“This Bird Can't Do It ‘Cause this Bird Doesn't Swim in Water”: Sibling Teaching During Naturalistic Home Observations in Early Childhood

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Social-constructivist models of learning highlight that cognitive development is embedded within the context of social relationships characterized by closeness and intimacy (Vygotsky, 1978). Therefore, in contrast to prior research employing semi-structured paradigms, naturalistic sibling-directed teaching was examined during ongoing interactions at home. Thirty-nine middle-class, two-parent families (older sibling, \(M_{\text{age}} = 6;3\); younger sibling, \(M_{\text{age}} = 4;4\)) were studied. Intentional sequences of sibling-directed teaching were coded for: a) frequency; b) type of knowledge taught (i.e., conceptual or procedural); c) initiation of teaching by the teacher or following a request by the learner; d) teaching strategies (e.g., direct instruction, demonstration); and e) learner responses (e.g., active involvement, rejection). Findings indicated that teachers were most likely to initiate teaching spontaneously rather than respond to direct requests by learners. Teachers were most likely to initiate teaching of procedural knowledge, while learners were most likely to request the teaching of conceptual knowledge. The type of teaching strategy employed depended on who initiated the teaching and the type of knowledge taught. The response of the learner was associated with who initiated the teaching and the teaching strategies employed. These findings reveal the nuances and sophistication of young children’s attempts to teach one another naturally in their homes. Findings are discussed in light of recent empirical and theoretical work.

Social-constructivist models of learning highlight that cognitive development is embedded within the context of social relationships characterized by closeness and intimacy (Palinscar, 1998; Vygotsky, 1978). Many studies on informal teaching in children’s everyday interactions have focused on parent–child (e.g., Rigney & Callanan, 2011) conversations or peer teaching (e.g., Ashley & Tomasello, 1998). Yet the sibling relationship is a unique context in which to study teaching and learning and affords children the opportunity to reveal their social understanding as they act as socialization agents influencing one another’s development (Carpendale & Lewis, 2004, 2006; Dunn, 2002; Pérez-Granados & Callanan, 1997b). One critical component...
of social understanding is the process whereby young siblings co-construct shared meanings during the complementary (e.g., teaching) interactions that partly define their relationship (Dunn, 1983; Hinde, 1979; Piaget, 1950; Vygotsky, 1978). The sibling teaching literature has typically employed semistructured instructional paradigms, whereas few studies have investigated naturalistic sibling teaching (Howe, Ross, & Recchia, 2011). Therefore, we focused on complementary interactions (i.e., teaching/learning) during naturalistic conversations when the siblings were engaged in teaching procedural and/or conceptual knowledge at home (Hatano & Inagaki, 1986). Specifically, we investigated a) the frequency of sibling teaching, b) the types of knowledge conveyed, c) how teaching was initiated, d) teaching strategies, and e) the response of the learner.

Developing Shared Meanings in Naturalistic Teaching Contexts

Recent ideas about “natural pedagogy” suggest that human communication developed for the purpose of transmitting generic cultural knowledge via the process of teaching (Csibra, 2007; Csibra & Gergely, 2009; Gergely, 2008). Certainly, the family is a major context in which cultural knowledge is acquired through natural communication. In fact, as Hughes and de Rosnay (2006) argue, naturalistic family conversations (i.e., parents–children, siblings) illuminate important processes in how children acquire knowledge and understanding of their social-cultural and cognitive worlds, which is likely to be of importance in how they manage their social lives (Carpendale & Lewis, 2004, 2006; Dunn, 2002; Pérez-Granados & Callanan, 1997a).

Naturalistic parent–child conversations have been investigated in a variety of domains as a context for the transmission of knowledge. For example, informal parent–child conversations at home or a museum guided European American and Mexican American children’s scientific understanding (e.g., Jipson & Callanan, 2003; Tenenbaum & Callanan, 2008). Mothers and children also engaged in conversations about mathematics and category structure during informal activities such as cooking or reading books (e.g., Gelman, Coley, Rosengren, Hartman, & Pappas, 1998; Vandermaas-Peeler, Boomgarden, Finn, & Pittard, 2012). Further, Dunn’s extensive body of research on early sibling relationships was guided by the premise that children’s development and their social understanding were facilitated during ongoing naturalistic conversations and exchanges at home (e.g., Dunn, 1988, 2002).

Alongside teaching interactions with parents, siblings are in a unique position to develop a shared understanding regarding cognitive knowledge and an intimate understanding of one another’s desires, abilities, and general knowledge based on their long, co-constructed, and affectively intense history (Howe et al., 2011). Due to the hierarchical characteristics of sibling relationships, first-born siblings often assume the lead during complementary interactions such as teaching, whereas second-born siblings are likely to assume a follower role such as learner (Dunn, 1983; Hinde, 1979). According to parent reports, during informal family conversations Mexican American older siblings learned social skills from their younger siblings, while younger siblings’ understanding of academic skills was guided by older siblings (Pérez-Granados & Callanan, 1997b). Thus, siblings apparently act as important socialization agents for one another, although specific patterns of socialization may vary across cultures.

Some ethnographic cultural work on sibling teaching is also relevant (Maynard, 2002, 2004; Rabain-Jamin, Maynard, & Greenfield, 2003; Volk, 1999). Maynard (2002) observed young Mayan children’s naturalistic interactions that included teaching their sibling daily cultural
routines (e.g., cooking, washing). Teaching sequences were embedded in the context of ongoing play and children demonstrated improved verbal discourse, scaffolding, and teaching strategies (e.g., demonstration, explanations, feedback) from early to middle childhood. In a case study of a Puerto Rican kindergarten-aged boy, Volk (1999) observed the adolescent siblings and the mother teaching literacy and numeracy skills to the child during ongoing family activities. Building on the literature reviewed, we examined how siblings co-construct shared meanings while teaching during naturalistic conversations at home so as to illuminate our understanding of the influence of siblings as potential socialization agents for one another.

Approaches to Teaching and Learning

Social-constructivist models highlight the importance of social relationships in facilitating learning (Vygotsky, 1978); thus, teaching is defined as one person (i.e., the teacher) intentionally directing or transmitting knowledge to a less knowledgeable person (i.e., the learner; Frye & Ziv, 2005). Piaget (1950) and Vygotsky (1978) argued that the key component of teaching is an asymmetry of knowledge or understanding and not authority or status per se (Tudge & Rogoff, 1999). Given this premise, children should be capable of teaching one another (LeBlanc & Bearison, 2004); in fact, Strauss and Ziv (2012) argue that teaching is a natural cognitive activity, which children do effortlessly and without seeming to have been taught how to do so (Strauss, Ziv, & Stein, 2002). Within this framework, teaching and learning are viewed as a collaborative and bidirectional process where both teacher and learner have active roles (Palinscar, 1998; Rogoff, 1990, 1998). Rogoff (1990) conceptualizes the overarching collaborative goal as the teacher building bridges between the known and unknown, structuring and supporting the learner’s active engagement, and providing problem-solving opportunities for the learner to take responsibility for managing activities and their own learning.

Successful teaching may partly depend on the teachers’ understanding of learners’ abilities and their points of view, teachers’ responsiveness to learners’ attempts to learn, and whether they employ strategies to create shared meanings so learners can complete the task (Howe, Recchia, Della Porta, & Funamoto, 2012; LeBlanc & Bearison, 2004; Strauss et al., 2002). Further, teachers must recognize the knowledge gap between what they and their learners know and, in turn, intentionally engage in teaching to close that gap. Thus, once individuals recognize that others are having difficulty or lack understanding, they may offer to teach or may just assume a teaching role, perhaps in the belief that they have the knowledge and ability to instruct or guide others in difficulty, a topic covered in the present study. Further, teachers who use a collaborative approach also offer learners the opportunity to correct their own mistakes, which may facilitate learners’ greater understanding (Recchia, Howe, & Alexander, 2009). Learners also play an active role by participating, asking questions, and demonstrating understanding (Howe & Recchia, 2005, 2009; Howe et al., 2012). Thus, teaching and learning are characterized as a mutual and collaborative process in which it is critical for two children to develop shared meanings. Of course, some teachers may employ more direct instruction strategies where the teacher maintains control of the task by providing demonstrations while at the same time expecting the learner to take a more passive role by watching and listening to the instruction. This approach reduces opportunities for learners’ hands-on active involvement and leaves fewer opportunities to correct mistakes and presumably to learn from their errors (Recchia et al., 2009). Different
contexts are likely to be conducive to a more guided participation teaching approach or alternatively, a direct instruction approach (Howe et al., 2012).

Teaching and Types of Knowledge

Teaching may involve procedural knowledge (e.g., “knowing how” to do something) or conceptual knowledge (e.g., “knowing that/why,” specifically conveying information, explanations, meanings about the world; Hatano & Inagaki, 1986). When conveying procedural knowledge, the teacher must shape the task requirements by using practical information strategies (e.g., how to operate a toy cash register), which establish shared meanings to guide the learner to complete the task. In contrast, conceptual knowledge allows children to make predictions in unfamiliar contexts and invent new strategies for understanding; to do so, the teacher must engage in explanations, clarifications, and discussions so as to convey the information clearly to the learner (e.g., rules to a game). Most empirical work employs semistructured teaching tasks that focus on procedural knowledge (e.g., how to complete a puzzle) to study sibling teaching processes (e.g., Azmitia & Hesser, 1993; Howe & Recchia, 2009; Recchia et al., 2009), whereas little attention has been devoted to siblings’ teaching of conceptual knowledge.

Sibling Teaching During Semistructured Tasks

Given the premise that older siblings take the lead in complementary interactions (Dunn, 1983), most studies have employed a semistructured task where researchers have taught the older sibling a task (e.g., constructing a toy) and then asked them to teach their younger sibling. In this literature, school-aged siblings are more likely than younger children to employ both a) a wider range and b) more sophisticated teaching strategies (e.g., explanations, verbal instruction, scaffolding, encouragement, demonstrations) so as to structure the task for the learner and thus provide the bridge between known and unknown information (Howe & Recchia, 2005, 2009; Howe et al., 2012; Rogoff, 1998; Strauss & Ziv, 2012). School-aged siblings are also less controlling of the situation than are younger teachers (Azmitia & Hesser, 1993; Recchia et al., 2009). Further, teachers’ social-cognitive skills may account for some age differences (Howe et al., 2012), and as older siblings enter middle childhood, they employ more learner-centered teaching strategies during semistructured tasks (Palinscar, 1998) such as scaffolding, allowing learners to correct their own mistakes, and facilitating active learner engagement.

Often there is little emphasis on how younger siblings approach their typical role as a learner (e.g., Brody, Stoneman, MacKinnon, & MacKinnon, 1985; Klein, Feldman, & Zazur, 2002), which is one focus of our study. Moreover, a number of questions remain about sibling teaching. Specifically, when researchers ask children to teach and tell them what to teach, we have limited information about the extent of spontaneous sibling-directed teaching. In addition, we do not know whether children focus on conceptual or procedural knowledge and what strategies (e.g., explanations, direct instruction) teachers employ with both kinds of knowledge: Do teachers commence by just assuming the role or do they respond to learners’ requests for teaching? Furthermore, we need to know how learners respond to these varied styles and contents of teaching. Examining children’s naturalistic discourse at home provides a window into siblings’
real-life social-cognitive understanding and complements our knowledge based on experimental manipulations (e.g., Jenkins & Astington, 2000), thus contributing significantly to the literature.

**The Present Study**

The present study employed both a relationship (Carpendale & Lewis, 2004, 2006; Dunn, 2002; Hartup & Laursen, 1999; Hinde, 1979) and sociocultural/social-constructivist model (Rogoff, 1998; Vygotsky, 1978) as the frameworks to investigate naturalistic sibling teaching at home. Teaching during complementary sibling interactions was investigated in a sample of 4- and 6-year-olds observed during ongoing family interaction. First, we investigated the frequency with which siblings teach one another during family interactions. Second, we examined the initiations of teaching (i.e., did older siblings assume the teaching role or did learners request teaching?); based on Hinde (1979), we expected older siblings to take the lead in initiating teaching. Third, the specific teaching strategies employed were identified, and following from Howe et al. (2012) and Howe and Recchia (2009), we expected that teachers would most likely employ direct instruction, encouragement, and demonstration strategies. Fourth, we examined the type of knowledge (conceptual, procedural) that children taught and associations with teaching strategies (e.g., demonstration, explanation, direct instruction). The fifth question addressed learners’ responses to the teaching (reject, ignore, comply, active involvement) and associations with how teaching was initiated and with specific teaching strategies. Given the lack of literature on the last two questions, no hypotheses were advanced.

**METHOD**

**Participants**

Participants included 39 middle-class Caucasian families (two siblings; two parents) residing in a midsized Canadian city. Older children’s ages ranged from 5;4 to 7;0 ($M_{age} = 6;3$; $SD = 0.42$ months), and the younger children’s ages ranged from 3;8 to 4;7 ($M_{age} = 4;4$; $SD = 0.21$ months); $M_{age\ gap} = 1;9$; $SD = 0.28$ months (range = 1;4–2;5). Parents’ ages varied: mothers’ $M_{age} = 32;8$; fathers’ $M_{age} = 34;6$ (range = 23;0–48;0). Their education level also varied: university degree = 29%, community college degree = 15%, high school diploma = 41%, and no high school diploma = 15%.

**Procedure**

Families were observed for six 90-min sessions for a total of 9 hr in their home, while some were observed for seven sessions ($n = 7$). Each session was preceded by a warm-up period so children could become accustomed to the presence of the observer. Observers were as inconspicuous as possible and children were instructed to ignore them and to pretend that the research assistants were not there; major distractions (i.e., television, video games) were not permitted. Observers quietly dictated the ongoing behavioral interaction into a tape recorder, which also recorded all participants’ language on a second track. The sessions were transcribed using both the recorded
language and detailed descriptive accounts of sibling and parent interaction (see Ross, Filyer, Lollis, Perlman, & Martin, 1994). Transcriptions included verbal and physical action codes of individuals’ behavior toward one another (e.g., request action, protest) to translate the interactions accurately. Reliability by two observers was determined during ten 20-min sessions conducted prior to the actual data collection, which were transcribed (agreement for presence of each coded behavior = .86 [range = 70%–100%], actor = .88 [range = 76%–100%], and sequences [e.g., play, conflict] of interaction = .95 [range = 86%–100%]).

Coding

Teaching sequences in the transcripts were identified based on the clear intention of one sibling to teach the other. Identified sequences began with the older sibling intending to teach something explicitly to the younger sibling (and thus the older child assumed the teaching role), or the younger sibling directly requested teaching from the older sibling. For example, there might be an explicit direct statement to teach (e.g., “I’m going to teach you dance steps”), a more indirect sharing of information or knowledge (e.g., “Those are little pencils. That’s the paper for the pencil.”) or a request for teaching from the younger sibling (e.g., “What’s a Valentine?”). Teaching could also include corrections (e.g., “That’s the wrong end, Sam.”). Thus, the start of each sequence began when teaching commenced and terminated when the teaching ended or the topic changed. We took a conservative approach to the identification of intentional teaching sequences, and the following situations were not considered to be teaching in the present study: general conversations and discussions where implicit learning might have occurred, or parents stepping into the sibling-directed teaching as guides or teachers themselves.

After the sequences were identified, coding commenced using a scheme based on Howe, Brody, and Recchia (2006) and Howe and Recchia (2009). First, initiation of teaching was coded with mutually exclusive categories as either a) initiated by the teacher whereby he or she assumed the teaching role (e.g., “This pulls me back, watch” referring to an exercise machine), or b) the learner requested knowledge from the teacher (e.g., “What’s ‘emergency?’”). Second, based on Hatano and Inagaki (1986), each sequence was coded into two mutually exclusive knowledge categories: a) Conceptual knowledge was defined as talk about concepts (e.g., difference between a square and a circle), labels (e.g., types of fruit or shapes), and general knowledge (e.g., days of the week), and b) procedural knowledge was defined as talk about how to do something (e.g., write the number 10; how to do a somersault).

Third, teaching strategies were coded as present or absent for each teaching sequence; because teachers often employed multiple strategies, more than one type of strategy could be coded per sequence. The eight strategies were defined as: a) Direct instruction, which referred to labeling, describing, or sharing information in a direct fashion (e.g., “do this”; “stand here”; “This is an H”); b) verbal or nonverbal demonstration, which entailed showing how to do something (e.g., teacher performs dance steps so the learner can see; asking learner to watch as teacher traces the letter “A”; pointing to an object required for constructing); c) explanation, which involved justifying or explaining a reason why and often included the words “because,” “so that,” or “in order to” (e.g., “This bird can’t do it ‘cause this bird doesn’t swim in water”); d) planning, which referred to describing the teaching steps explicitly so as to prepare the learner; the description was often phrased in the future tense and guided the learner toward a goal.
(e.g., “I’m going to show you what to do”; “I’m going to get you all lined up, and I’m going to see who can do it good.”); e) clarification, which referred to checking the learner’s understanding or to ascertaining the level of the learner’s knowledge by asking questions or for information but was not negative feedback (“OK?”; “Do you see how to do it?”; “How much is 2 + 2?”); f) positive feedback or giving praise (e.g., “Good”; “That’s right”); g) negative feedback or correction (e.g., “You don’t turn, no, not like that”; “That’s not the bull.”); and h) ignoring, which was coded as the teacher’s lack of a response after the learner requested knowledge during the ongoing teaching sequence (e.g., learner asks “I’m looking for a 1”’? Teacher does not respond). The strategies that most clearly reflected a guided participation approach included explanation, planning, and clarification.

Finally, mutually exclusive learner responses, which represented progressively higher levels of involvement, were coded as a) the learner not responding to the teacher’s instruction or changing the subject, b) explicit rejection of knowledge being taught (e.g., teacher says: “This puzzle piece goes right here”; learner replies: “No, it goes here”), c) complying with the teaching by imitating or verbally accepting information (e.g., teacher says: “Jump over it”; learner jumps over obstacle), or d) active involvement, which was considered the highest level of learner involvement, because the child could build on what was being taught with additional information or by asking questions (e.g., teacher: “This is its nose”; learner: “Where is it supposed to go?”). If there were multiple types of learner involvement in a sequence, the highest level of involvement was coded. For example, if the learner rejected and then was actively involved, the learner response was coded as the latter. See the Appendix for examples including the coding of initiation, type of knowledge, strategies, and learner response.

Reliability

In regard to identifying teaching sequences, 21% of the total number of transcripts was used to attain reliability on lines of teaching identified by the two naïve but trained research assistants. Reliability was calculated by recording whether the coders agreed or disagreed on whether each line was part of a teaching sequence ($kappa = .78$, $p < .001$). For example, if both coders identified the same sequence, each line was counted as an agreement. If one coder missed a line, that one line was considered a disagreement. Finally, if one coder missed an entire sequence, each line in that sequence was a disagreement. To control for misinterpretations in identification, research assistants met frequently with the first and third authors to discuss questions about the coding of specific sequences; overall, they took a very cautious approach to identifying teaching sequences. Reliability ($kappa$) for the coding of the older sibling’s teaching was obtained between two trained coders on 22% (231/830) of sequences; one person was unfamiliar with the study’s goals. $Kappas$ for identifying the sequence characteristics were as follows (all $ps < .001$): a) who was teaching = .96; b) initiation of teaching = .93; c) type of knowledge = .74; and d) learner response = .70. $Kappas$ for the eight teaching strategies were: a) direct instruction = .80; b) demonstration = .91; c) explanation = .80; d) planning = .60; e) clarification = .75; f) positive feedback = .89; g) negative feedback = .84; and h) ignore = .87. According to Fleiss (1981), a $kappa$ value between .60 and .75 is good, and a value greater than .75 is excellent.
RESULTS

Data Analysis

Based on the transcripts, 1,040 intentional sibling-directed teaching sequences were identified ranging from 2 to 114 conversational turns; however, in the present study, we only analyzed the 830 sequences taught by the older sibling. The average number of teaching sequences per family was 20.44 (median = 17; range = 3–82 teaching sequences). Because some families engaged in more teaching than others, data were analyzed with the family as the unit of analysis to ensure that each dyad was weighted equally in the analyses. Specifically, simple and conditional probabilities were calculated with the resulting proportion scores controlling for the number of sequences per family, thus yielding comparable data across families. Each analysis required a certain calculation of proportion scores, which are described for each set of results. Preliminary analyses revealed no gender or age effects; thus, they were not controlled for in the following analyses.

Characteristics of Sibling Teaching

Simple probabilities for mutually exclusive codes (e.g., conceptual vs. procedural knowledge) were calculated as the proportion of instances of each item (e.g., type of knowledge) divided by the total number of teaching sequences yielding a total score of 1.00 when proportions were summed across all categories (e.g., conceptual knowledge = number of sequences of conceptual knowledge/total number of sequences; procedural knowledge = number of sequences of procedural knowledge/total number of sequences). Similar methods of proportionalizing the data were conducted for initiation of teaching and learner responses. Teaching strategies were not mutually exclusive, and as such, the proportion of instances of each item (e.g., direct instruction) was divided by the total number of teaching sequences; thus, the sum of all categories did not yield a total score of 1.00.

Type of knowledge and initiation of teaching. One-sample $t$ tests were conducted to assess the relative proportions of the two types of knowledge taught, as well as how teaching was initiated between the sibling dyads at a comparison value of .50. In regard to type of knowledge taught, results revealed a significant difference, $t(38) = 7.98, p < .001$, indicating that conceptual knowledge ($M = 0.70, SE = .03$) was taught more often than expected by chance, whereas procedural knowledge was taught less often than expected by chance ($M = 0.30, SE = .03$). Further, teaching episodes were initiated in significantly different ways, $t(38) = 13.23, p < .001$; teaching sequences initiated by the teacher (older sibling) were more likely than expected by chance (i.e., $M = 0.77, SE = .02$), whereas sequences in which the learner (younger sibling) requested teaching were less likely than expected by chance (i.e., $M = 0.23, SE = .02$).

Teaching strategies and learner response. A one-way repeated-measures analysis of variance (ANOVA) measured the relative frequencies of teaching strategies, keeping in mind that more than one strategy could be used in each teaching episode. Findings indicated a
significant difference in the type of teaching strategies used, \( F(7, 32) = 293.98, p < .001 \). In particular, post-hoc comparisons (see Table 1 for overall proportions) revealed that direct instruction was used significantly more than any other strategy, followed by demonstration and negative feedback. Explanation was used more than clarification and ignoring; ignoring was used significantly less than all strategies, except clarification.

To assess the relative frequencies of learner responses to teaching, a one-sample \( t \) test was used to compare each learner response to a test value of .25, given that there were four possible response categories. With this approach, a significant difference was identified, in which learners’ failure to respond, \( t(38) = 2.05, p < .05 \), and compliant responses, \( t(38) = -8.13, p < .001 \), were more likely than expected by chance, whereas rejection was less likely than expected by chance, \( t(38) = 2.87, p < .01 \). There was no significant difference from the test value of .25 for active involvement.

### Table 1: Means and Standard Errors for the Post-Hoc Comparisons: Teaching Strategy by the Learner’s Response

<table>
<thead>
<tr>
<th>Strategy</th>
<th>No Response M (SE)</th>
<th>Reject M (SE)</th>
<th>Comply M (SE)</th>
<th>Active Involvement M (SE)</th>
<th>Overall Proportion of Teaching Strategies M (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Instruction</td>
<td>.78 (.05)(^a)</td>
<td>.91 (.03)</td>
<td>.91 (.03)</td>
<td>.95 (.03)(^a)</td>
<td>.88 (.02)</td>
</tr>
<tr>
<td>Demonstration</td>
<td>.37 (.05)</td>
<td>.57 (.07)</td>
<td>.43 (.05)</td>
<td>.49 (.05)</td>
<td>.42 (.03)</td>
</tr>
<tr>
<td>Explanation</td>
<td>.17 (.03)</td>
<td>.08 (.03)</td>
<td>.13 (.03)</td>
<td>.15 (.03)</td>
<td>.13 (.02)</td>
</tr>
<tr>
<td>Planning</td>
<td>.06 (.02)(^a)</td>
<td>.09 (.04)</td>
<td>.15 (.04)</td>
<td>.16 (.03)(^a)</td>
<td>.09 (.01)</td>
</tr>
<tr>
<td>Clarification</td>
<td>.02 (.02)(^a)</td>
<td>.01 (.01)(^b)</td>
<td>.07 (.02)</td>
<td>.12 (.03)(^b)</td>
<td>.06 (.01)</td>
</tr>
<tr>
<td>Positive Feedback</td>
<td>.09 (.03)</td>
<td>.03 (.02)(^b)</td>
<td>.07 (.02)(^b)</td>
<td>.20 (.04)(^b)</td>
<td>.10 (.02)</td>
</tr>
<tr>
<td>Negative Feedback</td>
<td>.30 (.06)</td>
<td>.30 (.07)</td>
<td>.25 (.04)</td>
<td>.37 (.05)</td>
<td>.28 (.02)</td>
</tr>
<tr>
<td>Ignore</td>
<td>.02 (.01)(^a)</td>
<td>.02 (.02)(^b)</td>
<td>.01 (.01)(^b)</td>
<td>.15 (.03)(^b)</td>
<td>.03 (.01)</td>
</tr>
<tr>
<td>Overall Proportion of Learner Response</td>
<td>.30 (.03)</td>
<td>.10 (.02)</td>
<td>.32 (.02)</td>
<td>.27 (.02)</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Means represent mean proportional use of strategies for each type of learner response as a function of the total number of learner responses (e.g., proportion of direct instruction with no response = [total number of direct instruction with no response]/[total number of sequences with no response]). Comparisons are to be made across rows (e.g., the direct instruction row reveals that this teaching strategy was used by the teachers proportionately more when learners responded actively than when learners did not respond).

\(^a\)Significantly different, \( p < .01 \).

\(^b\)Significantly different, \( p < .001 \).

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### Interrelations Among the Features of the Teaching Sequences

To assess interrelations between dimensions of teaching, different coding dimensions were cross-tabulated for each dyad to produce conditional probabilities. Each calculation of conditional probabilities is described under their respective set of findings. With this approach, we employed one-way repeated-measures multivariate analyses of variance (MANOVAs) to assess the variability of each dependent variable across levels of the independent variable (e.g., what type of knowledge is likely to be used with each type of initiation by the teacher?). Wilks’s Lambda is reported as a test of significance for MANOVAs along with effect size.
reported as partial eta-squared ($\eta^2_p$). Bonferroni corrections (with a familywise alpha level of $p < .05$ for each analysis) were used for all post-hoc pairwise comparisons.\footnote{Data were analyzed based on a variety of statistical techniques including repeated-measures ANOVAs and MANOVAs with a) raw frequencies, b) transformed (log10 + 1) frequency scores, as well as c) proportion scores. In each case, a total of 36 effects were tested. Out of the total, 34 significance tests revealed consistent outcomes, indicating that 94\% of the results were consistent across all three sets of analyses. To account for the correlation between the dependent variables and to control for Type I error, we report MANOVAs as they are a more conservative approach. The two inconsistent results (i.e., that failed to emerge as significant in the repeated-measures ANOVAs) were the initiation by knowledge interaction with transformed scores, $F(1, 38) = 1.29$, $p = .26$, and knowledge by strategy interaction with raw frequencies, $F(1.66, 63.07) = 567.64$, $p = .06$.}

**Initiation by type of knowledge.** To assess the difference in type of knowledge taught based on who initiated, conditional probabilities were calculated with knowledge as the numerator and initiation as the denominator. For example, instances where the teacher initiated and conceptual knowledge was taught were divided by the total instances that the teacher initiated, yielding comparable scores across families of the proportion of conceptual versus procedural knowledge, given that the teacher initiated the event.

A one-way MANOVA examining the effects of initiation type (i.e., teacher or learner) on each of the types of knowledge taught (i.e., conceptual, procedural) revealed a significant multivariate effect, Wilks’s $\lambda = .91$, $\eta^2_p = .10$. Follow-up tests revealed significant effects of initiation type on both conceptual and procedural knowledge, both $F(1, 38) = 3.99$, $\eta^2_p = .10$. Conceptual knowledge was taught proportionately more often in sequences initiated by the learner ($M = 0.79$, $SE = .05$) compared with those initiated by the teacher ($M = 0.68$, $SE = .03$). In contrast, procedural knowledge was taught more often in sequences initiated by the teacher ($M = 0.32$, $SE = .03$) as compared with those initiated by the learner ($M = 0.21$, $SE = .05$).

**Initiation by teaching strategy.** To analyze the variability in types of teaching strategies used based on who initiated the teaching, conditional probabilities were calculated with teaching strategy as the numerator and initiation as the denominator. For example, instances where the teacher initiated and used direct instruction were divided by the total instances of teacher initiation, yielding comparable scores across families of the proportion of strategies used, given that the teacher initiated the event.

A one-way MANOVA assessing the effects of initiation type (i.e., teacher or learner) on each type of teaching strategy (e.g., direct instruction, demonstration) revealed a significant multivariate effect, Wilks’s $\lambda = .37$, $\eta^2_p = .63$. Post-hoc analyses revealed significant effects of initiation on direct instruction, $F(1, 38) = 8.59$, $p < .01$, $\eta^2_p = .97$, demonstration, $F(1, 38) = 19.05$, $p < .001$, $\eta^2_p = .76$, planning, $F(1, 38) = 13.48$, $p < .01$, $\eta^2_p = .53$, clarification, $F(1, 38) = 6.22$, $p < .05$, $\eta^2_p = .35$, positive feedback, $F(1, 38) = 3.92$, $p = .05$, $\eta^2_p = .45$, negative feedback, $F(1, 38) = 5.82$, $p < .05$, $\eta^2_p = .74$, and ignoring, $F(1, 38) = 7.49$, $p < .01$, $\eta^2_p = .31$. Direct instruction, demonstration, planning, clarification, and negative feedback were used as teaching strategies proportionately more often when teachers initiated compared with when learners requested knowledge. Alternately, positive feedback and ignoring were used by the teacher proportionately more often in sequences where the learner initiated compared with when the teacher initiated (see Figure 1).
Initiation by learner response. To address the question of which learner response was most likely to occur based on who initiated, conditional probabilities were calculated with learner response as the numerator and initiation as the denominator. For example, instances where the teacher initiated and the learner did not respond were divided by the total instances of teacher initiation, thus yielding comparable scores across families of the proportion of learner response, given that the teacher initiated the event.

To identify the effects of initiation type (i.e., teacher or learner) on learner response (e.g., no response, rejection), a one-way MANOVA was conducted indicating a significant multivariate effect, Wilks’s $\lambda = .60$, $\eta_p^2 = .40$. Follow-up pairwise comparisons showed significant effects of initiation on no response, $F(1, 38) = 8.99$, $p < .01$, $\eta_p^2 = .19$, rejection, $F(1, 38) = 10.41$, $p < .01$, $\eta_p^2 = .22$, and compliance, $F(1, 38) = 11.11$, $p < .01$, $\eta_p^2 = .23$. When the teaching sequence was initiated by the teacher, learners were proportionately more likely to reject ($M = 0.12$, $SE = .02$) and comply ($M = 0.34$; $SE = .02$) compared with when the learner requested knowledge ($M = 0.04$, $SE = .02$; $M = 0.20$, $SE = .04$, respectively). In contrast, for sequences that began when learners requested knowledge, they (learners) were more likely to not respond ($M = 0.46$, $SE = .06$) than when the sequence was initiated by teachers ($M = 0.27$, $SE = .03$).

Type of knowledge by teaching strategy. Conditional probabilities for the strategies used based on the type of knowledge taught were calculated with strategies as the numerator and knowledge as the denominator. For example, instances where conceptual knowledge was taught and direct instruction was used were divided by the total instances of conceptual knowledge, thus yielding comparable scores across families of the proportion of each teaching strategy, given that conceptual knowledge was being taught.

A one-way MANOVA examining the effects of knowledge type (i.e., conceptual or procedural) on teaching strategies (e.g., direct instruction, demonstration) indicated a significant multivariate effect, Wilks’s $\lambda = .25$, $\eta_p^2 = .75$. In particular, univariate tests revealed significant
effects of type of knowledge on demonstration, $F(1, 37) = 46.18, p < .001, \eta_p^2 = .56$, planning, $F(1, 37) = 18.76, p < .001, \eta_p^2 = .34$, and explanation, $F(1, 37) = 25.38, p < .001, \eta_p^2 = .41$ (see Figure 2). When procedural knowledge was taught, teachers were more likely to use demonstration and planning than when conceptual knowledge was taught, whereas when conceptual knowledge was taught, teachers were more likely to use explanation than when teachers taught procedural knowledge.

**Learner response by teaching strategy.** To analyze the variability in teaching strategy used based on the learner response, conditional probabilities for the type of strategy used based on the learner’s response were calculated with strategies as the numerator and learner response as the denominator. For example, instances when direct instruction was used and the learner did not respond were divided by the total number of teaching episodes where the learner did not respond, allowing a comparison of scores across families of the proportion of each teaching strategy, given the particular learner response.

To assess the effects of type of learner response (e.g., no response, rejection) on teaching strategies utilized (e.g., direct instruction, demonstration), a one-way MANOVA was applied. Results indicated a significant multivariate effect, Wilk’s $\lambda = .01, \eta_p^2 = .99$, followed by specific significant univariate effects of learner response on direct instruction, $F(3, 75) = 5.18, p < .01, \eta_p^2 = .99$, planning, $F(3, 75) = 14.65, p < .01, \eta_p^2 = .62$, clarification, $F(3, 75) = 8.95, p < .001, \eta_p^2 = .37$, positive feedback, $F(3, 75) = 7.83, p < .001, \eta_p^2 = .52$, and ignoring, $F(3, 75) = 10.62, p < .001, \eta_p^2 = .50$ (see Table 1). In particular, direct instruction and planning were used by the teachers proportionately more when learners responded actively than when learners did not respond. Teachers were proportionately more likely to use clarification when learners were actively involved in teaching rather than when learners did not respond or rejected the teaching. Teachers were more likely to employ positive feedback when learners were actively involved than when learners rejected or complied. Finally, teachers were more likely to ignore
learners when they were actively involved than when learners did not respond or rejected or complied with the teaching.

**DISCUSSION**

This study investigated whether siblings engaged in teaching one another during naturalistic home interactions and, if so, how teaching was initiated, what kind of knowledge children were inclined to teach, what types of teaching strategies were employed, and how the learner responded. Our study demonstrates that young siblings naturally engage in spontaneous, intentional teaching of one another during early childhood as argued by Strauss and Ziv (2012). This teaching was independent of parental involvement and provides rich opportunities for children to act as socialization agents for one another by influencing their knowledge about the physical and social world (Dunn, 2002; Howe et al., 2012; Strauss et al., 2002).

**Initiation of Teaching and Types of Knowledge**

The manner in which the teaching was initiated provides a picture of how this behavior was integrated into the ongoing course of naturalistic conversations. Typically, the older sibling simply launched into the teaching episode by assuming the role without prompting by the learner to request teaching. This finding suggests that older siblings may perceive themselves as knowledgeable or skilled in a particular domain. Further, given their birth order, older siblings may be comfortable asserting themselves by taking on the role of instructor, provider, or transmitter of knowledge (Frye & Ziv, 2005) as was also evident in studies of Mayan children teaching their siblings cultural knowledge (Maynard, 2002; Rabain-Jamin et al., 2003). These behaviors may perhaps reflect some recognition by the teacher that they could provide instruction without any guidance from adults and that they had a range of teaching strategies available to enhance the younger sibling’s learning (Strauss & Ziv, 2012), as will be discussed. Our findings are generally in line with theoretical discussions regarding complementary interactions that are characteristic of the sibling relationship (Dunn, 1983; Hinde, 1979; Howe et al., 2011). Yet, sometimes, the learner actively requested teaching, perhaps in recognition of the teacher’s greater ability. Regardless, this finding supports the notion that younger siblings are active and collaborative partners and that the bidirectional nature of the relationship is dependent on initiations of exchanges by both partners (Rogoff, 1990, 1998).

Teachers were more likely to focus on providing conceptual rather than procedural knowledge about the world, which suggests that the semistructured paradigms employed in most sibling teaching studies, inasmuch as they focus on teaching procedural knowledge, may be limited in their ecological validity. Following from work by Hatano and Inagaki (1986), examples of conceptual knowledge in our study included the teaching of concepts (e.g., “The publishing company prints books”), labels (e.g., “That’s grandma in the photo”), and general knowledge (e.g., “Tree trunks are brown”). Children were less likely to focus on teaching procedural knowledge, namely instruction about how to do something (e.g., how to trace the letter A), although sometimes they did. Interestingly, teachers were more likely to engage in the spontaneous teaching of procedural knowledge than learners were to request it, perhaps indicating that older and younger siblings had somewhat different priorities. That is, in teaching situations,
older siblings were confident about their knowledge and understanding of how to do something and were focused on their ability to teach the relevant skills to the learner. Another possibility is that learners were more likely to request the teaching of conceptual knowledge, because sometimes they were struggling to broaden and deepen their cultural understanding of their social and physical worlds. Thus, they looked to their older siblings to enhance their knowledge.

This focus on conceptual knowledge may reflect some of the cognitive changes that occur in Canadian children’s thinking as they transition from early to middle childhood; whether it would be replicated in children from different cultures is an open question. At the very least, the focus on conceptual knowledge suggests that these children were curious about a wide range of topics and looked to their older siblings as a source of knowledge and expertise. In this way, we argue that there are rich opportunities for older siblings to influence and broaden the minds of their younger siblings as they attempt to teach them about aspects of the world that have captured the attention of both children during ongoing naturalistic interactions. As Hughes and de Rosnay (2006) state, these kinds of naturalistic conversations provide an opportunity to illuminate some of the processes of how children acquire knowledge and understanding of their world. Our findings are in line with previous literature highlighting that informal conversations in families from different cultural backgrounds are rich opportunities for the transmission of social, cognitive, scientific, and mathematical knowledge (e.g., Dunn, 1998; Gelman et al., 1998; Jipson & Callanan, 2003; Pérez-Granados & Callanan, 1997b; Rigney & Callanan, 2011; Tenenbaum & Callanan, 2008; Vandermaas-Peeler et al., 2012). These interactions indicate one process whereby children co-construct shared meanings about the world and influence their social-cognitive development (Carpendale & Lewis, 2004, 2006; Piaget, 1962). At the very least, it seems that siblings may play an active role in one another’s development by naturally and easily stepping into teaching and learning roles (Strauss & Ziv, 2012; Strauss et al., 2002).

Teaching Strategies: How Do Siblings Convey Knowledge?

Overall, teachers favored some teaching strategies over others; namely, direct instruction, demonstration, and negative feedback (i.e., correction of errors) were employed more frequently than explanation, positive feedback, planning, clarification, or ignoring the learner. Further, explanation was used more frequently than clarification and ignoring; clarification and ignoring were the least frequent teaching strategies employed. Nevertheless, the use of strategies was also related to how the teaching sequence was initiated. When older siblings initiated the teaching event, they were more likely to use direct instruction, demonstration, planning, clarification, and negative feedback than when learners requested teaching. In contrast, when learners requested teaching, teachers were more likely to use positive feedback or to ignore the request for instruction. The range and type of teaching strategies are in line with other research highlighting the teaching of children in middle childhood during semistructured teaching paradigms (e.g., Howe & Recchia, 2005, 2009; Howe et al., 2012), suggesting that Canadian children begin to employ these strategies in naturalistic contexts at quite an early age; whether there are cultural differences in siblings’ teaching strategies is a question for further research.

In the present study, the use of different strategies may indicate that children had different goals and interpretations depending on who initiated the teaching, and perhaps this suggests that teachers were able to adjust their strategies in context-sensitive ways. While many of the
teaching strategies were effectively employed to teach both types of knowledge, some strategies were also linked specifically to the type of knowledge taught. Teaching conceptual knowledge was associated with explanation, whereas teaching procedural knowledge was associated with demonstration and planning. This pattern makes intuitive sense; for example, if one is attempting to teach a person how to do something such as construct a toy, then demonstrating how the pieces fit together and planning out the next steps toward completion should aid in successful learning. On the other hand, teaching a concept (e.g., days of the week; types of trees) may be more effective if accompanied by an explanation (i.e., days come in an invariant order; trees are differentiated by the shape of their leaves). Certainly, by middle childhood, sibling teachers adjust their strategies according to task difficulty (Howe et al., 2006) and employ a broader and more sophisticated range of teaching strategies during semistructured teaching situations compared with chronologically younger children (e.g., Howe & Recchia, 2005, 2009; Howe et al., 2012; Rogoff, 1998). Our findings regarding the flexible use of specific teaching strategies may provide initial evidence of children’s ability to employ a guided participation approach to teaching at a young age. Pérez-Granados and Callanan (1997a) also reported that older siblings showed early evidence of employing a guided participation approach to teaching younger siblings (i.e., scaffolding) that was similar to the approach used by their mothers. Adjusting the use of specific strategies depending on the type of knowledge being taught may enhance the likelihood that teachers will build bridges between the known and unknown information for learners, structure and support learners’ active engagement, and allow learners to assume some responsibility so the learning process can unfold successfully (Rogoff, 1990). Interestingly, Pérez-Granados and Callanan (1997a) also reported that although the frequency of mothers’ and older siblings’ use of specific teaching strategies varied (e.g., children were more directive than were mothers), both were using similar strategies while teaching. Perhaps children’s approaches to teaching their siblings may have been influenced by growing up in families where parent–child conversations about early scientific or mathematical understanding provided a baseline or foundation from which siblings could model various teaching strategies (e.g., Jipson & Callanan, 2003; Vandermaas-Peeler et al., 2012). Clearly, this speculation requires further study.

The Role of the Learner

The definition of teaching as a bidirectional interaction between two individuals implies that it is also critical to examine the role of the learner in this process (Rogoff, 1998). Overall, learners were generally interested in (or at least tolerant of) being taught as evidenced by the fact that they were actively involved and more likely to comply or not respond than to forcefully reject the teaching attempts. These findings were partly qualified by the manner in which the teaching commenced. Specifically, when teachers initiated the interaction, learners were more likely to reject or comply with the teaching than if they (the learner) had requested teaching; both behaviors indicate that learners were not passive in this process but had a role in determining the bidirectional nature of the interaction and may have wanted to exert some control. In contrast, when learners requested the teaching, they were more likely not to respond to the teaching, perhaps because they were satisfied with the teachers’ answers and did not feel the need to respond in any way. Interestingly, the active involvement of learners in the teaching process did not
differ depending on how the teaching commenced, but instead, it was associated with the type of teaching strategy employed. Specifically, the teaching strategies of direct instruction, planning, clarification, positive feedback, and ignoring were more likely to be associated with learners’ active involvement than with compliance, rejection, or no response to the teaching. By engaging in direct instruction and planning, teachers may provide relevant information and also may anticipate what will be taught so as to prepare learners for the next steps, which may act to catch and maintain learners’ attention and involvement; clarification and positive feedback may play a similar role in the teaching process. Certainly, planning, clarifying, and providing positive feedback would be likely to enhance learners’ understanding and desire to be actively involved in teaching and are indicative of a guided participation approach to teaching (Rogoff, 1998). Of course, alternatively, active involvement by learners may have been the factor that facilitated the teachers’ use of these strategies. Ignoring the learner generally occurred after several attempts to instruct and may at times reflect a learner struggling to understand the teaching and a frustrated teacher as demonstrated in this example: Older sibling says ‘‘Coach’’; younger sibling responds ‘‘Couch couch’’; older sibling says ‘‘Coach!’’; younger sibling says ‘‘Couch couch’’; older sibling ignores and gives up the attempt to teach pronunciation correctly. In sum, these findings are in line with reports indicating that learners play an active role in teaching interactions by asking questions, participating, and demonstrating understanding (Howe et al., 2006; Howe & Recchia, 2009).

Conclusions

Our study has several limitations, which must be acknowledged. The sample of generally middle-class, Caucasian, Canadian families limits generalizability of our findings. We were not able to assess the accuracy of the children’s teaching, because in some cases, this was not recorded in sufficient detail to be determined, which presents a question for future research. It would have been beneficial if the children’s social-cognitive understanding, as well sibling relationship quality, had also been formally assessed. Yet, the transcripts provided a rich source of data to investigate sibling teaching in a relatively detailed and analytic way, thus furthering our understanding of the importance of siblings as socialization agents in children’s lives.

To our knowledge, this is one of the first studies to document the fact that not only are young siblings capable of teaching one another, but they do so with quite remarkable frequency during the course of ongoing naturalistic conversations and interactions while playing together at home. These young children were captivated by understanding their worlds, gaining both procedural but especially conceptual knowledge, and actively co-constructing a shared understanding in the context of their relationship. Our findings provide ample evidence that the role of siblings in fostering one another’s knowledge must not be underestimated and warrants further and more detailed investigation.

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REFERENCES


APPENDIX

Examples of Teaching Sequences

Example 1: Teacher initiated where older sibling is teaching younger sibling how to count.

Initiation: Teacher assumed role; Type of knowledge: Conceptual; Teaching strategies: Direct instruction, positive feedback, and negative feedback; Learner response: Active involvement.

<table>
<thead>
<tr>
<th>Line #</th>
<th>Actor</th>
<th>Nonverbal/Verbal Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>341</td>
<td>O</td>
<td>Here’s a number. What comes after four?</td>
</tr>
<tr>
<td>342</td>
<td>Y</td>
<td>(No response)</td>
</tr>
<tr>
<td>343</td>
<td>O</td>
<td>(Helps Y by counting). One, two, three, four… (pauses for Y’s response)</td>
</tr>
<tr>
<td>344</td>
<td>Y</td>
<td>Four.</td>
</tr>
<tr>
<td>345</td>
<td>O</td>
<td>No.</td>
</tr>
<tr>
<td>346</td>
<td>Y</td>
<td>(No response)</td>
</tr>
<tr>
<td>347</td>
<td>O</td>
<td>What comes after four?</td>
</tr>
<tr>
<td>348</td>
<td>Y</td>
<td>Ahhh, Six. (Self-corrects) Five.</td>
</tr>
<tr>
<td>349</td>
<td>O</td>
<td>Right!</td>
</tr>
</tbody>
</table>

Note. O = older sibling; Y = younger sibling.

Example 2: Learner initiated teaching by asking how to erase chalk.

Initiation: Learner request; Type of knowledge: Procedural; Teaching strategies: Direct instruction and demonstration; Learner response: No response.

<table>
<thead>
<tr>
<th>Line #</th>
<th>Actor</th>
<th>Nonverbal/Verbal Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>567</td>
<td>Y</td>
<td>How do I rub it off?</td>
</tr>
<tr>
<td>568</td>
<td>O</td>
<td>Max, see what I just did.</td>
</tr>
<tr>
<td>569</td>
<td>O</td>
<td>I wiped it off.</td>
</tr>
<tr>
<td>570</td>
<td>O</td>
<td>Look.</td>
</tr>
<tr>
<td>571</td>
<td>O</td>
<td>Go like this.</td>
</tr>
<tr>
<td>572</td>
<td>O</td>
<td>(Makes a square on younger sibling’s side and then wipes chalk off with her hand, then continues to draw on her side of chalkboard.)</td>
</tr>
<tr>
<td>573</td>
<td>O</td>
<td>Just wipe it off.</td>
</tr>
<tr>
<td>574</td>
<td>Y</td>
<td>(Draws on his side) &lt;no response&gt;</td>
</tr>
</tbody>
</table>

Note. O = older sibling; Y = younger sibling.