ELSEVIER

Cognitive Development 17 (2002) 1473–1787

COGNITIVE DEVELOPMENT

Teaching as a natural cognition and its relations to preschoolers' developing theory of mind

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Abstract

Teaching is an important aspect in people's lives and cultures. We explore it from a cognitive-developmental perspective. Teaching may be a natural cognition that, despite its complexity, is learned at an early age without any apparent instruction. We propose that theory of mind may be an important cognitive prerequisite for teaching. We briefly describe a study that tested relations between children's developing theory of mind and actual teaching. Children at the ages of 3- and 5-years were presented new theory of mind tasks about teaching and then were observed teaching peers a game they had just learned. We found corresponding age-related differences in children's understanding of teaching as manifested in their performance on the teaching-theory of mind tasks and in their teaching strategies. It is suggested that theory and research on theory of mind might need to be expanded to include on-line, interactive situations such as teaching.

Keywords: Teaching; Natural cognition; Learning

Teaching, the social transformation of knowledge from one person to another is one of the most remarkable of human enterprises. The majority of research concerning teaching explored its educational aspects, focusing on transmission of knowledge from professional adults to people who are less knowledgeable in certain domains.

We propose that teaching could also be seen as an essential domain of inquiry in the field of cognitive development. This is so because, as we attempt to show,

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0885-2014/02/$ – see front matter © 2002 Published by Elsevier Science Inc.
PII: S0885-2014(02)00128-4

teaching may be a natural cognition and its development is fundamental to what it means to be a human being. Furthermore, the search for the cognitive underpinnings of teaching may provide new insights into fundamental cognitive processes, an important one being the development of theory of mind.

Unlike teaching, learning, its mirror image, has been a major focus of research in cognitive development. In other words, although children's learning has been extensively studied, little is known about children's construction of the concept of teaching, as well as of the actual process of teaching. In an attempt to tell the story of teaching as a natural cognition and its relation to children's developing theory of mind, we present our ideas in five sections. First, we provide different definitions of teaching. Second, we motivate reasons why teaching may be a natural cognition. This section concludes with the point that if teaching is a natural cognition, there is a need to determine the nature of the cognitive prerequisites that underlie it. We then present areas that could be helpful to establish what these cognitive building blocks might be. Next, we review research on preschool children's teaching and sketch a study we conducted on that topic. And, finally, we discuss the implications of the study for the area of the cognition of teaching and its development.

1. Definitions of teaching

Teaching is a rather elusive concept and has been differently defined by scholars and researchers from various disciplines. Caro and Hauser (1992) studied teaching from a biological perspective. Their definition of teaching, whose origins are in evolutionary theory and empirical data, is as follows:

> An individual actor A can be said to teach if it modifies its behaviors only in the presence of a naïve observer, B, at some cost or at least without obtaining an immediate benefit for itself. A's behavior thereby encourages or punishes B's behavior, or provides B with experience or sets an example for B. As a result, B acquires knowledge or learns a skill earlier in life or more rapidly or efficiently than it might otherwise do, or that it would not learn at all. (p. 153)

Importantly, Caro and Hauser (1992) argue that this definition of teaching requires neither theory of mind nor the intentionality involved in teaching on the part of the many animals whose teaching they described.

Premack (Premack, 1991, 1993; Premack & Premack, 1994, 1996) critiqued this position by arguing that teaching among animals other than humans is generally related to getting food to survive, which makes it very circumscribed. In addition, Premack believes that animals other than humans are not sensitive to their offsprings' progress. For example, the mother cheetah does not give extra time to a cub of hers who might be slow in learning how to kill prey. And she is unlikely to keep that same cub back and not allow it to seek prey on its own, at the time that his siblings are on their own, so as to give him "remedial lessons."

In contrast to this biologically-based definition, psychologists describe teaching in other, non-evolutionary terms, as can be seen by the following representative quote, from Pearson (1989):

> When faced with the question of determining whether an action is a teaching action, as opposed to some other action such as reciting, talking or acting in a play, it is the *intention* of bringing about learning that is the basis for distinguishing teaching from other activities. The *intention* the activity serves, then, is a part of the meaning of the concept, and not a factual discovery one makes about the activity. (Italics added) (p. 66)

Kruger and Tomasello (1996) postulated that defining teaching in terms of its intention — to cause learning, suggests that teaching is linked to theory of mind, i.e., that teaching relies on the human ability to understand the other's mind. Olson and Bruner (1996) also identified theoretical links between theory of mind and teaching. They suggested that teaching is possible only when a lack of knowledge can be recognized and that the goal of teaching then is to enhance the learner's knowledge. Thus, a theory of mind definition of teaching should refer to both the intentionality involved in teaching and the knowledge component, as follows: teaching is an intentional activity that is pursued in order to increase the knowledge (or understanding) of another who lacks knowledge, has partial knowledge or possesses a false belief (Frye & Ziv, in press).

2. Teaching as a natural cognition

Strauss (in press) suggested that there are at least seven reasons to motivate the notion that teaching is a natural cognition. None by itself leads inevitably to this conclusion; however, in concert, they suggest that teaching might just be a natural cognition. In broad terms, a natural cognition is a universal cognition that appears early in life and does not in itself require intentional teaching for it to be learned and young children seem to effortlessly learn the domain in question. The seven main points of the natural cognition argument are as follows:

1. As mentioned, the cognition underlying teaching among some species of animals and human beings has not been thoroughly examined. There is some controversy about whether or not non-primates teach, but there is little controversy that chimpanzees, our closest relatives, and other primates do not teach with a theory of mind (Povinelli & Eddy, 1996, 1997; Premack, 1984, 1991; Premack & Premack, 1994, 1996; Tomasello, 1999; Tomasello & Call, 1997). There is some convergence, then, on the idea that human beings are the only species that teaches by using a theory of mind. Thus, teaching with a theory of mind may be *species-specific*.
2. Despite the controversy among scientists concerning whether or not primates teach, it is (almost) incontrovertible that teaching is ubiquitous among human beings, which means that, with few exceptions, every person in

every society has taught and has been taught by others (Kruger & Tomasello, 1996; Tomasello, Kruger, & Ratner, 1993). These are *universal activities* that take place in everyday life in the home, the streets, the workplace, and the fields.

3. Teaching is an extraordinarily complex enterprise that has much to do with mind, emotions, and motivation-reading. The richness of the kinds of knowledge needed to teach is impressive. As a miniscule sampling, consider this: in order to teach, one needs to know when knowledge, beliefs, skills, etc. are missing, incomplete, or distorted, as well as how people learn. One also knows about others' emotions and motivation.

   In addition, the number and complexity of inferences that must be made when teaching others are remarkable. This idea can be illustrated by several of the myriad inferences necessary for teaching to occur. As teachers, we have a representation of a problem and its potential solutions. If a student solves the problem in another fashion, we infer that s/he has a different representation of the same problem. Furthermore, we infer what that representation might be, given the nature of the student's solution. And we infer from the student's responses to our teaching if there have been representational, emotional, and/or motivational changes. In sum, there is remarkable complexity to teaching.
4. One of the many remarkable aspects of teaching is that so much of it is invisible to the eye. The visible part is the external acts of teaching. It is what we see and hear when we are being taught. It is the teacher's questions, her request for her pupils to reflect on their learning, and much, much more. It is also the Kung hunter's demonstration and explanations to a youngster of how to string a bow and the ways he checks to see if it was learned. And it is the ways carpet weavers in Mexico serve as masters who teach apprentice youngsters to fashion carpets for local use.

   These are slight examples of what people do when they teach. This is what is visible to the eyes of the learner, the person to whom the teaching is directed. And, as shown, it is very complex. But the visible part of teaching is quite impoverished in comparison to the depth of what underlies it, the part that is not revealed to the eye. What is invisible are the teacher's intention, the inferences teachers make, and the mental processes that lead to these inferences. In addition, it is possible that the visible part of teaching does not reveal what gives rise to it. In other words, it might be the case that one cannot infer the invisible (what underlies teaching) from the visible (actual teaching acts). This has been termed "the poverty of the stimulus" in the linguistics and language acquisition literature.
5. Teaching may be a *specialized kind of social interaction*, unlike others. For example, people have conversations and arguments; they collaborate to achieve common goals, and they engage in deception to achieve private aspirations. The critical difference between these social interactions and teaching is in the intention underlying the activity. As mentioned earlier,

the teacher directs her activities towards the learner in order to enhance the learner's knowledge, or understanding. This may be a unique intentionality.

6. Although teaching is universal among human beings, it seems to be learned without formal, or even informal teaching. It is *unschooled cognition*. A sliver of the 6 billion inhabitants of planet earth has been taught how to teach; yet all know how to teach. All have been exposed to pedagogy; they have been taught. But, with few exceptions, they have had no instruction about how to teach.
7. The premise here is that if *very young children engage in teaching* and they have not been taught to teach, we might have another case for the claim that teaching is a natural cognition. Little research has been conducted on the topic of preschoolers' teaching, but what exists suggests that children as young as age 3.5 years of age teach, as discussed below.

3. Cognitive prerequisites of teaching: mind the gap

The seven features listed suggest that it is reasonable to propose that teaching is a natural cognition. As recognized by several researchers, theory of mind may play an important role in the construction of the notion of teaching. First, recognizing the need for teaching requires appreciating the knowledge gap between a knowledgeable person and a person with less knowledge. In addition, understanding the intent of teaching relies on appreciating its goal — causing learning, or enhancing the learner's knowledge (Frye & Ziv, in press; Strauss, 1993). Furthermore, a more complete understanding of teaching involves understanding how teaching affects others' minds, or, in other words, how teaching leads to learning and how teaching helps knowledge become acquired (Strauss, 1993, 1996, 1997, 2000, 2001; Strauss, Ravid, Magen, & Berliner, 1998; Strauss, Ravid, Zelcer, & Berliner, 1999).

Strauss (in press) proposed that in order to fully understand the relations between ToM and teaching, an expanded notion of ToM might be needed. Whereas classical ToM deals with declarative knowledge about the state of others' beliefs, desires, etc., teaching is dynamic and interactive. An expanded ToM should allow for on-line and interactive conditions, the kind that occurs when children (and adults) teach others.

Let us elaborate on the nature of relations between ToM and teaching and reasons for an expanded ToM. In standard false belief tasks employed to tap ToM, a child who has a ToM understands that someone can behave incorrectly because he has a false belief or incomplete knowledge. In a teaching situation, a child who has a ToM can recognize an error on the part of the learner and can attribute it to a false belief or incomplete knowledge. Here ToM and teaching are similar. The on-line aspect of teaching with a ToM is that the child acts on his (implicit) understanding about how false beliefs and partial knowledge can be changed, i.e.,

the child teacher teaches in a way that indicates her understanding of how learning takes place in others' minds.

This on-line aspect of ToM includes the teacher's ability to monitor the knowledge, emotional, and motivational states of the learner. Furthermore, teaching may require coordinating teaching strategies and this monitoring. In other words, monitoring, say, the learner's knowledge state can lead to certain teaching strategies whose results are the learner's behaviors that indicate what and how much was learned which is again monitored and may lead to further teaching strategies, etc.

A related notion is of psychological causality that has, at its core, the notion that I, the teacher, can stand outside others' minds and can influence what is happening in their minds by talking, demonstrating, etc. These behaviors, external to others' minds, are thought to cause learning in others' minds. So the ways teachers teach indicate their understanding of the mind and how learning takes place in it (Strauss, 1993, 1996, 1997, 2001).

4. Preschoolers' teaching

Researching young children's teaching may be a window into ascertaining the cognitive prerequisites needed for teaching. Studying the ontogenetic emergence of teaching may contribute to our understanding of some of the fundamental cognitive building blocks that underlie it. Specifically, acknowledging the possibility that theory of mind may be critical for teaching, highlights the importance of empirically testing the relation between the development of theory of mind and teaching in preschoolers.

However, searching for the earliest signs for the appreciation of teaching leads us first to recent studies concerning word learning in toddlers that raise the question of whether toddlers already have some appreciation of teaching.

4.1. Toddlers may request teaching

Long before children themselves engage in teaching, they are exposed to it and may already start developing an early sensitivity to teaching. The domain of word learning may serve as an illustration. Recent studies suggest that learning words may involve direct teaching acts on the adult's part as well as understanding the adult's referential intention on toddler's part (Bloom, 2000). Furthermore, toddlers at the age of 2 years often ask what the name of an object is and, by so doing, initiate teaching on the adult's part. In these instances, toddlers request an object's name, and their requests are then met with intentional teaching. These instances may be important for the early construction of teaching. Cautiously interpreting toddlers' behaviors as reflecting an early grasp of some aspects of teaching, although debatable, may be intriguing (Strauss & Ziv, in press).

Toddlers may know that objects have names, or words associated with them. In addition, they identify objects whose names they don't know and show a desire to

know that name. In doing so, they may show some understanding of their own lack of knowledge. Toddlers then direct their request to an adult whom they know from previous experience can provide them with the desired word. This may indicate that they also assume knowledge on the adult's part. Finally, they probably expect their request to result in an adult's production of a word, directed to them, in an act known to adults as teaching. Although children's actions can also be interpreted in behavioral terms that do not assume understanding of their knowledge state, that of adults', and the gap between them, the possibility that already at the age of 2 years children begin to understand the mental state aspects of teaching should be empirically tested.

4.2. Preschoolers' teaching

Only a few studies have been conducted on young children's teaching as related to ToM. These studies found age-related changes in children's teaching and interpreted the differences referring to children's developing theory of mind. However, none of the previous experiments actually tested theory of mind.

Wood, Wood, Ainsworth, and O'Malley (1995) conducted a study on 3-, 5-, and 7-year-olds with the purpose of studying the ontogenesis of skills for what they termed "contingent instruction." This kind of instruction involves offering help when a learner experiences difficulty and providing less help as the learner increasingly succeeds on a task. The experimenters taught children how to assemble a five-layered pyramid of wood blocks, where each layer had two pairs of same-size wooden blocks that had to be fit together in such a way that pegs from one block of each pair fit into a hole in the second block of the pair. The children were then asked to teach a friend how to assemble the pyramid. For the purposes of our exposition, the findings from this study were that the 7-year-olds were more effective contingent instruction teachers than the 3- and 5-year-olds.

Astington and Pelletier (1996) observed kindergarten and first grade children in three situations — spontaneous pretend play of school, pretend play of school prompted by the experimenter's questions about learning and teaching, and modeled teaching followed by children teaching their peers. They found a change in children's conception of teaching with age. The youngest children talked about teaching as showing, whereas older children tended to describe teaching as telling and finally as helping or collaboration. The authors interpreted the change in children's conception of teaching in terms of their level of understanding the mind, as tested in separate studies about preschooler's theory of mind.

Ashley and Tomasello (1998) studied teaching and cooperative problem solving among younger children — 2-, 2.5-, 3-, and 3.5-year-olds. In the teaching part of their study, they found that the 2-year-olds could not teach; the 2.5-year-olds may not have been aware of the learner's lack of knowledge, as measured by their language-use; the 3-year-olds showed that they were somewhat more sensitive to the learners when teaching them than the 2.5- and 3.5-year-olds were more adapted to the learner than the children in the other age groups.

In conclusion, previous studies have found initial attempts of teaching around the age of 3.5 years. Young children's teaching seems to be not as adaptive to the learner as the teaching of preschoolers aged 5.5, and they demonstrate more and speak less while teaching, as compared to the 5.5-year-olds. Interpreting children's teaching suggested that these age-related differences in teaching strategies might be related to changes in mental state understanding. We conducted a study to directly test this possibility.

4.3. Understandings of teaching and children's teaching

Guided by the theoretical notion of teaching as a natural cognition that is related to children's developing ToM, the goal of the study was to explore preschoolers' understanding of teaching, as well as the actual strategies they use while teaching. Consequently, the study included presenting children with new theory of mind tasks about teaching (Frye & Ziv, in press), observing children teaching peers, and finally, interviewing children about their own teaching. Fifty dyads participated in the study: 25 with a mean age of 3.5 and 25 with a mean age of 5.5.

Testing children's understanding of teaching was guided by the theory of mind-based definition of teaching, an intentional act to enhance the learner's knowledge or understanding. The study focused on the knowledge component and tested whether children understand that a prerequisite for teaching is a difference in knowledge, or a knowledge gap between the teacher and the learner, and whether they realize that teachers may have mistaken beliefs about learners' knowledge that determine whether they will teach or not.

All the teachers were given six tasks, two each for testing children's theory of mind *via* classic false belief (FB) tasks; understanding the knowledge gap; and testing children's theory of mind *via* FB tasks about teaching.

4.3.1. Theory of mind via classic false belief tasks

All the children were given two classical FB tasks, where a doll knew where an object was, and its location was changed unbeknownst to the doll, and the child was asked where the doll would look for the object.

4.3.2. Understanding the knowledge gap

Children were given two tasks to tap their understandings of the necessity of gaps in knowledge for teaching; e.g., a teacher who knows how to read has two pupils, one who knows and one who does not know how to read. The children were asked which pupil the teacher would teach.

4.3.3. Theory of mind via false belief tasks about teaching

Children were given two tasks: an overestimation and an underestimation task. For example, the overestimation task had a teacher who thought that a child knew how to read, but the child really did not know how to. The teacher, as a result, had a false belief about the child's knowledge. The children in the study were asked if

they thought that the teacher would teach the child who didn't know how to read (but whom the teacher thought did know how to read).

Children's actual teaching was explored by observing children teach a board game to a peer. The game is a commercial board game that, according to the commercial guidelines, is appropriate for children aged 2.5–6 years. The goal of the game is to collect a complete set of four cubes, each of a different color. The game involves taking turns and following a set of rules regarding the moves that are allowed in each turn. For example, a player can only take a cube that matches the color depicted on the upper face of the dice, and is only allowed to have one cube of each color.

Children were first taught how to play the game. The teaching included two phases: (1) explaining the rules of the game, integrating verbal explanations and demonstrations, for example: "You move the train along the track and stop next to one of the stations." (2) Playing the game. This was accompanied by explanations repeating the important game rules and responses to children's questions, errors, hesitations, etc. (i.e., responsiveness, or contingent teaching). During this phase the experimenter also determined whether the child learned how to play the game and was ready for the teaching phase.

After demonstrating proficiency in playing the game, the experimenter asked the child who now knew how to play the game whether she would like to teach a peer who was not familiar with how to play the game. All the children responded positively. The new dyad received no further encouragement or instructions from the experimenter. The children were given all the time they needed in order to teach and play the game until they said that one of them won the game or that they finished playing.

The children's teaching sessions were divided into two stages. The first was the explanation stage in which the rules of the game were made explicit to the learner. The child-teachers explained, demonstrated or combined both to indicate how to play the game to the learner. The second stage was the play stage. Here the children played, and the teacher intervened if and when the learner erred.

All intentional demonstration gestures and utterances were categorized into seven categories that are summarized in Table 1. The percentage of children's use of each of the above teaching strategies was determined by calculating the mean frequency of occurrences of each of the strategies.

At the end of the teaching session, the experimenter asked each child-teacher two questions to explore their reflections on the teaching process and the learner's learning:

1. How did you teach (name of learner) how to play?
2. How do you know that (name of learner) learned/did not learn how to play?

Children's descriptions of teaching (question 1) tapped their reflections about their teaching strategies, and were classified as focusing on demonstration, verbal explanations, and a combination of demonstration and verbal explanations. Analysis of children's answers about the learner's learning (question 2) were intended

Table 1
Teaching strategies

Demonstration — teacher actively shows learner what to do, e.g., moves the train on the track and stops at a station
Specific directive — teacher tells the learner what to do right now, e.g., "Take this"
Verbal explanation — teacher explains to the learner a rule or what he/she should be doing, e.g., "You got green. You can take the cube"
Demonstration accompanied by a verbal explanation
Questions aimed at checking learner's understanding — "Do you understand"? "Remember"?
Teacher talk about own teaching — teacher shares with the learner his/her teaching strategies, e.g., "I will now explain to you how to play"
Responsiveness — teacher responds to utterances or actions of the learner, e.g., answers questions when a learner errs and demonstrates or verbally repeats a rule

to tap their reflections about others' learning, and indicated the learner's behaviors that the teachers referred to as evidence for their learning.

The main findings of the study were significant age differences in each of the measures of children's understanding of and engaging in teaching and significant correlations among children's performance on the different measures. We now flesh this out.

It will be recalled that two kinds of tasks were added to the standard false belief tasks to test children's understandings of teaching: understanding the knowledge gap, and tasks specific to teaching. In line with two decades of research on false belief tasks and theory of mind, we found that significantly more older than younger children solved the classic false belief tasks. No significant difference was found between 3- and 5-year-olds' performance on the knowledge difference tasks. Virtually all the children in both age groups realized that a knowledgeable teacher would teach a certain skill to a child who lacks knowledge and not to the child who has the specific knowledge.

There was a significant difference, however, in 3- versus 5-year-olds' understanding of teachers' false beliefs. Three-year-olds, who performed poorly on classic FB tasks, performed at chance level in the tasks about teachers' false beliefs. For example, when a child was said not to know how to sing a particular song, but the teacher thought that the child could sing it, 3-year-olds said that the teacher would try to teach the child to sing, indicating their reliance on the child's actual knowledge rather than the teacher's belief. In contrast, 5-year-olds, similar to their better performance on traditional false belief tasks, said that a teacher who thought that a child did not know how to read would teach the child to read, even though in reality the child knows how to read, indicating understanding of the implications of teacher's false beliefs on their decision whether to teach or not.

The teaching strategies of 3-year-olds differed from those of the 5-year-olds in both the stage of explaining the game and in playing the game. In the explanation stage, the most frequent strategy in both groups was a combination of demonstration and verbal explanation. In contrast, the groups differed in the frequency of demonstration and verbal explanations. Three-year-olds used demonstration more

frequently than 5-year-olds, whereas 5-year-olds used verbal explanations more frequently than 3-year-olds.

In the play stage, there was again a significant difference in the frequency of demonstration versus verbal explanations. Younger children's most frequent strategy was demonstration, whereas the most frequently employed strategy by the 5-year-olds was verbal explanations. In addition, two new strategies appeared among 5-year-olds during the play stage. First, 5-year-olds showed responsiveness to the learner's actions, mainly by verbally repeating, or reminding the learner about some of the rules they had already previously explained, usually in a shortened version, or as a behavioral directive. They also employed a new strategy of asking children whether they understood or remembered what to do.

In describing their own teaching, children in both age groups recognized that the learner who initially did not know how to play learned how to play. However, younger and older children differed in their answers regarding both the teaching process and the evidence for the learning that took place.

When asked how they taught, 3-year-olds tended to say that they showed the learner, and/or they described or demonstrated their acts, e.g., "I took the game out of the box and showed her"; "I moved the train and stopped it at a station." Older children tended to say that they taught, told, or explained, e.g., "I told him what to do, how to play the game," and "I explained the rules. I had to explain all the rules." Although many older and some younger children both demonstrated and explained the rules, the older children spoke about their explanations when describing what they did when they taught, suggesting that the older children believe that explaining is at the heart of teaching, unlike the younger children who spoke mostly in terms of demonstration.

When asked how they knew that the peer had learned how to play, younger children tended to refer to their own act of teaching: "I taught him." In contrast, older children referred to the learner's behavior that could indicate that he/she had learned how to play. The most frequent answers referred to the learner's proficiency in playing the game or winning "I saw that she played well," and "Because she won the game."

In also attempted to determine how children's understandings of all three aspects of teaching that were tested (understanding the knowledge difference, actual teaching, and children's description of their own teaching), were related. Significant correlations were found among all three aspects. Higher scores on the new false belief tasks correlated with teaching by employing verbal explanations, as well as with describing teaching by referring to verbal explanation and the learner's proficiency in playing the game.

The findings support and expand previous findings regarding the relation between children's level of ToM understanding and teaching (Ashley & Tomasello, 1998; Astington & Pelletier, 1996; Wood et al., 1995). Our study showed that children's understanding of teaching as well as the actual teaching strategies they employ change during the preschool years and that these changes correspond to changes in children's ToM.

Three-year-olds have some understanding of teaching. They understand that in order to determine the need for teaching as well as the target learner, there is a need to recognize a difference in knowledge between (at least) two people. However, they do not appear to realize that it is the teacher's belief about the learner's knowledge that will determine whether they will teach or not.

Recognition of the learner's lack of knowledge seems to be a necessary prerequisite for any attempt to teach. Thus, 3-year-olds who identify a peer who doesn't know to play a game will attempt to teach the peer. However, they will differ from 5-year-olds in their teaching strategies, reflecting the further change in ToM and understanding of teaching that occurs between the ages of 3- and 5-years. The strong reliance of 3-year-olds on demonstrations in their actual teaching as well as in their description of their own teaching may suggest interpreting knowledge — their own and the learner's, as well as teaching in behavioral — rather than mental terms.

Furthermore, if teaching is considered primarily as a means for changing behavior, demonstration that produces imitation is naturally the means to accomplish the goal. In Olson and Bruner's (1996) terms, 3-year-olds may consider themselves and their peers as doers and teaching as showing how to do something.

Five-year-old children have a more advanced understanding of teaching. In accord with their better understanding of standard false belief tasks, 5-year-olds also understood teachers' false beliefs and could correctly predict that a misinformed teacher would or would not teach, depending on the whether they over-estimated or under-estimated the learner's knowledge. When actually teaching, these same children's teaching strategies relied more than younger children's on verbal explanations and included responsiveness to the learner and questions aimed at checking the learner's understanding.

The strategies employed by 5-year-olds as well as their descriptions of their own teaching may suggest a shift in children's understanding of teaching — from focusing on behavioral aspects to appreciating the mental states involved, specifically knowledge and understanding. In order to teach an ignorant peer, 5-year-olds provided verbal explanations of the rules of the game, indicating an underlying assumption that procedural knowledge, or knowing how, will follow from knowing the facts, or rules. Olson and Bruner (1996) suggested that this approach, which sees teaching as providing propositional knowledge is the most common in educational practice today. Teachers do not speak directly to the behaviors; they speak to the learner's mind, which leads to changed behaviors.

A particularly interesting finding was that when the learners erred, some of the 5-year-old teachers corrected their mistakes by repeating a previously mentioned rule, usually in a shortened version. Already at the age of 5-years, children showed attempts at contingent teaching, or adjusting their teaching to the learner's present knowledge state. Thus, in addition to understanding other's false belief as revealed in stories about static situations, the current study shows that preschoolers also come to understand the process by which partial knowledge or false beliefs can be changed, i.e., teaching.

When asked how they knew that the peer had learned, 5-year-olds referred to the learner's behavior, saying that the learner can now play the game, win etc. These responses suggest that they understand the causal relation between teaching and learning and realize that learners' behaviors that indicate newly acquired knowledge are the outcomes of teaching.

5. The cognition of teaching and its development

We have seen that there are differences between 3- and 5-year-olds' understandings of theory of mind when their false beliefs are tapped by classic false belief tasks and by tasks designed to measure false beliefs about teaching situations. We also found age differences when children were asked how they taught the game, and how they knew that the learner had learned to play. All of these tasks tapped children's declarative knowledge when they were interviewed, and they were motivated by ideas consistent with classic theory of mind propositions.

We also found differences in the teaching strategies employed by 3- and 5-year-old children. In contrast to the interview tasks, actual teaching involves procedural knowledge, and it is interactive and on-line. Being process-oriented, it may involve monitoring the responses of the learner and adjusting the next teaching strategy to the interpretation of that monitoring. We suggested that the two main teaching strategies children employed (demonstration and explanation) may involve an understanding of how knowledge changes, which is a form of theory of mind. In short, we may be dealing here with a way to think about an expanded notion of theory of mind.

Of course, these age differences may not necessarily be developmental differences. To determine that for an expanded theory of mind, we need an analysis of the cognitive entities that underlie the children's declarative and procedural knowledge about others' minds. A more complete understanding of an expanded theory of mind also requires a search for teaching's origins. Here we could look at its phylogenetic beginnings, as well as study the emergence of young children's teaching in ontogenesis. And, in addition, one would want to describe the mechanisms that underlie this cognitive development.

But young children are not the only group for determining the cognitive prerequisites for teaching. Strauss (in press) suggested that other groups could shed light on this area; e.g., Asperger autistic children, those with brain damage in certain areas, individuals with semantic-pragmatic deficits, unusually gifted adult teachers, unusually non-gifted teachers (what Strauss, in press, coined teachers with teaching disabilities), and primates. In addition, work in artificial intelligence can be done to attempt to simulate teaching. Work being done at Tel Aviv University is testing some of the above. The work we are describing has yet to be completed. But its aim is to come up with ways to elucidate the theoretical framework, in which our work is embedded, i.e., teaching as a natural cognition.

Acknowledgments

The empirical part of the present article is based on an MA thesis conducted by Adi Stein and submitted to the Department of Developmental Perspectives in Education at Tel Aviv University in partial requirement for her MA degree. Authors Strauss and Ziv were her thesis guides.

We would like to thank Anna Gavrilov for help in some of the data collection.

This study was conducted in the framework of the Lieselotte Adler Fund for Child Development at Tel Aviv University's School of Education.

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