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Siblings’ Understanding of Teaching in Early and Middle Childhood: ‘Watch Me and You’ll Know How to Do It’

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This study examined siblings’ knowledge about the teaching concept during naturalistic teaching contexts, wherein children’s communicative interactions were used as a gateway to their social understanding (Turnbull, Carpendale, & Racine, 2009). Participants included 39 sibling dyads (older age group, \( M_{\text{age}} = 6;4 \); younger age group, \( M_{\text{age}} = 4;5 \)) observed for six 90-min sessions at home. Teaching episodes were identified and coded for: a) initiation of teaching (i.e., assumes role or learner requests teaching), b) knowledge states (i.e., knowledge, lack of knowledge, questioning knowledge), c) transfer of knowledge (i.e., learning), and d) teaching strategies (e.g., direct instruction). Children who assumed the teaching role referenced knowledge and questioning knowledge, whereas learners requested teaching by referencing a lack of knowledge. Firstborn learners were more likely to reference knowledge versus second-born learners who referenced a lack of knowledge. Transfer of knowledge occurred when teachers referenced knowledge. When learners referenced knowledge states, teachers were more likely to use direct instruction, demonstration, and negative feedback. Results underscore the developmental significance of sibling teaching and demonstrate a novel approach to studying children’s social understanding in the teaching context (Turnbull et al., 2009).

Teaching is defined as an intentional activity aimed to increase the knowledge of another person (Frye & Ziv, 2005) with teacher and learner roles varying across audiences and contexts (LeBlanc & Bearison, 2004). Social constructivist models highlight the importance of interactions in close relationships for children’s development and learning (Carpendale & Lewis, 2006; Hinde, 1979; Vygotsky, 1978). In particular, the sibling relationship affords a unique context in which to study interactions that promote children’s social-cognitive development (Dunn, 2002; Howe, Ross, & Recchia, 2011), including siblings’ co-construction of shared meanings in hierarchical interactions during teaching (Howe, Recchia, Della Porta, & Funamoto, 2012).

Although researchers have examined some mechanisms and antecedents (e.g., theory of mind) of youngsters’ teaching (Strauss, Ziv, & Stein, 2002; Ziv & Frye, 2004), successful teaching may also depend on children’s understanding of the teaching concept (Rogoff, 1990,

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That is, the teacher holds knowledge, whereas the learner lacks knowledge in some way; thus, the goal of teaching is to convey this knowledge and help the recipient to learn. Arguably, this understanding may facilitate the teacher’s capacity to assess the learner’s level of ability, respond effectively to the learner’s involvement, and understand what teaching strategies may create shared meanings to facilitate the learner’s successful completion of the task (Howe & Recchia, 2005, 2009). We examined the extent to which siblings demonstrate their understanding of teaching as a means of knowledge transfer and learner acquisition during naturalistic teaching in the home setting. In particular, children’s references to states of knowledge during teaching were examined in relation to: a) birth order and teacher/learner role, b) initiation of teaching, c) teaching strategies, and d) transfer of knowledge (i.e., learning).

Teaching as a Natural Human Activity

Piaget (1950) and Vygotsky (1978) argued that a disparity in knowledge, not authority or status, is crucial for teaching, whereas Strauss and Ziv (2012) posited that teaching is a natural cognitive activity that occurs early in life without requiring intentional adult instruction. Consistent with both arguments, children as young as 3;6 are capable of teaching and learning from one another in both the sibling and peer contexts (e.g., Ashley & Tomasello, 1998; Astington & Pelletier, 1996; Howe & Recchia, 2005). In fact, although children may be exposed to teaching, they are rarely explicitly taught how to teach. As such, it is likely that children’s sources of knowledge (e.g., siblings, parents, childcare educators), their social understanding, and approaches to teaching stem from their ongoing interactions with others (Carpendale & Lewis, 2004).

Piaget (1950) and Vygotsky (1978) both argued that the mechanisms by which social interaction leads to learning and understanding are critical and require both individual and social processes in the co-construction of knowledge (Palincsar, 1998). Accordingly, Strauss et al. (2002) stipulated that teaching is composed of both visible and invisible features. The visible parts refer to the external acts, such as what is seen and heard (e.g., the teacher’s questions, demonstrations), whereas the invisible aspects refer to the teacher’s mental processes (e.g., intentions, inferences about learners’ knowledge). Given the varying forms and sources of children’s knowledge, the following question is posed: If teaching is a natural and early cognitive ability, how do children recognize teaching? Because teaching is defined by a knowledge disparity and is an intentional activity to facilitate learning (Kruger & Tomasello, 1996; Olson & Bruner, 1996), clearly an understanding of teaching requires the ability to detect knowledge differences and engage in goal-directed behavior.

Teaching and Social Understanding

Children’s understanding of teaching has been studied in terms of intention, knowledge differences, and false beliefs. For instance, 3- and 4-year-olds detected knowledge differences in stories about teaching, but only 5- and 6-year-olds understood that teachers could have false beliefs about the learner’s knowledge state (Bensalah, Oliver, & Stefaniak, 2012; Ziv & Frye, 2004). Ziv, Solomon, and Frye (2008) examined children’s understanding of teaching using hypothetical stories of imitation and teaching that differed in intention (i.e., agent trying to teach the other character) and outcome (i.e., learning). When successful learning occurred, 3-year-olds
did not distinguish between stories based on intent (teaching vs. imitation) but instead said that teaching occurred in both stories. In contrast, 5-year-olds judged according to intention, thereby stating that the character taught in the teaching stories but not in the imitation stories. Although some studies demonstrate a link between theory of mind and children’s teaching behaviors (Davis-Unger & Carlson, 2008; Howe et al., 2012), Strauss et al. (2002) argued for a broader notion of theory of mind—specifically, a view that accounts for an assessment of others’ knowledge and belief states, where a teacher must recognize the learner’s error, attribute it to a false belief or incomplete knowledge, and monitor motivational and mental-state changes.

To this end, there are alternative ways to understand others’ psychological functioning during teaching. Turnbull, Carpendale, and Racine (2009) offered a novel approach to considering cognitive-state concepts, whereby terms such as “think” or “know” are not the sole indicators of an understanding of mind. Instead, the authors argued that children’s understanding is based on their emerging ability to talk about human activity in psychological terms and advocate for a focus on the narrative content of children’s language as a whole. To illustrate this point, the authors provided an example of an individual named Rick who thought he had lost his car keys but was relieved to see them on the kitchen table. Although “see” is not a mental-state term, “seeing” for Rick entailed a belief (i.e., Rick was incorrect to believe that he had lost his keys). This example demonstrates that one can talk about the mind without having to use mental-state terms. In other words, according to Turnbull et al., it may be beneficial to shift the focus of research from specific internal-state terms to examining which aspects of language or talk may facilitate a developing understanding of mind in a particular context. Further, by examining children’s language more broadly (i.e., whole-phrase utterances) and also accounting for the content and context of their narrative and behavioral interactions, we can gain insight into their understanding of mind. This broader and novel approach to examining children’s social-cognitive understanding of the mind provides the conceptual framework for our study of children’s understanding of teaching.

Furthermore, according to Rogoff’s (1990, 1998) notion of guided participation, the teacher’s goal is to build bridges between the known and unknown by structuring and supporting the learner’s active engagement and providing problem-solving opportunities. The knowledgeable teacher may guide the learner through the steps of a task via verbal feedback or physical demonstrations, and the learner, in turn, may participate and ask questions (Howe & Recchia, 2009). Thus, the success of teaching depends on both the teacher’s and learner’s understanding of the teaching process as an intentional act requiring the transfer of knowledge. If, as Rogoff (1990) has argued, the first step in the process of teaching is to build bridges between the known and unknown for the learner, then the question concerning the teacher’s and learner’s degree of understanding is critical for ensuing successful teaching.

Sibling Teaching

As siblings co-construct an effectively intense, shared, and long history, they develop an understanding of one another’s abilities and knowledge and act as socialization agents influencing one another’s development (Dunn, 1988, 2002; Howe et al., 2011; Perez-Granados & Callanan, 1997). Further, the sibling relationship is composed of both reciprocal (i.e., equal and returned exchanges) and complementary (i.e., exchanges reflecting differences in power and knowledge) interactions (DeHart, 1999; Hinde, 1979; Howe & Recchia, 2008). Factors that
contribute to the nature of complementary interactions include age and birth order, which in turn produce differences in physical size and strength, power, knowledge, skills, and status (Buhrmester & Furman, 1990; DeHart, 1999; Furman & Buhrmester, 1985).

Accordingly, research indicates that sibling structural variables of age and birth order contribute to older siblings having a developmental advantage over their younger siblings (Howe et al., 2011; Vandell & Bailey, 1992; Volling, 2003). This advantage, in turn, may grant firstborns greater knowledge and understanding in naturalistic teaching contexts. Indeed, this notion has already been evidenced by reports of firstborns using a wider range of teaching strategies and as being more likely to assume the teacher role (Howe, Della Porta, Recchia, Funamoto, & Ross, 2013; Howe & Recchia, 2005; Howe et al., 2012; Recchia, Howe, & Alexander, 2009). In this vein, the complementary (i.e., hierarchical) features defining sibling relationships afford a unique context for examining the processes of teaching (Dunn, 1983, 1988; Hinde, 1979).

Studies of sibling-directed teaching frequently employ semistructured paradigms, where one child (typically the older sibling) is taught a task by a research assistant and is then instructed to teach their (younger) sibling. In a series of studies, Howe and colleagues demonstrated that both older and younger siblings employ a variety of sophisticated teaching strategies (i.e., instruction, explanation, praise, scaffolding), particularly as they enter middle childhood (Howe & Recchia, 2005, 2009; Howe et al., 2012; Recchia et al., 2009); these findings are in line with work by Rogoff (1998) and Strauss and Ziv (2012).

School-aged older siblings also take into account task difficulty when teaching their younger siblings (Howe, Brody, & Recchia, 2006), perhaps reflecting their own perspective-taking skills and recognition of the learner’s degree of understanding (Ziv & Frye, 2004). Additionally, school-aged older-sibling teachers are less controlling than younger-sibling teachers and facilitate active learner involvement (Azmitia & Hesser, 1993; Howe et al., 2012; Recchia et al., 2009). Further, school-aged sibling teachers’ use of guided participation strategies (e.g., encouragement, nonverbal attention, help, demonstration) and permission for learners to correct their own mistakes is positively associated with learners’ active involvement and with their social-cognitive skills (Howe et al., 2012; Palinscar, 1998; Rogoff, 1990, 1998).

The range and sophistication of these strategies are fundamental to teaching because they create the context for the transfer of knowledge from teacher to learner by structuring the situation and facilitating the learner’s involvement (Howe et al., 2012; Rogoff, 1990; Vygotsky, 1978). Learners are active in this bidirectional process by asking questions, participating, and demonstrating understanding so as to take responsibility for their own learning (Howe & Recchia, 2005, 2009; Howe et al., 2012; Rogoff, 1990). Given that teaching is a dyadic exchange in which the teacher and learner enact or adopt collaborative roles to achieve a mutual understanding (Rogoff, 1990), both the quantity and quality of the learner’s talk may vary according to the teacher’s use of strategies. Thus, studying the relationship between the teacher’s use of strategies and the learner’s understanding of teaching provides a fresh lens for examining siblings’ participation in the teaching and learning context.

A few studies have investigated sibling-directed teaching during naturalistic contexts such as at home (e.g., Rabain-Jamin, Maynard, & Greenfield, 2003). According to parents’ reports, Mexican American siblings learned social and academic skills from one another during informal family conversations (Perez-Granados & Callanan, 1997). Rural Mayan children taught their siblings relevant cultural routines such as food preparation during ongoing play by employing
scaffolding and teaching strategies such as explanations, demonstrations, and feedback (Maynard, 2002, 2004). Volk (1999) reported a case study of adolescent siblings and their mother teaching a kindergarten-aged brother. Lastly, Howe et al. (2013) reported that during naturalistic teaching, 6-year-old teachers employ a variety of strategies (i.e., demonstrations, instructions) while teaching their 4-year-old siblings, particularly about conceptual rather than procedural knowledge. Further, learners were engaged in the teaching process based on their active involvement, compliance, and rejection of instruction.

In sum, by employing naturalistic observational methods to study sibling-directed teaching, we achieve a more nuanced picture of children’s teaching abilities and how they develop shared meanings, acquire knowledge, and enhance their understanding of the social world (Hughes & de Rosnay, 2006). However, to what extent do siblings understand the teaching concept as an intentional act reflecting a knowledge disparity? As Turnbull et al. (2009) have advocated, how can this understanding be captured by examining siblings’ forms of talk in naturalistic contexts?

The Present Study

Our study examined siblings’ understanding of teaching during naturalistic home observations by utilizing the narrative content of children’s language (i.e., whole-phrase utterances) and their behavior as a marker of social understanding (Turnbull et al., 2009). Sibling-directed teaching sequences were identified from transcripts based on 9 hr of observation per family. The following four knowledge-state categories were then coded during each teaching sequence as indicators of their understanding of teaching as an intentional act dependent on a knowledge disparity between teacher and learner: a) knowledge (e.g., “That’s a triangle”); b) questioning knowledge (e.g., “Are you sure?”); c) lack of knowledge (e.g., “I don’t know”); and d) uncertain knowledge (e.g., “Maybe it works on here”); for an illustrative example, see Table 1. These knowledge-related constructs were analyzed according to a) birth order and teacher/learner roles, b) initiation of teaching, c) teaching strategies, and d) transfer of knowledge (e.g., the younger sibling pushes the space bar on the keyboard after the older sibling teaches her where it is).

Given the developmental advantage of older siblings (Howe et al., 2011; Vandell & Bailey, 1992; Volland, 2003), we predicted that older siblings would have a greater understanding of the teaching concept than their younger counterparts and thus would be more likely to indicate their knowledge and question knowledge, whereas younger siblings would be more likely to reference a lack of knowledge. Based on the premise noted earlier (e.g., Vandell & Bailey, 1992; Volland, 2003), we also expected that older siblings in the teacher role would be more likely to state their knowledge and question the other’s knowledge more than younger siblings in the teacher role, whereas younger siblings in the learner role would be more likely to reference a lack of knowledge than older siblings in the learner role.

Furthermore, intentional teaching behavior is defined as the ability to detect knowledge differences (Olson & Bruner, 1996), and in fact, research highlights children’s understanding of teaching in terms of their ability to identify knowledge differences in teaching stories (Bensalah et al., 2012; Ziv & Frye, 2004). Based on this premise, we predicted that siblings’ understanding of the knowledge difference required for teaching will be evidenced by older- and
younger-sibling teachers being more likely to make knowledge statements, whereas older- and younger-sibling learners would be more likely to indicate a lack of knowledge.

Next, teaching is also defined as an intentional activity based on the premise that children believe they have knowledge to impart to a less-informed learner, which will cause learning (Kruger & Tomasello, 1996). In fact, children demonstrate an understanding of teaching in terms of their ability to distinguish teaching stories based on intent (Ziv et al., 2008). We were interested in whether there was evidence for children’s understanding of the intentional nature of teaching through their references to knowledge states when they assumed the teacher role (i.e., intent to impart knowledge) and when they made a request for learning (i.e., intent to receive knowledge). Therefore, we predicted that siblings who assumed the teacher role would be more likely to reference knowledge states (e.g., teacher: “This is the letter x”) and question the other’s knowledge state (e.g., teacher: “You wanna learn how to make an onion?”), whereas siblings who requested learning would be more likely to indicate a lack of knowledge (e.g., learner: “How do you make ABC?”).

We also investigated associations between teaching strategies and learners’ states of knowledge. Given that learners are more actively involved when teachers use guided participation strategies (Howe et al., 2012, 2013), we expected that teachers would be more likely to use direct instruction, demonstration, explanation, clarification, and positive feedback strategies when learners demonstrated their active involvement in terms of their references to knowledge as opposed to lack of knowledge or questioning knowledge. We also predicted that when teachers were certain of their knowledge, there would be evidence of transfer of knowledge (i.e., successful learning for the learner; Rogoff, 1990, 1998).

<table>
<thead>
<tr>
<th>Child/Role</th>
<th>Action/Comment</th>
<th>Knowledge State</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 O/Teacher</td>
<td>“Now you have to come right here and go” (throws ball to show younger sibling).</td>
<td>Knowledge</td>
</tr>
<tr>
<td>2 Y/Learner</td>
<td>“Like that?”</td>
<td>Uncertain</td>
</tr>
<tr>
<td>3 O/Teacher</td>
<td>“OK, can you do that?”</td>
<td>Questioning</td>
</tr>
<tr>
<td>4 Y/Learner</td>
<td>“No.”</td>
<td>Lack of Knowledge</td>
</tr>
<tr>
<td>5 O/Teacher</td>
<td>“OK, but you have to just go right here and go” (throws ball to demonstrate).</td>
<td>Knowledge</td>
</tr>
</tbody>
</table>

Note. In this teaching sequence, the older sibling (O) in the teacher role demonstrates her knowledge and ability of how to throw a ball to the younger sibling (Y). On the second turn, the younger sibling in the learner role demonstrates his uncertainty about how to throw the ball by double-checking with his older sibling (i.e., “Like that?”). On the third turn, the older-sibling teacher questions the knowledge or ability of the younger sibling to perform the action, which results in the younger sibling indicating a lack of knowledge on the fourth line and then a second demonstration of knowledge by the older sibling on the fifth and final line of the teaching sequence. This example illustrates that insight into children’s understanding of mind—a necessary prerequisite for teaching—is possible by identifying children’s whole-utterance phrases on a turn-by-turn basis.
METHOD

Participants

Participants included 39 sibling dyads from 2-parent middle-class Caucasian families living in Southwestern Ontario, Canada. Older siblings’ mean age was 6;4 (SD = 5.04 months) and younger siblings’ mean age was 4;5 (SD = 2.52 months); average age gap between siblings was 1;11 (SD = 3.36 months). Dyadic gender composition was balanced. Parents’ ages ranged from 23 to 48 years (mothers’ M_age = 30;10; fathers’ M_age = 32;7), and their education levels included university degree (29%), community college (15%), high school (41%), and no high school diploma (15%).

Procedure

Families were observed at home for six or seven 90-min sessions for a total of 9 hr. Observers dictated behavioral accounts of all family members’ ongoing interactions (e.g., give, hit) into a tape recorder, which also recorded their speech on a second track. The children were free to choose their activities, excluding electronic devices and interacting with the observer. The sessions were transcribed using recorded accounts of the verbal and physical exchanges between family members (Ross, Filyer, Lollis, Perlman, & Martin, 1994). Two trained assistants conducted reliability analyses on 10 20-min sessions prior to the actual data collection; sessions were transcribed, and percent agreement for presence of each behavior was .86 (range = 70%–100%) and percent agreement for actor was .88 (range = 76%–100%; see Perlman, Garfinkel, & Turrell, 2007).

Measures

**Teaching sequences.** Sibling-directed teaching sequences (n = 1,040) were identified in the transcripts based on a child’s clear intention to teach the other (Howe et al., 2013). Intentional teaching activities were based on direct (e.g., “I will show you how to make a nose”) or indirect (e.g., “This is the letter x”) statements to teach, as well as learner requests for teaching (e.g., “How do you spell Dorothy?”). Each teaching sequence commenced with an intentional act to enhance the learner’s knowledge or a request for teaching and ended when the teaching process ceased as defined by the learner’s lack of response (i.e., interaction coded as “no response”), learner’s acceptance (e.g., teacher states, “Her name is Cherry,” and learner responds by imitating “Cherry”; teacher points to a bingo card to show the learner how it should be played, and learner responds by looking where the teacher indicates), or learner’s rejection of the instruction (e.g., teacher instructs the learner how to put a LEGO train together and the learner refuses by stating “no”). In all cases, the teaching sequences were identified as ceasing when the topic had changed or when the teacher/learner roles had switched. To be conservative, implicit forms of sibling-directed teaching or learning were not included (i.e., when there was lack of direct evidence of teaching strategies) nor were sequences in which a parent intervened in the sibling teaching. Coding for roles, initiation of teaching, and strategies was based on Howe et al. (2013) and as discussed in Strauss and Ziv (2012). In the present study, we build on Howe
et al. (2013) by focusing on children’s understanding of teaching (i.e., assessing the knowledge states) and evidence of a transfer of knowledge (i.e., learning).

Initiation of teaching. Sequences were coded for initiation of teaching: a) Child proposes teaching (e.g., “You wanna learn how to make an onion?”); b) child assumes teacher role (e.g., “I’ll show you how to write “AT”); and c) the learner directly requests teaching by asking for information or assistance (e.g., “How do you make ABC?”). Teacher roles were assigned to younger or older siblings depending on who initiated or requested instruction.

Teaching strategies. Eight teaching strategies were coded as either present or absent in each sequence: a) direct instruction including labeling, describing, or sharing information (e.g., “That goes there”; “This is an H”); b) demonstration about how to do something (e.g., showing how to draw the letter L); c) explanation such as reasons or justifications (e.g., “because it’s a name for a grandma”); d) planning or outlining the steps required to teach/learn (e.g., “I’m going to get you all lined up and I’m going to see who can do it good”; “Now, do this . . .”); e) positive feedback such as praise or confirmation (e.g., “good”; “That’s right”); f) negative feedback or correction (e.g., “You’re not doing it right”); and g) ignore/no response.

Knowledge states. To identify children’s understanding of teaching, we focused on both children’s behaviors and the narrative content of their language (Turnbull et al., 2009). Four mutually exclusive knowledge-state categories were identified in each conversational turn per teaching sequence and included the following: a) knowledge: statements indicating one’s own knowledge or ability (e.g., “Now you have to come right here and throw”; “You can’t place it down, you have to drop it”); b) lack of knowledge, including statements indicating one’s own lack of knowledge or ability (e.g., “I don’t know how”; “I can’t get the tape to stick”); c) uncertain knowledge, including statements indicating one’s uncertain knowledge (e.g., “Like that?”; “I think so”); and d) questioning knowledge, including statements that question or assess the degree of the partner’s knowledge or ability (e.g., “OK, can you do that?”; “How do you know?”). These four states of knowledge were coded for both older and younger siblings. To illustrate an example of siblings’ references to knowledge states in a teaching sequence, refer to Table 1.

Transfer of knowledge. To identify instances in which children may have learned something within the teaching sequence, statements indicating overt evidence of learning were identified as transfer of knowledge. These statements included statements of surprise (e.g., “Ooh!” in response to “Cause nobody else got the one tooth. See, see”), imitation (e.g., the younger sibling imitates the older sibling’s singing after being corrected: “No, it goes like this”), or a change in ability, belief, or knowledge (e.g., the older sibling has his hand over the younger sibling’s hand and helps her draw the number five on the board, followed by the younger sibling independently drawing the number). Due to the observational nature of the data, it is possible that children could have learned without displaying overt behaviors or language to indicate their learning; thus, it is important to note that the identification of knowledge transfer does not preclude all instances of learning but only identifies overt instances of learning.

Reliability. First, two assistants (one naïve about the study’s goals) conducted interrater reliability analyses for identification of the teaching sequences for 21% of the transcripts. Reliability was established on the lines of the teaching sequences; if both coders agreed that the line was part of the teaching sequence, it was counted as an agreement, but if one coder missed a
line or an entire sequence, each line counted as a disagreement \((kappa = .78, p < .001; \text{all kappas were significant at} \ p < .001)\). A second set of two coders (one naïve) obtained reliability for the sibling teaching coding on 22% of sequences \((n = 229/1,040)\). Cohen’s kappas for all the analyses were significant at \(p < .001\) and included: who was teaching = .96; initiation of teaching = .93; and the eight teaching strategies: 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. Third, two new assistants (one naïve) coded the knowledge states on each line of 15% of sequences \((n = 160/1,040)\); kappas were: a) knowledge = .98; b) lack of knowledge = .90; c) uncertain knowledge = .75; d) questioning knowledge = .95; and e) knowledge transfer = .89.

RESULTS

Descriptive Statistics

In total, 1,040 sibling-directed teaching sequences were identified in the 39 sibling dyads; 830 sequences (80%) and 210 sequences (20%) were taught by older and younger siblings, respectively. The number of conversational turns in teaching sequences ranged from 2 to 114 turns \((M = 20.44 \text{ turns})\); the average number of teaching sequences per family was 27.66 \((SD = 18, \text{range} = 6–96)\). Given variability in teaching across families, the family was the unit of analysis and proportion scores were calculated to yield comparable variables based on the respective hypotheses and research questions. The uncertain-knowledge category was rarely coded and thus was collapsed with lack of knowledge due to the conceptual similarity (i.e., partial vs. total lack of knowledge). Preliminary analyses revealed no gender or age effects. The Bonferroni correction method was applied to all repeated-measures analysis of variance (ANOVA) post-hoc comparisons.

Knowledge States and Teacher/Learner Roles

This analysis addressed the hypothesis that older- and younger-sibling teachers would be more likely to make knowledge statements, whereas older- and younger-sibling learners would be more likely to indicate a lack of knowledge. To compare teachers’ and learners’ references to the three knowledge states, proportion scores were calculated, for example, by dividing all cases where the teacher referenced knowledge by the total references to knowledge. A 3 (knowledge) × 2 (teacher/learner role) repeated-measures ANOVA was conducted with knowledge as the dependent variable. Mauchly’s test indicated that the assumption of sphericity was violated for the interaction, \(\chi^2(2) = 18.48, p < .001\); the degrees of freedom were corrected using Greenhouse-Geisser estimates \((\varepsilon = .69)\). Results revealed a significant difference by actor role, \(F(1.38, 44.17) = 53.43, p < .001, \eta^2_p = .63\). As expected, simple effects tests indicated that teachers were more likely to reference knowledge and question knowledge than were learners, while learners were more likely to reference lack of knowledge than were teachers (see Table 2).

Birth Order and Teacher/Learner Roles

To test the hypothesis that older-sibling teachers would be more likely to reference knowledge and questioning-knowledge states than younger-sibling teachers, proportion scores were
calculated, for instance, by dividing older teachers’ references to knowledge by the sum of all teachers’ references to knowledge. A 3 (knowledge) × 2 (older/younger teacher) repeated-measures ANOVA, with knowledge as the dependent variable, revealed a main effect of teacher, $F(1, 17) = 17.73, p < .01, \eta^2_p = .51$. Pairwise comparisons indicated older-sibling teachers were more likely to reference knowledge ($M = 0.74, SD = 0.04$), reference a lack of knowledge ($M = 0.66, SD = 0.10$), and question knowledge ($M = 0.76, SD = 0.08$) compared with younger-sibling teachers. These findings may reflect results indicating that older siblings ($M = 0.72, SE = 0.05$) taught significantly more often than younger siblings ($M = 0.28, SE = 0.05$).

Analogous to the previous set of analyses, to assess our prediction that younger-sibling learners would be more likely to reference a lack of knowledge than older-sibling learners, proportion scores were calculated, for example, by dividing younger-sibling learner’s references to lack of knowledge by the sum of all learners’ references to lack of knowledge. A 3 (knowledge) × 2 (older/younger learner) repeated-measures ANOVA was performed with knowledge as the dependent variable. Mauchly’s test showed that the assumption of sphericity was violated for the interaction, $\chi^2(2) = 9.23, p < .05$; therefore, the degrees of freedom were corrected with Greenhouse-Geisser estimates ($\epsilon = .71$). Results revealed a significant difference in references to knowledge by the learner, $F(1.43, 27.12) = 19.86, p < .001, \eta^2_p = .51$. Simple effect comparisons indicated that older-sibling learners were more likely to reference knowledge ($M = 0.74, SE = 0.04$) than were younger-sibling learners ($M = 0.26, SE = 0.04$), and as expected, younger-sibling learners were more likely to reference lack of knowledge ($M = 0.84, SE = 0.04$) than were older-sibling learners ($M = 0.16, SE = 0.04$).

Knowledge States and Initiation of Teaching

This analysis tested our predictions that siblings who assumed the teacher role would be more likely to reference knowledge and questioning-knowledge states, whereas siblings who assumed the learner role would be more likely to reference a lack of knowledge. To assess the differences in siblings’ references to the three knowledge states according to the initiation of teaching, proportion scores were calculated by dividing all instances where the teacher assumed the role and referenced knowledge by the total instances of references to knowledge. A 3 (knowledge) × 2 (teacher initiation, learner request) repeated-measures ANOVA was conducted with knowledge states as the dependent variable. Mauchly’s test indicated that the assumption of sphericity was violated for the interaction effect, $\chi^2(2) = 12.56, p < .01$; therefore, the degrees of freedom were

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>Teacher</th>
<th>Learner</th>
<th>Teacher-Initiated</th>
<th>Learner-Initiated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SE</td>
<td>M</td>
<td>SE</td>
</tr>
<tr>
<td>Knowledge</td>
<td>0.66</td>
<td>0.01</td>
<td>0.34</td>
<td>0.01</td>
</tr>
<tr>
<td>Lack of Knowledge</td>
<td>0.16</td>
<td>0.03</td>
<td>0.84</td>
<td>0.03</td>
</tr>
<tr>
<td>Questioning Knowledge</td>
<td>0.70</td>
<td>0.06</td>
<td>0.30</td>
<td>0.06</td>
</tr>
</tbody>
</table>

TABLE 2
Knowledge by Teacher/Learner Role
corrected using Greenhouse-Geisser estimates ($\varepsilon = .73$). Results (see Table 2) indicated a significant interaction between initiation of teaching and type of knowledge referenced, $F(1.47, 42.60) = 73.45, p < .001, \eta^2_p = .72$. Congruent with our hypotheses, simple effects tests showed that when teachers initiated the role, they were more likely to reference knowledge and question knowledge than when learners requested teaching. Alternatively and as predicted, when learners requested teaching, they were more likely to reference a lack of knowledge than when teachers initiated instruction.

### Teaching Strategies and Knowledge States

To test the prediction that teachers would be more likely to employ specific strategies (e.g., direct instruction, demonstration) when learners referenced the three knowledge states, proportion scores were calculated—for example, by dividing all instances where the teacher used direct instruction and the learner referenced knowledge by the total instances where the learner referenced knowledge. One-way repeated-measures ANOVAs were conducted separately for each knowledge state with the six teaching strategies as the dependent variable. Mauchly’s test indicated that the assumption of sphericity was violated for the three main effects of knowledge, $\chi^2(14) = 73.41, p < .001$, lack of knowledge, $\chi^2(14) = 75.63, p < .001$, and questioning knowledge, $\chi^2(14) = 108.63, p < .001$; thus, the degrees of freedom were corrected using Greenhouse-Geisser estimates ($\varepsilon = .55, .56, .55$, respectively).

First, results indicated a significant main effect of knowledge, $F(2.76, 104.77) = 116.69, p < .001, \eta^2_p = .75$. In partial support of our predictions, when learners referenced knowledge, teachers used direct instruction more often than all other strategies; demonstration more than negative feedback and the remaining strategies; and negative feedback more than explanation, planning, and positive feedback. Second, results indicated a significant main effect of lack of knowledge, $F(2.80, 106.29) = 60.53, p < .001, \eta^2_p = .61$. When learners conveyed a lack of knowledge, teachers used direct instruction more than all other strategies and used demonstration more than explanation and planning; and finally, negative feedback was employed more than planning. Third, a significant main effect of questioning knowledge was evident, $F(2.74, 104.23) = 11.69, p < .001, \eta^2_p = .24$. When learners questioned knowledge, teachers used direct instruction more often than all other strategies. See Table 3 for means and standard errors.

### Knowledge States and Learning Outcomes

To investigate older- and younger-sibling teachers’ references to knowledge when learners demonstrated learning (transfer of knowledge), proportion scores were calculated. For example, teachers’ references to knowledge during learners’ transfer of knowledge was divided by all instances of teachers’ references to knowledge when transfer of knowledge occurred. A 2 (older-, younger-sibling teacher) × 3 (transfer of knowledge based on knowledge state) repeated-measures ANOVA was performed. There was no significant difference of older- or younger-sibling teacher by transfer of knowledge; however, there was a main effect of transfer of knowledge based on type of knowledge taught. Mauchly’s test indicated that the assumption of sphericity was violated for the main effect, $\chi^2(2) = 21.20, p < .001$; therefore, the degrees of freedom were corrected with Greenhouse-Geisser estimates ($\varepsilon = .57$). Statements of transfer of knowledge were most likely to occur, $F(1.14, 18.22) = 372.65, p < .001, \eta^2_p = .96$, when older-
sibling teachers ($M = 0.86, SD = 0.04$) and younger-sibling teachers ($M = 0.95, SD = 0.03$) referred to knowledge as opposed to the other categories regardless of birth order (see Table 4).

### DISCUSSION

The present study investigated siblings’ understanding of the teaching concept in naturalistic contexts. We first discuss findings related to children’s understanding of teaching and learning, followed by associations between teaching strategies and learners’ understanding.

#### Siblings’ Social Understanding of Teaching

The success of teaching is argued to depend on children’s understanding of the teaching concept (Rogoff, 1990, 1998), which requires an understanding of others’ minds (Strauss et al., 2002). Certainly, investigating naturalistic conversations and interactions may illuminate how children acquire an understanding of their social world (Hughes & de Rosnay, 2006). In fact, our findings revealed naturalistic sibling teaching is a context in which children demonstrate sociocognitive understanding of teaching, specifically by examining siblings’ references to knowledge states.
and associations with: a) the initiation of teaching, b) teacher/learner roles, and c) the teaching outcome. Importantly, our findings relied on the use of siblings’ language and behavior as a gateway to their understanding of mind and its role in their understanding of the teaching concept. This approach provides support for Turnbull et al.’s (2009) notion that the development of children’s understanding of mind can be facilitated by engaging in conversations that demonstrate appropriate ways to talk about beliefs, knowledge, actions, and consequences. One interesting future question would be to examine the associations between children’s use of such language and more traditional means for measuring theory-of-mind skills (i.e., false-belief tests) to determine convergence across paradigms.

First, siblings’ understanding of teaching was examined from the vantage point of the initiation of the teaching process. Specifically, when siblings assumed the teacher role, they were more likely to demonstrate their knowledge and question the knowledge state of the learner; alternatively, when siblings requested teaching, they were more likely to reference a lack of knowledge. These patterns of findings indicate that when assuming the teacher role, siblings were more likely to describe or question the knowledge the learner lacked, whereas when assuming the learner role, siblings described the knowledge they wanted or lacked. Congruent with the definition of teaching, our findings suggest that teachers and learners have an understanding of the knowledge difference required for teaching and the intentional nature of this behavior (Kruger & Tomasello, 1996; Olson & Bruner, 1996; Ziv & Frye, 2004). Given that our observations of sibling-directed teaching were collected during naturalistic home sessions and occurred without adult prompting, it appears that teaching may be a natural cognitive activity for young children (Strauss & Ziv, 2012). Thus, our findings converge with other research that demonstrates children’s understanding of teaching as an intentional act via their detection of knowledge differences in storytelling tasks (Ziv & Frye, 2004; Ziv et al., 2008).

Second, when taking into account birth-order effects, important differences in children’s understanding of teaching were highlighted. For instance, although older siblings taught more and consequently referenced all three knowledge states more often than younger siblings, older-sibling learners were more likely to reference knowledge and younger-sibling learners were more likely to reference a lack of knowledge. These findings indicate that older siblings in the learner role were more likely to demonstrate their understanding of what was being taught or learned, whereas younger siblings in the learner role were more likely to lack this understanding. Findings suggest that older siblings have a developmental advantage over their younger counterparts even in the learner role, which further reflects differences due to the complementary nature of sibling interactions and their more advanced social-cognitive skills (Howe et al., 2011; Vandell & Bailey, 1992; Volling, 2003). Furthermore, older- and younger-sibling learners’ references to knowledge or lack of knowledge highlight teaching as a bidirectional process, in which the learner assumes an active role (LeBlanc & Bearison, 2004; Rogoff, 1990, 1998). That is, by demonstrating their knowledge or lack thereof, learners reveal that they are not merely passive participants, but rather showcase their efforts to learn and engage in the teaching process.

Third, siblings’ understanding of teaching was further captured in terms of the teaching goal being achieved (i.e., overt evidence or statements of learning or knowledge transfer). In particular, knowledge transfer was most likely to occur when both older- and younger-sibling teachers verbally or physically demonstrated their knowledge compared with when they indicated a lack of knowledge or questioned the learner’s knowledge. These findings support Rogoff’s (1990, 1998) conceptualization of guided participation, whereby siblings’
understanding of teaching facilitates the goal of teaching by bridging the gap between the known and unknown for learners. For example, while playing tic-tac-toe, an older sibling instructed her younger sibling by stating, “This is where you win if you put it (letter O) in the middle.” The younger sibling responded as instructed and the older sibling proclaimed, “(Younger sibling) wins!” As illustrated, the success of this collaborative interaction partly depended on the teacher’s degree of understanding that she had to convey information to the learner for learning to occur. In this manner, siblings’ understanding of teaching provides new insights into how young children facilitate one another’s development within the context of close, intimate relationships and how they co-construct shared meanings about their world (Carpendale & Lewis, 2006; Howe et al., 2011).

Teaching Strategies and Learners’ Understanding

Due to the bidirectional nature of teaching (LeBlanc & Bearison, 2004), there are many levels of communication and interaction in which children’s understanding of teaching can be facilitated. One such avenue includes an examination of the means (i.e., strategies) by which teachers transmit knowledge in response to learners’ varying degrees of understanding. Regardless of the learners’ state of knowledge, teachers were most likely to use direct instruction followed by demonstration, thereby underscoring teachers’ first line of action as a verbal strategy to instruct the learner in a direct way (e.g., “This is batman” or “Stand here”). This approach was consistent with prior research demonstrating positive associations between teachers’ use of direct instruction and demonstration strategies with active learner involvement (Howe et al., 2012, 2013). Further, direct instruction is a more common teaching strategy than verbal explanation with demonstration during the preschool years (Davis-Unger & Carlson, 2008; Strauss et al., 2002). These teaching strategies may reflect a guided participation or learner-centered approach to teaching (Rogoff, 1990, 1998), wherein the use of labeling, describing, sharing information, or physical assistance is an informative response to learners who display partial knowledge or lack of knowledge. Thus, these findings may reflect the means by which children co-construct knowledge in the context of teaching by allowing the teacher to structure and scaffold the task so that the learner can assume responsibility for their own learning (Palincsar, 1998; Rogoff, 1990; Vygotsky, 1978).

Differences further emerged with respect to teachers’ comparative use of strategies. When learners conveyed their knowledge, teachers were more likely to use demonstration than negative feedback, whereas when learners stated a lack of knowledge, teachers were more likely to use demonstration than planning and explanation. Perhaps when selecting among an array of response patterns, teachers may prefer a more adaptive response (i.e., demonstration over negative feedback), indicating some sensitivity or monitoring of the learner’s ability level (Strauss et al., 2002). Teachers may also have preferred the concrete act of demonstration (over planning and explanation) as a more effective response when they perceived a gap in the learners’ understanding. These findings are in line with literature indicating that older-sibling teachers adapt their teaching strategies to take account of task difficulty to enhance younger siblings’ learning (Howe et al., 2006).

Moreover, there were circumstances when teachers consistently employed negative feedback over other strategies. Specifically, when learners conveyed their knowledge, teachers employed negative feedback more often than explanation, planning, and positive feedback. Similarly, when
learners conveyed a lack of knowledge, teachers used negative feedback more than planning. This pattern highlights that teachers are likely to employ negative feedback in various scenarios such as using correction when there is a lack of knowledge (e.g., “No, not like that” in response to the learner’s attempt to throw a ball). Teachers’ negative feedback may also possibly be linked to issues of control when learners convey partial understanding. Clearly, these speculations require further investigation.

Conclusion

The study’s limitations include the use of a middle-class, Caucasian sample that limits the generalizability of the results but was representative of the local population. Future research should include a more ethnically diverse pool of participants from various socioeconomic backgrounds that may perhaps capture a different set of patterns. Moreover, the inclusion of a formal sociocognitive measure (e.g., theory of mind) would have provided additional insights regarding siblings’ interaction patterns and their social understanding. Nevertheless, our study provided a refined and rich examination of how children use language to develop an understanding of one another’s minds in the context of teaching.

In sum, by examining siblings’ understanding of teaching in naturalistic contexts, we advance knowledge regarding the processes associated with an important socialization context in which children learn from one another. Both parents and educators may benefit from knowing that children are indeed capable of teaching and learning from one another in rich, meaningful, and relevant ways. The developmental significance of informal learning contexts such as sibling teaching can encourage educators and parents to facilitate naturalistic teaching opportunities so as to foster children’s communication skills and social understanding.

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