategies in 72 dyads (firstborn and second born, M ages = 81.64 and 56.31 months) as a function of dyad age, age gap between siblings, and teacher birth order. One child per dyad was randomly assigned to teach her or his sibling to construct a tractor toy. Interactions were coded for the topic of teachers’ speech, specificity of instructions, learner involvement, and how learner errors were corrected. Teachers from chronologically older dyads used more learner-centered strategies, as did those who were second born (age controlled). However, these main effects were qualified by various interactions between age and birth order, generally suggesting that firstborn children’s teaching may benefit more from the experience that comes with age. Correlations between strategies also suggested that independent of age, siblings differ in the goals and abilities underlying their teaching behavior. Results support the role that siblings play in development and the value of assessing their teaching interactions.

Siblings play a distinctive role in each others’ development, as these relationships are characterized by a number of unique features. Particularly
during early childhood, children spend a great deal of time with their siblings and thus construct an intimate history of shared experiences, collaboration, and pretense (Dunn, 2002). At the same time, these relationships are affectively intense and can be highly conflictual (Howe, Rinaldi, Jennings, & Petrakos, 2002; Martin & Ross, 1995). Sibling relationships are characterized by a number of reciprocal (i.e., equal, returned) features that are implicated in the development of children’s social understanding (Dunn, 1983, 1988). Yet the inherent imbalance in knowledge, power, and ability between older and younger siblings means that these relationships also provide opportunities for complementary (i.e., hierarchical) interactions such as teaching (Azmitia & Hesser, 1993; Hinde, 1979) and caretaking (Garner, Jones, & Miner, 1994; Howe & Rinaldi, 2004).

Most research examining the impact of the sibling relationship on children’s development has focused on its reciprocal features. However, there may be compelling reasons why complementary sibling interactions could also reveal meaningful variations in children’s social-cognitive abilities. In fact, it may be precisely the relative differences in siblings’ levels of ability that foster the development of social understanding (Cassidy, Fineberg, Brown, & Perkins, 2005). The purpose of the present study was to examine how complementary interactions might reveal age and birth-order differences in children’s abilities to develop shared meanings, namely by investigating variations in the strategies that children use to teach their sibling a novel task.

Theoretical Perspectives on Teaching and Learning

Both Piaget and Vygotsky have argued that an asymmetry of knowledge but not authority is ideal for learning (Piaget, 1950; Tudge & Rogoff, 1989). Thus, when an adult teaches a child, the child learns “despite adult authority and not because of it” (LeBlanc & Bearison, 2004, p. 501). As such, the less hierarchical and more reciprocal pairing of an older and a younger child (compared to adult-child dyads) is an excellent context for knowledge acquisition by the less-experienced child. This may be true of both siblings and mixed-age peers (Hartup, 1989).

Although the goal of teaching is ostensibly to transfer information and skills from the more knowledgeable to the less knowledgeable partner, children’s strategies may not always be conducive to achieving this outcome. Providing instruction and establishing roles are both important aspects of teaching, but children may have difficulty balancing these goals (Ellis & Rogoff, 1992; LeBlanc & Bearison, 2004). Specifically, some children focus on controlling the process at the expense of providing instruction, suggesting that they may have difficulty in juggling multiple task demands (LeBlanc & Bearison, 2004). Teachers who choose to focus on controlling
the process may be prioritizing the goal of completing the assigned task quickly and successfully. Such teachers may employ strategies that focus on maintaining the learner’s compliance by controlling the process of teaching itself, including physically demonstrating as opposed to involving the learner in the task, and by using relatively infrequent and ambiguous instructions. To the extent that learner involvement is permitted, teachers using these strategies may be inclined to correct the learner’s errors themselves rather than allowing the learner to find a solution. Thus, these strategies ensure successful completion of the task by maintaining control over the interaction and minimizing collaboration with the learner. A mature understanding of teaching is critically related not only to awareness of knowledge differences between teacher and learner but also to the intent to reduce those differences (Frye & Ziv, 2005). As such, the above strategies may reflect less ability or motivation to engage in knowledge transfer activities during teaching and thus may be expected to decline with age as children develop a better understanding of teaching.

In contrast, some teaching strategies more directly reflect the goal of imparting knowledge, with this aim taking precedence over task efficiency. These learner-centered strategies involve guiding the learner in the task, allowing him or her to participate actively in the process, and providing detailed and unambiguous instructions to maximize the learner’s understanding. These collaborative strategies may result in more generalization of learning than direct instruction (Palincsar, 1998). By virtue of being actively involved, learners are likely to make errors; teachers who use these strategies tend to let learners generate solutions themselves, or the teachers might provide hints about a possible solution as opposed to taking control by correcting the error themselves. These strategies are reminiscent of Rogoff’s (1990, 1998) notion of guided participation in which teachers build bridges between what is known and new information to be learned, support and structure the learner’s involvement, and give the learner responsibility for problem solving. Rogoff (1998) argues that guided participation is more likely to facilitate collaborative engagement and makes greater cognitive demands on both teacher and learner. It is during the process of collaboration that discourse is likely to lead to shared meanings regarding the task (Olson & Bruner, 1996). The use of learner-centered strategies would be expected to increase with age as children develop a more sophisticated understanding of the importance of knowledge transfer during teaching.

Sibling Teaching as a Context for Development

Older siblings may be particularly important socialization agents for younger children, given their history of collaborative interactions and the
emotional intensity of the relationship (Dunn, 1983, 2002). In interactions with their younger brothers and sisters, older siblings are at a developmental advantage in terms of their ability to direct and control interactions (Perlman, Siddiqui, Ram, & Ross, 2000). This power difference can manifest itself destructively, as in older siblings’ power assertion and aggression in conflict (e.g., Martin & Ross, 1995), or constructively, as in older siblings’ caretaking behaviors (Garner et al., 1994). Both children may benefit in unique ways from these role differences. Younger siblings have the advantage of interacting with an older, more experienced child; this seems to promote development of their social-cognitive skills (Ruffman, Perner, Naito, Parkin, & Clements, 1998). Besides immediate power benefits for older siblings such as their ability to win arguments (e.g., Dunn & Munn, 1986), older children may also have selective opportunities to manage positive interactions with younger siblings (Brody, Stoneman, & MacKinnon, 1982; Stoneman, Brody, & MacKinnon, 1984). Most relevant to the present investigation, older siblings may have greater experience teaching their younger siblings than vice versa and thus may be more attuned to their younger sibling’s cognitive competence (Klein, Feldman, & Zarur, 2002).

In addition, younger children may be more likely to solicit teaching from older siblings than from older peers and to be more active participants in the process (Azmitia & Hesser, 1993). In turn, older siblings provide more frequent explanations and feedback, and they spontaneously instruct and correct their younger siblings more often than do older peers (Azmitia & Hesser, 1993; Koester & Johnson, 1984). Apparently, older siblings are comfortable assuming the role of teacher, while younger siblings take on the corresponding role of learner (Brody et al., 1982; Stoneman et al., 1984). Thus, sibling relationships may be a particularly relevant context in which to examine individual differences in children’s teaching strategies. Past research has provided some evidence that sibling teaching strategies may be reliably related to sibling age and birth order. However, because research on sibling teaching is limited, investigations of peer teaching in childhood can provide additional insights. Thus, the following review of the peer and sibling teaching literatures provides the conceptual basis for the present investigation.

**Research on Children’s Teaching**

A number of studies demonstrate age-related differences in children’s teaching strategies when interacting with peers. By 3.5 years of age, children show awareness of the learner’s lack of knowledge in a teaching task and engage in some explicit instruction (Ashley & Tomasello, 1998). Between 3 and 5 years of age, children show increased use of verbal instructions and
explanations and rely less heavily on passive physical demonstrations (Strauss, Ziv, & Stein, 2002). Finally, by age 7, teachers use contingent strategies; based on the other child’s success in learning the task, they offer more or less help as necessary. In addition, 7-year-old teachers begin to provide more hints to learners and to engage the learner in the task (Wood, Wood, Ainsworth, & O’Malley, 1995). Thus, evidence suggests that children’s strategies become increasingly sophisticated with age and that these changes may be linked to advances in children’s abilities to understand the learner’s divergent knowledge and perspective (Ziv & Frye, 2004). Related to this point, age effects in children’s teaching strategies are paralleled by changes in their concepts of teaching. Kindergarten-aged children described teaching as “showing,” whereas older children described it as “telling” and later still as “helping” (Astington & Pelletier, 1996; Strauss et al., 2002). Thus, over time children’s conceptions of teaching become more collaborative, with the learner’s role perceived as increasingly active.

The small amount of literature on sibling teaching reveals considerable individual differences in children’s tendencies to use strategies such as verbal instruction, physical demonstrations, control, and learner involvement in the task (Howe, Brody, & Recchia, 2006; Poris & Vølling, 2001). As reflected in the peer teaching literature, chronologically older sibling teachers use more verbal instruction and learner involvement (Poris & Vølling, 2001); however, they also tend to be more controlling (Howe & Recchia, 2005). In addition, firstborn children use more frequent and varied strategies for teaching their younger siblings when the age gap is larger rather than smaller (Perez-Granados & Callanan, 1997).

Most studies of sibling teaching have focused on firstborn sibling teachers. The present investigation is one of the first to assign both firstborn and second-born children to the teacher and learner roles, respectively. By providing privileged knowledge of the task to the younger child and then requesting that he or she teach the older sibling, the natural balance of power between siblings is reversed. As such, it provides an interesting applied test of the finding that children recognize that the person with more knowledge should act as teacher, regardless of authority or status (Ziv & Frye, 2004). The one existing preliminary study on teacher birth order revealed that second-born teachers were more likely to involve the firstborn learner than vice versa (Howe & Recchia, 2005). This result is consistent with research showing that placing a high-ability child in a novice role and a lower-ability child in an expert role tends to lead to more collaboration and joint construction than in pairs in which the lower-ability child is the novice (Verba & Winnikamen, 1992). However, the opposite hypothesis is also entirely plausible. Given that firstborn teachers are more familiar with
the teaching role, they may be more versed in strategies that optimize learning. As such, firstborn teachers might be expected to be more likely to engage in sophisticated learner-centered strategies.

To summarize, there may be two important processes underlying birth-order effects on sibling teaching. The first is the perceived ability of the learner relative to the teacher. If this is the most important factor, then second-born teachers may be more likely to involve the learner than vice versa, given that they are teaching their older and more sophisticated sibling. On the other hand, if familiarity with the teaching role is the most critical process, then firstborn teachers may be more likely to involve the learner, reflecting their greater understanding of the teaching process and the factors that lead to successful learning.

The above studies on sibling and peer teaching reveal interesting age and birth-order effects. Relevant to the present investigation, research suggests that as children get older, they use more sophisticated strategies. Nevertheless, little is known about individual differences in children’s teaching strategies independent of age. First, how are these individual differences related to the unique and interactive effects of teacher birth order, considering the role that both experience and relative power can play in sibling interactions? Second, with age and birth-order effects controlled, does the pattern of associations between teaching strategies reveal differences between children’s abilities to teach their sibling effectively? Questions about developmental effects, birth-order effects, and individual differences form the focus of our study.

**The Current Study**

We recruited sibling dyads in early and middle childhood and assigned either the firstborn or second-born sibling to the teacher role. Including sibling dyads ranging in age from 3 to 9 years allowed us to examine developmental changes in teaching strategies across this entire period (Strauss et al., 2002; Wood et al., 1995). In addition, assigning either the firstborn or second-born sibling to the teacher role allowed us to test the replicability of previous findings regarding birth order (Howe & Recchia, 2005) and to examine additional birth-order effects. Given findings suggesting age gap effects on sibling teaching (Perez-Granados & Callanan, 1997), we also included this variable as a correlate of siblings’ teaching strategies. The interactions among these three variables (i.e., chronological age, teacher birth order, and age gap between siblings) were also investigated for the first time. Independent of age and birth order, we assessed individual differences in siblings’ approaches to teaching.
To examine these questions, we assessed a number of teaching strategies. Expanding on previous studies (Howe et al., 2006; Poris & Volling, 2001), we coded the degree of learner involvement in the teaching process by recording the number of teaching steps performed by learner as opposed to teacher. Similar to these studies, we also examined whether teachers focused on providing verbal instruction or controlling the process. Moreover, we incorporated some previously unexamined variables that are critical to competent teaching. Specifically, we assessed the clarity of teachers’ instructions by noting whether each verb, noun, and adjective used was specific or ambiguous. Furthermore, we examined how learner errors were corrected by coding who initiated the correction (i.e., noticed the error) and who ultimately fixed the mistake.

**Hypotheses**

Our hypothesis regarding age was that teachers from chronologically older dyads (independent of birth order and age gap) would engage in strategies conducive to transferring knowledge to the learner: encouraging learner involvement, providing instruction rather than controlling the interaction, providing unambiguous instruction, and allowing the learner to participate in error corrections.

Two competing hypotheses were possible for the effect of birth order. On the one hand, firstborn teachers may be more likely to engage in learner-centered strategies given their greater familiarity (and thus expertise) with the teaching role (i.e., expertise hypothesis): providing instruction rather than controlling the interaction, giving unambiguous instructions, involving the learner, and allowing learners to correct their own errors. Conversely, firstborn teachers may engage in fewer learner-centered strategies given the fact that they were teaching their younger, less knowledgeable sibling (i.e., perceived ability hypothesis). That is, firstborn teachers may have less confidence in the learner’s ability to participate in the process than second-born teachers, thus employing more controlling strategies. As described above, these strategies include controlling the process rather than providing instruction, giving vague instructions, permitting less learner involvement, and not allowing the learner to correct errors.

We predicted age gap effects on children’s teaching strategies but expected that all age gap effects would be moderated by birth order, as the implications of age difference between siblings depend largely on whether one is teaching a chronologically older or younger child. If a child was teaching her or his younger sibling, we expected a larger age gap to be associated with fewer learner-centered strategies, as teachers may perceive a
much younger learner to be less capable of participating in the teaching process. On the other hand, if a child was teaching her or his older sibling, we expected a larger age gap to be associated with more learner-centered strategies, given the perceived competence of a much older learner.

Finally, we predicted that independent of age and birth-order effects, there may be individual differences in children’s tendencies to engage in various strategies. Beyond variability explained by age and birth order, we expected that strategies would be correlated in such a way as to differentiate more and less learner-centered sibling teachers. Some strategies appear to be aimed at maximizing the chances of knowledge transfer by giving the learner ample opportunities to take responsibility for her or his own problem-solving (i.e., detailed instructions, learner involvement, learner correction of own errors). In contrast, we expected other teachers to use strategies that reflected an understanding of the learner as a passive observer of the teaching process (i.e., controlling the process, failing to involve the learner, and correcting errors themselves). These behaviors were more consistent with the interaction goal of finishing the task quickly and efficiently but were perhaps less conducive to learning. Thus, the learner is not seen as an essential collaborator in the process.

Method

Participants

Participants included 72 middle-class sibling dyads from a large bilingual community in Quebec, Canada. All families spoke English as one of their mother tongues. Families were recruited through newspaper advertisements, day care centers, kindergartens, and word of mouth. Older siblings were exclusively firstborn children, and their ages ranged from 59 months to 119 months (M = 81.64); second-born younger siblings were between 35 months and 81 months of age (M = 56.31). All dyadic gender compositions were represented approximately equally: 36 same-gender pairs (21 female, 15 male) and 36 mixed-gender pairs (20 older female, 16 older male). Family socioeconomic status (as assessed by parental occupation) and ethnic backgrounds (more than 90% European Canadian, with the remaining families of Asian and Middle Eastern descent) were reasonably representative of the sampled population (i.e., Anglophone Canadians). Some eligible families who were contacted chose not to participate, typically due to the scheduling commitment required for a home visit. All participating parents provided written informed consent on behalf of each of their children prior to the study. Both children in each dyad also provided verbal assent to all procedures at the time of the home visit.
Procedure

An experienced female research assistant conducted the sessions in the families’ homes. After a warm-up task, half of the firstborn ($N = 35$) and half of the second-born ($N = 37$) siblings were assigned to the teacher role (in counterbalanced order). The research assistant privately instructed the teacher how to build a tractor out of a construction toy (manufactured by Lasy Co., Germany). This task has not been used previously in the literature; pilot testing indicated that it was a novel toy that maintained children’s interest and that the difficulty of construction was appropriate for the age range sampled. The assistant received extensive prior training to ensure uniformity of instructions across sessions, and consistency was also checked periodically throughout data collection. The tractor construction consisted of 20 pieces whose function and manner of assembly were not obvious without prior instruction. First, the research assistant demonstrated each step of construction for the child along with verbal instruction and explanation for that step. Next, the child was asked to demonstrate competence by independently building the tractor. Feedback was given as necessary. This process took approximately 10 minutes. After demonstrating competence by building the tractor without errors, the teachers were asked to show their sibling how to construct it. Because all sibling teachers were shown how to build the tractor in the same way, any variability in the strategies they used to instruct their sibling was not attributable to differences in how they themselves were taught. The teaching sessions were videotaped and later transcribed in preparation for coding.

Coding

As an initial step, each transcript was parsed into individual speech clauses (i.e., one subject-verb group per line). Subsequently, several verbal and nonverbal behaviors were coded. One dyad was not coded for verbal behaviors because poor audio quality during taping made detailed verbal analyses impossible.

Conversational topic. The topic of each speech clause by the teacher was coded as pertaining to instruction (e.g., “Put all four of those on the tube”), structuring the interaction (e.g., “Don’t touch, I’m the teacher”), or off-topic. To establish reliability, two independent raters coded 26% of the dyads (19/72 transcripts; Cohen’s $\kappa = .85$).

Clarity of instructions. Once the conversational topic was coded, each line of instruction by the teacher was further coded for its clarity and detail.

1A detailed teaching script is available upon request from the second author.
Specifically, coders identified each noun, verb, and modifier (adjective or adverb) used by the teacher and then subsequently coded each word as specific (e.g., tube, slide, red) or ambiguous (e.g., thing, put, very). Interrater correlations for the number of specific nouns, verbs, and modifiers were all high (rs > .90).

Learner involvement. Successful construction of the tractor involved 19 distinct steps (e.g., assembling the axles, adding the steering wheel). As a measure of learner involvement in the teaching process, we coded the proportion of building steps completed independently by the learner as opposed to the teacher. Interrater agreement on the actor and behavior were high (agreements were 93% and 94%, respectively). Although it was possible for teachers and learners to perform building steps together, this occurred relatively infrequently (on average, less than 3% of building steps were completed jointly by teacher and learner).

Learner error correction. Learners made a variety of errors during the tractor construction (e.g., placing pieces backwards, in the wrong place, or in the wrong order). We computed global frequencies of learner errors ($\kappa$ for presence vs. absence of learner errors = .66). For every error identified, coders noted whether it was eventually fixed or not ($\kappa$ = 1.0) and, if fixed, whether the teacher (T) or learner (L) initiated (i) the correction (Ti or Li; $\kappa$ = .71) and who (T or L) ultimately corrected (c) the error (Tc or Lc; $\kappa$ = 1.0). For example, a teacher could verbally indicate that an error had been made (Ti) but allow the learner to correct it on her or his own (Lc). Initiations could be either verbal (e.g., “Oh, I made a mistake”) or nonverbal (e.g., pointing to the place where the error was made). Corrections were always nonverbal and involved physically adjusting or removing a misplaced piece. This coding yielded four distinct types of error corrections: Ti-Tc, Ti-Lc, Li-Tc, and Li-Lc.

Results

For all analyses, statistical significance was assessed using 2-tailed tests. Preliminary analyses revealed that two variables exhibited substantial skewness and kurtosis. Specifically, these were the proportion of conversational turns in which teachers were off-topic and the proportions of learner errors that were initiated by the learner but corrected by the teacher. Furthermore, scores for both variables were extremely low ($M$ proportions =

\(^2\)These agreements were computed as agreements/(agreements + disagreements) and thus constitute a relatively conservative measure of interrater reliability.
As neither was of particular theoretical significance, these variables were not examined further. Descriptive statistics for all other teaching variables are presented in Table 1.

A series of 2 (teacher gender) × 2 (learner gender) ANOVAs with teaching strategies as outcomes revealed only one main effect of teacher gender (of 20 possible main effects and 10 interactions). Given that at least one association would be expected due to chance alone, this single result was not interpreted. As gender effects were not the focus of the present study, more complex interactive effects of gender were not considered.

We first present analyses examining teacher birth order, dyadic age, and age gap effects on each of the measured teaching strategies. Following this, we present the associations between the observed teaching strategies, statistically controlling for age and birth-order effects.

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**Table 1.** Descriptive Statistics for Teacher and Learner Behaviors

<table>
<thead>
<tr>
<th>Variable</th>
<th>Overall M (SD)</th>
<th>Range</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide instructions</td>
<td>.66 (.19)</td>
<td>.13–1.00</td>
<td>71</td>
</tr>
<tr>
<td>Structure interaction</td>
<td>.32 (.18)</td>
<td>.00–.87</td>
<td>71</td>
</tr>
<tr>
<td>Specific nouns</td>
<td>.26 (.14)</td>
<td>.00–.56</td>
<td>71</td>
</tr>
<tr>
<td>Specific verbs</td>
<td>.22 (.19)</td>
<td>.00–1.00</td>
<td>71</td>
</tr>
<tr>
<td>Specific modifiers</td>
<td>.58 (.19)</td>
<td>.00–1.00</td>
<td>70</td>
</tr>
<tr>
<td>Learner involvement</td>
<td>.35 (.23)</td>
<td>.00–1.00</td>
<td>72</td>
</tr>
<tr>
<td>Learner errors</td>
<td>3.03 (2.61)</td>
<td>0–12</td>
<td>72</td>
</tr>
<tr>
<td>Learner-initiated learner correction (Li-Lc)</td>
<td>.28 (.38)</td>
<td>.00–1.00</td>
<td>61</td>
</tr>
<tr>
<td>Teacher-initiated learner correction (Ti-Lc)</td>
<td>.25 (.34)</td>
<td>.00–1.00</td>
<td>61</td>
</tr>
<tr>
<td>Teacher-initiated teacher correction (Ti-Tc)</td>
<td>.40 (.41)</td>
<td>.00–1.00</td>
<td>61</td>
</tr>
</tbody>
</table>

*Note.* All means are presented as proportions, with the exceptions of the number of learner errors. Providing instructions and structuring the interaction were proportionalized by the total number of speech clauses by the teacher (including off-topic speech). Specific nouns, verbs, and modifiers were proportionalized by the total number of nouns, verbs, and modifiers, respectively. Learner involvement was proportionalized by the number of teaching steps completed. Types of errors were proportionalized by the total number of error corrections (including learner-initiated teacher corrections). One teacher used no modifiers, and 11 learners made no errors, and thus these children are not included in the descriptives for these variables.

.03 and .07, respectively). As neither was of particular theoretical significance, these variables were not examined further. Descriptive statistics for all other teaching variables are presented in Table 1.3

3For all proportionalized variables, we conducted arcsine square root transformations and performed analyses a second time. Results were essentially identical; as such, for ease of interpretation, analyses of untransformed proportional values are reported in the text.
Birth-Order and Age Effects

To examine the unique and interactive effects of dyadic age (i.e., average age of children in the dyad), age gap between siblings (the difference between older and younger siblings’ ages), and teacher birth order (first-born or second-born sibling, scored as 1 and 0, respectively) on each of the teaching strategies, we conducted a series of hierarchical multiple regressions (see Cohen, 1978). The three predictors were standardized and entered simultaneously in the first step. Two-way interactions were entered in the second step by computing the multiplicative products for each pair of standardized variables. Finally, the three-way interaction term was entered in the third step (i.e., the multiplicative product of the three standardized variables). As none of the three-way interactions were significant, only results from the first two steps are reported. Furthermore, there were no significant main effects or interactions in the prediction of specific nouns, verbs, or modifiers. Regression results for the remaining variables are presented in Table 2.

As expected (i.e., age hypothesis), there was a significant association between dyadic age and the teacher’s tendency to provide instructions; when siblings were older, teachers provided more instructions. The opposite effect was found for the teacher’s tendency to structure the interaction; in the second step, dyadic age was negatively associated with the teacher’s focus on structuring the interaction. Note that these two dependent variables were strongly negatively dependent on one another, as they were computed as proportions of total speech. The interaction between dyad age and birth order in predicting the teacher’s focus on structuring the interaction was also significant. When the firstborn child was teaching, there was a negative association between structuring the interaction and dyadic age ($r = -0.39, p < .05$). However, there was no association between these two variables for second-born teachers ($r = 0.02, ns$).

Consistent with the perceived ability (as opposed to expertise) birth-order hypothesis, second-born teachers were more likely to involve the firstborn learner than vice versa. This effect was qualified by an interaction between dyadic age and birth order. For second-born teachers, there was a negative association between dyadic age and learner involvement ($r = -0.33, p < .05$). However, for firstborn teachers, there was a positive association between dyadic age and learner involvement ($r = 0.41, p < .01$). Finally, there was an unexpected interaction between dyadic age and age gap. When children were close in age (i.e., 1 SD below the age gap mean), the association between dyad age and learner involvement was positive ($r = 0.27, p < 0.10$). In contrast, when age gap was larger (i.e., above the mean), the association between dyadic age and learner involvement was slightly negative ($r = -0.10, ns$).
Table 2. Sibling Teaching Strategies as a Function of Dyadic Age, Age Gap, and Teacher Birth Order

<table>
<thead>
<tr>
<th>Provide Instructions</th>
<th>Structure Interaction</th>
<th>Learner Involvement</th>
<th>Learner Errors</th>
<th>Li-Lc Error Corrections</th>
<th>Ti-Lc Error Corrections</th>
<th>Ti-Tc Error Corrections</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R^2$ = .08</td>
<td>$R^2$ = .08</td>
<td>$R^2$ = .09</td>
<td>$R^2$ = .13**</td>
<td>$R^2$ = .17**</td>
<td>$R^2$ = .03</td>
<td>$R^2$ = .26*</td>
</tr>
<tr>
<td>$\beta_{sr}$</td>
<td>$\beta_{sr}$</td>
<td>$\beta_{sr}$</td>
<td>$\beta_{sr}$</td>
<td>$\beta_{sr}$</td>
<td>$\beta_{sr}$</td>
<td>$\beta_{sr}$</td>
</tr>
<tr>
<td>Dyad age (D)</td>
<td>.27** .27**</td>
<td>-.21† .22†</td>
<td>.06 .06</td>
<td>-.27** -.27**</td>
<td>-.03 -.03</td>
<td>.04 .04</td>
</tr>
<tr>
<td>Age gap (G)</td>
<td>.04 .04</td>
<td>-.09 -.09</td>
<td>-.01 -.01</td>
<td>.02 .01</td>
<td>.14 .14</td>
<td>-.07 -.06</td>
</tr>
<tr>
<td>Birth order (B)</td>
<td>-.03 -.03</td>
<td>.13 .13</td>
<td>-.29** -.29**</td>
<td>-.25** -.25**</td>
<td>-.40* -.40*</td>
<td>-.16 -.16</td>
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<tr>
<td><strong>Step 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R^2_\Delta$ = .05</td>
<td>$R^2_\Delta$ = .09†</td>
<td>$R^2_\Delta$ = .22**</td>
<td>$R^2_\Delta$ = .12**</td>
<td>$R^2_\Delta$ = .02</td>
<td>$R^2_\Delta$ = .11</td>
<td>$R^2_\Delta$ = .07</td>
</tr>
<tr>
<td>$\beta_{sr}$</td>
<td>$\beta_{sr}$</td>
<td>$\beta_{sr}$</td>
<td>$\beta_{sr}$</td>
<td>$\beta_{sr}$</td>
<td>$\beta_{sr}$</td>
<td>$\beta_{sr}$</td>
</tr>
<tr>
<td>D</td>
<td>.30** .28**</td>
<td>-.27** -.25**</td>
<td>.12 .10</td>
<td>-.37* -.35*</td>
<td>-.01 -.01</td>
<td>.04 .04</td>
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<tr>
<td>G</td>
<td>.06 .06</td>
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<td>.05 .04</td>
<td>-.08 -.08</td>
<td>.18 .17</td>
<td>-.01 -.01</td>
</tr>
<tr>
<td>B</td>
<td>-.01 -.01</td>
<td>.10 .10</td>
<td>-.25** -.25**</td>
<td>-.27** -.27**</td>
<td>-.40* -.40*</td>
<td>-.18 -.17</td>
</tr>
<tr>
<td>D × G</td>
<td>-.17 .14</td>
<td>.23 .19†</td>
<td>-.26** -.22**</td>
<td>.21 .18</td>
<td>-.02 -.02</td>
<td>.15 .12</td>
</tr>
<tr>
<td>D × B</td>
<td>.22† .21†</td>
<td>-.27** -.26**</td>
<td>.44* .42*</td>
<td>.25** .23**</td>
<td>-.01 -.01</td>
<td>-.13 -.12</td>
</tr>
<tr>
<td>G × B</td>
<td>-.01 -.01</td>
<td>.02 .02</td>
<td>-.20† .19†</td>
<td>.05 .05</td>
<td>-.14 -.13</td>
<td>-.30** -.28**</td>
</tr>
</tbody>
</table>

Note. There were no significant effects for regression analyses predicting the proportions of specific nouns, verbs, and modifiers. As such, results are not presented here.

Li-Lc = learner-initiated learner correction, Ti-Lc = teacher-initiated learner correction, Ti-Tc = teacher-initiated teacher correction, $sr$ = Semi-partial Correlation.

**p < .01, *p < .05, †p < .10
Learner errors were negatively associated with dyadic age, and learners made fewer errors when firstborns were teaching. However, these main effects were qualified by an interaction between dyadic age and birth order. When second-born siblings were teaching, dyadic age was negatively correlated with learner errors ($r = -0.51, p < .01$). In contrast, there was no association between dyadic age and learner errors when firstborns were teaching ($r = -0.01, ns$).

The last three regression analyses examined the proportions of each of three types of error corrections. Also consistent with the perceived ability hypothesis concerning birth order, learner-initiated learner corrections were more frequent when second-born children were teaching than when firstborn children were teaching. The opposite was true of teacher-initiated teacher corrections; these were more frequent when firstborns were teaching. Birth order moderated the association between age gap and teacher-initiated learner corrections. When the second-born siblings were teaching, there was a nonsignificant positive association between age gap and this type of error correction ($r = 0.22, ns$). However, when firstborns were teaching, this association was negative ($r = -0.37, p < .10$).

**Associations between Teaching Behaviors**

We also investigated associations between children’s teaching behaviors not accounted for by age and birth order. To assess this question, we examined partial correlations between each of the teaching variables, controlling for dyadic age, age gap, and teacher birth order.

Results partially supported the hypothesis regarding individual differences in children’s teaching strategies, although not all expected relationships were present. As described above, the proportions of speech in which teachers provided instructions versus structured the interaction were negatively dependent, thus explaining their strong negative association. Consistent with predictions, when teachers provided instructions rather than structured the interaction, they used more specific modifiers and involved the learner in the task. Contrary to our predictions, teachers who provided more instructions used proportionately fewer specific nouns. In contrast, when teachers structured the interaction, they provided more ambiguous instructions (i.e., fewer specific modifiers) and were less likely to involve the learner. Not surprisingly, learners who were more involved in the process also made more errors. The correlations between the proportions of specific nouns, verbs, and adjectives were close to zero, suggesting that contrary to expectations these variables did not reliably measure one underlying construct (Table 3).
Furthermore, we examined whether the above teaching strategies were correlated with the proportional frequency of each type of learner error after controlling for age and birth order. As described in Table 1, 11 learners made no errors and were thus omitted from these analyses (9 second-born and 2 firstborn learners). An average of 86% of learner errors made by the remaining 61 children were fixed during the tractor construction, thus constituting the data set for these analyses. Associations between teaching strategies and error corrections are reported in Table 4, with dyadic age, age

### Table 3. Partial Correlations among Teacher’s Speech Topic, Specificity of Instructions, Learner Involvement, and Number of Errors

<table>
<thead>
<tr>
<th></th>
<th>PI</th>
<th>SI</th>
<th>SN</th>
<th>SV</th>
<th>SM</th>
<th>LI</th>
<th>NE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide instructions (PI)</td>
<td></td>
<td>-.92**</td>
<td>-.25**</td>
<td>-.17</td>
<td>.29**</td>
<td>.33*</td>
<td>.16</td>
</tr>
<tr>
<td>Structure interaction (SI)</td>
<td>-.09</td>
<td>.22†</td>
<td>-.28**</td>
<td>-.42*</td>
<td>-.20†</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific nouns (SN)</td>
<td>-.03</td>
<td>.07</td>
<td>.07</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Specific verbs (SV)</td>
<td>-.05</td>
<td>.05</td>
<td>.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific modifiers (SM)</td>
<td></td>
<td>.23†</td>
<td>.12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learner involvement (LI)</td>
<td></td>
<td></td>
<td>.44*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of errors (NE)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. Dyadic age, age gap, and teacher birth order controlled; df = 66.  
* p < .01, ** p < .05, † p < .10.*

### Table 4. Partial Correlations between Types of Learner Error Correction and Other Teaching Variables

<table>
<thead>
<tr>
<th>Teaching Variable</th>
<th>Li-Lc</th>
<th>Ti-Lc</th>
<th>Ti-Tc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide Instructions</td>
<td>-.22</td>
<td>.31*</td>
<td>-.11</td>
</tr>
<tr>
<td>Structure Interaction</td>
<td>-.05</td>
<td>-.20</td>
<td>.25**</td>
</tr>
<tr>
<td>Specific Nouns</td>
<td>.30*</td>
<td>.02</td>
<td>-.26**</td>
</tr>
<tr>
<td>Specific Verbs</td>
<td>-.08</td>
<td>.18</td>
<td>-.15</td>
</tr>
<tr>
<td>Specific Modifiers</td>
<td>-.08</td>
<td>-.03</td>
<td>.10</td>
</tr>
<tr>
<td>Learner Involvement</td>
<td>.09</td>
<td>.20</td>
<td>-.23**</td>
</tr>
<tr>
<td>Number of Errors</td>
<td>.17</td>
<td>.02</td>
<td>-.17</td>
</tr>
</tbody>
</table>

*Note. Dyadic age, age gap, and teacher birth order controlled; df = 53. Li-Lc = learner-initiated learner corrected, Ti-Lc = teacher-initiated learner corrected, Ti-Tc = teacher-initiated teacher corrected.  
* p < .05, ** p < .10.*
gap, and teacher birth order controlled. Although generally relationships were in the expected directions, only two associations were statistically significant. Specifically, teachers who pointed out errors but allowed the learner to correct them (i.e., Ti-Lc) provided proportionately more instructions. Furthermore, the proportion of specific nouns was positively related to the learner’s tendency to correct errors entirely on their own (i.e., Li-Lc).

Discussion

Generally, our results reveal some individual differences in siblings’ teaching strategies during early and middle childhood. As expected, the manner in which strategies were related to age and birth order reflected differences between children in both the sophistication of their teaching and their apparent familiarity with the teaching role. Furthermore, once age effects were controlled, the pattern of associations among teaching strategies, learner behaviors, and error corrections suggested that some children used more learner-centered strategies than others. That is, some children seemed better able to understand the knowledge-transfer goal of the task and were more likely to engage in behaviors conducive to achieving this aim. The relative dominance and ability of the teacher and learner also appeared to contribute to differences between dyads. Each of these patterns of associations is discussed in turn.

Developmental and Birth-Order Effects on Sibling Teaching Strategies

Consistent with the perceived ability hypothesis regarding birth order, first-born teachers tended to use fewer learner-centered strategies (i.e., less learner involvement, and a failure to allow the learner to participate in the error correction process) than second-born teachers. As a case in point, one second-born learner complained to her sibling, “You didn’t teach me, you showed me.” In interpreting this effect, it is important to note the different status of the learner in these two situations. In firstborn teacher dyads, the second-born learner may have been perceived as less competent than the teacher (Klein et al., 2002). In contrast, as second-born teachers were providing instruction to their older sibling, typical teacher and learner roles were reversed (Brody et al., 1982; Stoneman et al., 1984).

The observed effects are consistent with research suggesting that in dyads in which a novice acts as teacher, the process tends to be more collaborative (i.e., learner-centered) than in dyads in which the recognized expert provides instruction (Verba & Winnykamen, 1992). Surely both teacher and
learner behavior contribute to this effect. In taking on the unusual role as the bearer of knowledge in this context, second-born teachers may nevertheless defer to their older sibling because of the nature of their hierarchical interactions established in other contexts (Dunn, 1983). However, firstborn learners are unlikely to be passive and allow their less advanced sibling to monopolize the interaction and may engage in behaviors that ensure their involvement in the task (e.g., asking questions, actively attempting to build). Thus, although young children may understand that the teaching role is assigned on the basis of knowledge rather than authority (Ziv & Frye, 2004), established sibling roles nevertheless may influence their actual teaching interactions.

Some of the hypothesized associations between dyadic age and teaching strategies were also supported but were often qualified by interactions with teacher birth order. When siblings were older, teachers provided more instructions, and learners made fewer errors. However, the latter effect was qualified by a birth order by dyadic age interaction. Dyadic age was associated with fewer learner errors only when second-born children were teaching their older sibling; the association was close to zero for firstborn teachers. This effect is particularly interesting when the interaction between dyadic age and birth order in predicting learner involvement is simultaneously considered. In line with past research (Poris & Vølling, 2001), firstborn teachers were more likely to involve their sibling as dyadic age increased. However, the opposite was true when the second-born child was teaching.

Thus, although older firstborn children increasingly involved their second-born sibling in the teaching process, the learner did not make more errors. As greater involvement increases the possibility of making errors, these findings suggest that as firstborn children grow older, they are more likely to engage in a scaffolding style that involves the learner without sacrificing the efficiency and success of the building process (Klein et al., 2002; Rogoff, 1990, 1998). In contrast, although firstborn learners made fewer errors when the dyad was older, this was accompanied by less learner involvement. Although older second-born children did manage to limit the number of learner errors, they did so by excluding their sibling from participating in the process. Thus, these effects together suggest that the teaching strategies of children who habitually take on this role (i.e., firstborns) may particularly benefit from the knowledge and experience gained with age.

A third interaction effect is also consistent with this distinction between firstborn and second-born teachers in the association between age and teaching strategies. When firstborn teachers were older, they were less likely to focus on controlling the interaction at the expense of providing instruction. This association with age was close to zero for second-born teachers. Again,
this suggests that firstborn children are more likely to benefit from the experience that comes with age. However, one additional interpretation is possible, namely that when the typical teaching roles of firstborn and second-born children are reversed, both children are ill at ease. Thus, although second-born children may be less effective teachers, firstborns may also be less cooperative learners. If firstborns consistently attempt to take control of the interaction, second-born teachers would presumably focus more on controlling the process regardless of age. It is possible that both of these processes are playing a role in producing the observed effects.

As anticipated in the hypothesis regarding age gap, the main effect of age gap was not associated with any teaching strategies. This is not surprising, given that age gap effects should depend on whether the firstborn or second-born sibling is teaching. Yet there was only one interaction between age gap and teacher birth order, namely the tendency for error corrections to be initiated by the teacher but ultimately corrected by the learner. When second-born children were teaching, these error corrections were more frequent when the learner was substantially older. Perhaps older firstborn learners could infer the kind of correction that was needed and easily complete it independently. They may also have been reluctant to allow their very young sibling to correct the mistake for them. In contrast, for firstborn teachers these corrections were less frequent when their sibling was much younger. Again, this may be related to perceptions of learner competence in that a young second-born child may not be seen as capable of correcting her or his own mistakes (Klein et al., 2002). Age gap is presumably a reflection of the extent to which the hierarchical dimension of a relationship is salient in sibling interaction. Thus, this latter finding is also consistent with the notion that greater symmetry in authority between teacher and learner is ideal for knowledge acquisition (Piaget, 1950; Tudge & Rogoff, 1989).

One final unexpected interaction between age gap and dyadic age deserves comment. When children were close in age, learners from older dyads were more involved. In contrast, when the difference between siblings’ ages was large, older dyads engaged in less learner involvement. Teachers who perceive their sibling as an equal may increasingly involve the learner as they become developmentally capable of doing so. In contrast, when one’s sibling is at a very different developmental level, age may be less consistently related to learner involvement, especially because a larger age gap has different implications for firstborn and second-born teachers. Clearly these interpretations are speculative, and this moderated effect should be replicated and explored in future studies.

Contrary to hypotheses regarding dyadic age, birth order, and age gap, the specificity of teachers’ instructions were not related to any of these
variables, nor were they consistently related to one another with these variables controlled. It may be that specific instructions were provided inconsistently in the current task, as more effective teaching strategies were available (e.g., learner involvement combined with demonstrations). Alternatively, perhaps developmental differences in these strategies would be more apparent if this study had been conducted in an older sample, when children’s ability to produce unambiguous verbal messages has developed further (Dickson, 1982). Only the very eldest children in our study may have been capable of systematically constructing teaching messages that were comprehensible to an uninformed learner. Yet the use of unambiguous communication was occasionally related in predictable ways to other teaching variables. It is these associations to which we now turn.

Variations in Siblings’ Teaching Styles

As predicted, the associations between teaching strategies suggested individual differences in children’s approaches to teaching, independent of age and birth order. Some teachers appeared to treat the learner as essentially a passive observer of the process rather than an active participant or collaborator. Specifically, teachers who did not involve the learner in the task also focused verbally on structuring the interaction. When they provided instructions, they used fewer specific modifiers. When these teachers provided opportunities for the learner to make errors, they typically corrected the learner’s errors themselves, thus not allowing the learners to solve the problems independently. This investigation focused on variations in the teaching process rather than learner success outcomes per se, but these strategies seemed to reflect less understanding of the knowledge transfer goals critical to successful teaching (LeBlanc & Bearison, 2004).

In contrast, some teachers used strategies more characteristic of Rogoff’s (1990, 1998) notion of guided participation in that their goal seemed to be imparting knowledge by treating the learner as an equal participant in the process (Palincsar, 1998). Learners may have had the opportunity to become collaborators by virtue of the kinds of scaffolding that teachers provided. Specifically, teachers who involved the learner in the task also provided more instructions. Although they did also use more specific modifiers, they used fewer specific nouns. This latter unexpected finding may be related to the fact that teachers who provided ample instructions frequently referred to the same parts of the tractor and thus eventually may have naturally substituted pronouns. Learners involved in the process made more errors overall; this was likely because they were more involved in the construction and thus had greater opportunity to make mistakes. When mis-
takes were made, teachers who provided more instructions pointed out the learner’s errors but allowed learners to correct the mistakes independently. Thus, although these teachers were attentive to the learners, their behavior suggested that they had confidence in the learner’s ability to solve problems. Given the observational nature of these data, we do not have information about the explicit task understanding that led to this pattern of associations. Nevertheless, results certainly suggest that some sibling teachers had a good understanding of the central knowledge-imparting goals implicated in teaching as well as some effective strategies to employ in achieving their goals.

Limitations
The current study was conducted with a European Canadian, Anglophone sample of middle socioeconomic status, and thus the results may not be generalizable to other socioeconomic, cultural, or linguistic groups. Furthermore, children were not administered linguistic or social-cognitive measures; the availability of these data may have clarified some of the observed associations. The small sample size limited the power to detect some effects (e.g., interactive regression effects), and we were not able to conduct a detailed examination of teaching strategies as a function of gender; previous studies of gender effects on sibling teaching are inconsistent (e.g., Azmitia & Hesser, 1993; Maynard, 2002; Minnert, Vandell, & Santrock, 1983; Poris & Volling, 2001), and thus future research should make use of larger samples to address this issue. Finally, it is unclear whether the results obtained with the procedural task of constructing a toy tractor would generalize to other types of learning, such as acquisition of concepts, or whether the teaching strategies observed in this structured context would be observed during naturalistic exchanges.

Summary and Future Directions
Our study is one of the first to assign second-born siblings to the teaching role, placing unusual cognitive and role demands on these children. Placing these children in the teaching role upset the natural power balance between children (Perlman et al., 2000) and thus provided an indirect test of children’s understanding that the individual with greater knowledge, as opposed to power, should act as teacher (Piaget, 1950; Tudge & Rogoff, 1989; Ziv & Frye, 2004). Our results suggested a number of effects of birth order, and this variable also moderated various developmental age effects. However, our design does not allow us to differentiate between the influences of second-born teacher (i.e., “I’m not a competent instructor, thus I
should involve the learner”) and firstborn learner (i.e., “I need to reassert my dominance and assist my less competent younger sibling”) effects on behavior in this context. The characteristics of the child being taught are clearly relevant to the strategies used and should be examined in future research. The distinction between teacher and learner effects may have implications for interventions that aim to promote collaborative sibling teaching; it may be important to guide firstborns to engage in more learner-centered teaching strategies and also to become more cooperative learners. Another possibility may be to target second-born siblings and guide them to become more active learners and to develop effective teaching strategies in their own right.

In some ways, our study raises as many questions as it answers. Although the observed birth-order and age gap effects suggest that the perceived status of the learner plays a role in sibling teaching, this may not be the whole story. Certainly, variability in children’s social-cognitive skills may be an important correlate of individual differences in teaching strategies. If some children are better able to understand their sibling’s degree of knowledge, they may employ techniques aimed at maximizing knowledge transfer. There is also some evidence that sibling relationship quality is associated with the features of children’s sibling teaching interactions (Howe & Recchia, 2005), and the degree to which parents encourage children’s sibling teaching may certainly have an impact. Related to this point, there may be cultural differences in the extent to which sibling teaching is formalized and valued (Maynard, 2002).

We sacrificed ecological validity and the ability to examine contextual factors to gain control over the teaching situation. Longitudinal research on the detailed processes underlying sibling teaching in a naturalistic context is generally lacking in the literature and would complement our own cross-sectional laboratory study to show how some of these patterns become established over time. Our own results provide initial evidence that our understanding of children’s cognitive development, the relevance of asymmetrical roles, and relationship dynamics can benefit from a detailed examination of the processes underlying siblings’ complementary interactions.

References


biennial meeting of the Society for Research in Child Development, Minneapolis, MN.


