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"They Danced Around in My Head and I Learned Them": Children's Developing Conceptions of Learning

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Two studies examined how 3–6-year-olds understand the process of learning. In study 1 examined how children spontaneously talk about learning via a CHILDES language analysis. Talk about the learning process increased between the ages of 3–5. Talk specifically about learning in terms of desire decreased during this period. This suggests the possibility that desire is important to children's initial understanding of learning, and children develop an understanding that various mental states including desire, attention, and intention, play a role in the learning process. In Study 2, we presented 4- and 6-year-olds with a set of stories designed to test their understanding of the role of these mental states. In both their judgments about whether someone learns and their justifications of their responses, younger children relied more on the character's desires whereas older children were more likely to integrate desire, attention, and intention together. These data suggest that children's understanding of the process of learning is developing during the early elementary school years.

A great deal of research in cognitive development has considered how children learn. Young children clearly have powerful learning mechanisms (see e.g., Bloom, 2000; Gopnik, Glymour, Sobel, Schulz, Kushnir, & Danks, 2004). How-

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ever, some researchers suggest that young children lack particular metacognitive abilities, which prevent them from reflecting on the process of learning (Dunbar & Klahr, 1989; Kuhn, 1989; Schauble, 1990, 1996; Klahr, 2000; Kuhn & Dean, 2004) or from introspecting in general (e.g., Flavell, Green, & Flavell, 1995). These difficulties do not imply that young children cannot engage in learning; they suggest that young children might not conceptualize the process of learning in the same manner as older children or adults. The goal of this paper is to investigate what young children know about the process of learning: specifically about how, when, and why learning takes place.

This question is especially important given research on children entering elementary school, which suggests that how children understand the process of learning potentially influences their later conceptions of knowledge. This research also suggests that how children understand learning events might affect their general engagement in learning, and ultimately, their academic achievement (Dweck & Leggitt, 1988; Stipek & Mac Iver, 1989; Skinner, 1995; Eccles, Wigfield, & Schiefele, 1998; Dweck, 1999; Li, 2004). What young children know about learning might initially shape how engaged they are by learning as well as their developing concepts of their own or others' intellectual ability or drive. If children's academic engagement is influenced by their understanding of learning, then one might also conceptualize early interventions that foster understanding the fundamental processes that underlie the learning process.

Investigating how children understand the process of learning also potentially relates to children's developing theory of mind. Learning involves the acquisition of knowledge. Several researchers have examined when and how children recognize other's knowledge states. For instance, 3-year-olds understand the difference between knowing and not knowing; they realize that someone who looked inside a container was more likely to know about its contents than another person who did not (e.g., Pratt & Bryant, 1990). However, children's ability to keep track of what they and another person know develops during this time. Wimmer, Hogrefe, and Perner (1988) demonstrated that a 3-year-old with privileged knowledge of the contents of a box would not recognize that another child who lacked this knowledge did not know what is in the box; 5-year-olds did not have this difficulty.

Also developing during this time is children's ability to keep track of their own knowledge states. When shown a deceptive container (e.g., a crayon box that contains candles), 3-year-olds will typically state that they knew candles were in the box all along. By age 5, children claim that they originally thought crayons were in the box, and then update their belief accordingly (Perner, Leekham, & Wimmer, 1987; Gopnik & Astington, 1988). More generally, preschoolers rarely understand where their knowledge comes from or that they have acquired a new piece of knowledge. Taylor, Esbensen, and Bennett (1994) taught preschoolers either a novel or a known piece of information. In both cases, children readily claimed that they had known the piece of knowledge all along (see also Esbensen, Taylor, &

Stoess, 1997). Children continue to develop an understanding of the relation between a person's experience and his/her knowledge states after the age of five. Miller, Hardin, and Montgomery (2003) showed that 6-year-olds overestimate an infant's ability to gather information from the world. Most 6-year-olds claimed that an infant (who could not walk or talk) would know about the hidden contents of a box if the infant was only told about its contents. They could not take the infant's own learning abilities into account.

Taken together, these data suggest that young children might have not an adult-like concept of when and how knowledge is acquired—that is, a concept about the process of learning. Strauss and colleagues indirectly investigated what children know about the learning process by examining their understanding of teaching. In order to understand that someone must be taught, children must realize that there is a gap in knowledge between the teacher and the student (Strauss, 2005). Strauss, Ziv, and Stein (2002) presented young children with two characters—one who knew how to read and one who did not. They found that 3-year-olds would say that a teacher would teach the character with the knowledge gap. These data suggested that children's knowledge of teaching was consistent with their psychological knowledge: Those who were ignorant about a particular topic must be taught. However, this understanding was also related to children's developing theory of mind abilities. In a follow-up experiment, children were told about a teacher who falsely believed a student knew a song, when in fact the student did not. Three-year-olds asserted that the teacher would teach the student to sing the song, relying on the actual knowledge state of the student as opposed to the teacher's knowledge state. Five-year-olds claimed that the teacher would not teach the child.

Strauss et al. (2002; Strauss & Shilony, 1994) argued that teaching is a form of "natural cognition": Children's concepts of teaching were related to their developing folk psychological knowledge. We suspect that children's understanding of learning has a similar conceptualization. Learning appears to be highly interrelated with a variety of other mental states and capacities, and children's understanding of learning should be rooted in children's developing knowledge of the psychological world. Strauss and Shilony (1994), who relied on work by Wellman (1988, 1990), suggested that during the preschool years, children's understanding of learning might be akin to a "copy" theory of mind, in which children believe that "the mind is a container that holds ideas and thoughts, which are passively acquired" (Strauss & Shilony, 1994, p. 457). This view suggests that children recognize that knowledge is acquired—information is "copied" into the mind from the world, but the process by which this occurs is not well-defined. On this view, sometime during early elementary school, children acquire a "homunculus" theory of mind, in which they recognize agents as active interpreters of information. This allows children to integrate new information with already-existent knowledge via a learning process that involves a variety of mental states.

To examine this development in action, consider how children might understand whether another has learned a discrete piece of information (e.g., learning how to sing a song, which will be used as an example in this paper). One piece of knowledge potentially important for understanding the learning process is whether a learner already knows the material. If a teacher were to expose a group of children to a song, a child who already knows the words and music is not learning the song.[1]

In addition, children might consider at least three other aspects of mental state knowledge relevant for the learning process. First, learning should be facilitated by the *desire* to learn. One who wants to learn a song might be more likely to succeed than one who does not. Second, learning seems to involve *attention* to a task. A person who hears and/or pays attention to the words of a song is more likely to learn that song than a person who does not hear or does not pay attention to those words. Third, learning should be aided by the *intention* to learn: Learning is better off when one transforms the desire to learn into an action that helps this process, such as practicing or singing along with a teacher. While these are not the only mental states involved in learning, we suspect that each of these states is important to the learning process.

The goal of this paper is to begin an investigation of children's understanding of the relations among learning and these mental states. Paralleling research in theory of mind (e.g., Wellman, 1990; Bartsch & Wellman, 1995), we hypothesize that children's understanding of the learning process develops from a more immature conception that relies on the learner's desires to one that integrates mental states more closely together. Younger children who have a firm understanding of desire (e.g., Bartsch & Wellman, 1989; Wellman & Woolley, 1990; Repacholi & Gopnik, 1997) might treat learning as a function of one's desires, even when other mental states are in conflict with the possibility that learning occurs. The roles of attention and intention might be more complicated for preschoolers to comprehend. By age four, children do realize the importance of noise-level and interest to paying attention to a particular topic (e.g., Miller & Zalenski, 1982). However, preschoolers have had difficulty articulating an adult-like conception of attentional focus (e.g., Flavell et al., 1995, 1997). As such, we predict that children's understanding of the role of attention in learning might lag behind that of desire.

Similarly, some researchers have suggested that very young children have a sophisticated understanding of intentionality (e.g., Gergeley, Nadasdy, Csibra, &

[1]Intuitions about continuous information (e.g., learning how to play the piano) are a little more difficult. However, we believe this base definition holds. A more expert piano player—one who can sight-read music—would still have to learn new or unfamiliar pieces of music. But one might not say that the same person is learning when they are playing scales. In our empirical investigation, we focused only on learning a discrete piece of knowledge, and suggest that whether children understand learning discrete vs. continuous information differently is a question for future investigation.

Biro, 1995; Woodward, 1998). However, Moses (2001) has suggested that children develop different interrelated aspects of knowledge regarding intentionality and that this early competence is indicative of their understanding only that actions are goal-directed. For instance, infants and toddlers might not understand that an intended action can produce a desired result by accident. This conceptualization develops after the fourth birthday (e.g., Schult, 1998), and might correspond to the hypothesis that children understand that learning is facilitated by actions intended to help the learner (e.g., practice). Further, understanding this aspect of intentions involves integrating several mental states together, an indication that the child has moved to a more representational theory of mind. As such, children's ability to demonstrate this knowledge in making judgments about learning might not emerge until after the preschool years.

STUDY 1

We examined the CHILDES database to gather evidence of children's conceptions of learning in their spontaneous language utterances. We were interested in whether children talked about the process of learning, and if so whether this talk changes over development. Bartsch, Horvath, and Estes (2003) conducted a similar analysis on children's utterances of the words *learn* and *teach*. They analyzed the transcripts of five children, aged approximately 3–7. Their focus was on whether the utterance contained information about what was learned, who did the learning, and where, when, and how learning took place. They found that children most frequently referred to what was being learned and who was learning. Children generally made few references to how, where, or when learning occurred. They also found no indication of any significant developmental changes.

A question we had about the Bartsch et al. (2003) investigation was whether developmental differences do exist in particular subsets of the data they analyzed. In particular, in the present language analysis, we replicated several aspects of this investigation while making certain changes to their preliminary and analytical coding scheme. Instead of analyzing utterances from both children and adults, we only analyzed child data, and focused on utterances that were not elicited by an adult conversation partner nor embedded in the context of scripted play. The goal of these modifications was to produce a set of utterances that reflected how children spontaneously talked about learning. Isolating such spontaneous language might provide further insight into children's conceptions of the learning process. We were interested in whether developmental differences in children's talk about what, how, and where learning occurred existed in this spontaneous talk, as well as whether and at what age children referred to other mental states, like desire, attention, and intentionality in their spontaneous language.

TABLE 1
Collection Procedures for each Child in Study 1

Child	*Contributor*	*Collection Procedure*	*Age Range*
Adam	Brown (1973)	1–2 hr every 2 weeks	2;6 – 4;10
Abe	Kuczaj & Marastos (1975)	1 hr every week until 4;0, ½ hr a week until 5;0	2;6 – 5;0
Sarah	Brown (1973)	½ hr 1–2 times per week	
Mark	MacWhinney (2000)	Multiple episodes every 2–3 weeks	2;6 – 5;11
Ross	MacWhinney (2000)	Multiple episodes every 2–3 weeks	2;6 – 6;0

Method

Database

Five native English-speaking children—the same five analyzed by Bartsch et al. (2003)—provided the conversations analyzed in this study. Transcripts were selected from CHILDES (MacWhinney, 2000), a computerized database of children's speech samples. Because we were interested in children's talk about learning during the preschool period, we focused on data when children (taken from multiple research projects) ranged in age from 2;6 to 6;0. Speech samples were collected in sessions ranging from ½ to 2 hr every 1–3 weeks. All samples were from children's everyday conversations with parents, siblings, and other visitors, and were recorded at home during routine activities. Four of the five participants were first-born; all participants were raised in two-parent families in the United States. Details about these samples are given in Table 1 (for additional descriptions see Brown, 1973; Kuczaj & Marastos, 1975; Kuczaj, 1977; Bartsch & Wellman, 1995; MacWhinney, 2000).

Preliminary coding

We searched the transcripts for utterances that explicitly mentioned learning and teaching. Target words included the primary terms *learn* and *teach*, and words with those roots (e.g., *learned*, *teaching*). A computerized search located every child utterance containing at least one of the target terms. This search revealed 276 utterances—a smaller sample than Bartsch et al. (2003), who considered both child and adult data as well as data from children as old as 7;10. It is important to note that there are relatively few utterances about learning in the corpus.

Before we applied our coding scheme, we excluded a set of utterances from analysis for a variety of reasons. First, we excluded utterances that were made by the child that obviously came from a preexisting script. These examples all involved references to Star Wars in the Ross and Mark corpora (e.g., Ross [3;10]: "You have *learned* much young Skywalker but you are not a Jedi yet."). In these examples, it seems likely that the children were parroting lines from Star Wars as

opposed to talking about the learning process spontaneously. Nineteen of the initial 276 utterances were excluded for this reason. Similarly, some of the uses of the target terms were not about learning/teaching as an action or event, but referred to a person. These utterances involved the word *teacher*, which was used to identify an individual (e.g., Sarah[4;8]: "teacher's always right"). This usage of the word *teacher* was not included in the present analysis, resulting in 134 of the initial 276 utterances being excluded.

Next, we assigned each utterance to one of two mutually exclusive categories: spontaneous or elicited. A spontaneous utterance was one in which the child generated one of the target words without their conversational partner generating it previously in the conversation. Elicited utterances were ones in which the child generated one of the target words in response to their conversational partner generated that word or another target word (often in the form of a question). Only spontaneous utterances were included in the analysis. This is also a difference between our analysis and Bartsch et al. (2003), who included these utterances. We wanted to examine only the utterances that children initiated themselves, since these utterances might reveal more about what young children know about learning. Thirty-two of the remaining utterances were coded as elicited, and were not considered further. Overall, the final sample applied to the coding scheme consisted of 91 utterances.

These exclusion measures were coded by the third author and an undergraduate assistant blind to the hypotheses of the study. Agreement was 99% (Cohen's Kappa = .982). The small number of disagreements was resolved through discussion with the first author.

Coding scheme

The remaining 91 utterances were examined on three dimensions. First, we examined whether each utterance considered the source of learning (i.e., whether the child talked about where and when learning/teaching occurred). Second, we examined whether each utterance reflected the process of learning (i.e., whether the child talked about how learning/teaching occurred). Finally, each utterance was coded as to whether it referred to the content of learning (i.e., whether the child talked about something that was actually learned or taught). These codes were not mutually exclusive, and all utterances reflected at least one of these three concepts. This coding scheme was similar to Bartsch et al. (2003) with one exception. They considered utterances with a particular semantic ambiguity to be members of two categories. Specifically, Bartsch et al. (2003) considered utterances like, Adam [3;9]: "I learned it at home on the TV set," to be an example of where something was learned as well as how something was learned. We only considered this utterance to be about the source of knowledge. Table 2 shows a set of example utterances and how they were coded. The third author and an undergraduate assistant, blind to the experimental hypotheses coded the 91 utterances included in the final analysis. Overall agreement was 90% (Cohen's Kappa = .804). Disagreements

TABLE 2
Sample Source, Process and Content Utterances

Source Utterances
Mark [3;0]: "I learned those bad words from Gabor but I'm not going to say them any more."
Sarah [4;7]: "Where did you learn that lesson?"
Process Utterances
Abe [3;9] "I think they hear their mother and father talk to them and they listen and that's how they learn to talk."
Ross [3;11]: "She must have learned that in a stupid way."
Content Utterances
Ross [3;7]: "Let's teach him some words."
Adam [4;10]: "Hey Mommy, that's a new song that I learned."

Notes. Coding was not mutually exclusive, so an utterance could be in more than one group.

were resolved through discussion with the first author (who was blind to the age of child).

After agreement was reached on the utterances that were given a process code, these utterances were analyzed to determine whether they were about particular processes that we believed were important for learning. In particular, each process utterance was coded for three factors. Utterances given a *Desire* code indicated that the child talked about their own or another's desire in the context of the learning process. For example, Adam[4;6]: "I want to see if he can try it. And learn about nature" was coded as a desire utterance. Such utterances did not necessarily have to include a mental state verb like 'want', and could simply have been about the child's desire to learn a piece of information. For instance, Sarah [3;6]: "Now teach me how to play the game" was also coded as a desire utterance. Since there were so few process utterances, we did not separate the desire codes any further.

Second, process utterances given an *Attention* code indicated that the child is talking about paying attention or exposure to information. Specifically, the child indicated that they or someone else had paid attention or had been exposed to some piece of information in the context of the learning process (e.g., Abe[4;11]: "Momma I taught you how to do that you watched me and you tried to do it right?"). However, calls for the conversation partner to pay attention to the child (e.g., Abe[3;9]: "…Mommy, how do babies learn to talk?") were not indicative of this code.

Third, during this coding process, the coders were also examining these utterances for signs of *intention*—explicit utterances in which the child indicated that he or she or another was trying to learn. Only three such utterances were found in the sample. As a result, this code was not considered further.

Two new research assistants, who were not involved in the previous coding, and who were also blind to the goals of the study and ages of the child when they made the utterances coded these data. Overall agreement was 93% (Cohen's Kappa = .797). Disagreements were resolved through discussion with the first author (who was blind to the age of child).

TABLE 3
Total Number of Utterances in Analysis across Children by Age

	Teach			*Learn*		
	2;6 – 3;11	*4;0 – 6;0*	*Total*	*2;6 – 3;11*	*4;0 – 6;0*	*Total*
Abe	3	5	8	5	3	8
Adam	5	7	12	4	2	6
Mark	5	1	6	5	8	13
Sarah	8	4	12	0	6	6
Ross	0	7	7	0	13	13
Total	21	24	45	14	32	46

Results and Discussion

We divided the 91 utterances into two groups: those made by the children when they were 2.5–3-year-olds, and those made when they were 4–5-year-olds. Table 3 shows the distribution of spontaneous occurrences of *learn* and *teach* from each child.

Overall, children began to produce *learn* and *teach* utterances at roughly the same time (first occurrence of *learn* was approximately 36 months, of *teach* was 41 months). Similarly, children produced equal amounts of *learn* utterances and *teach* utterances (46 vs. 45). Figure 1 shows the three utterance types broken down by source, process, or content information for the two age groups. To increase the number of observations, and therefore the reliability of any statistical tests, we pooled the data across children such that the utterance and not the participant constituted the basic unit of analysis (Bartsch et al. [2003] used a similar strategy).

Children began to refer to the content of learned and taught information as soon as they used the language. Ninety-one percent of the *learn* and *teach* utterances made by 2.5–3-year-olds contained content information. Seventy-nine percent of the utterances made by 4–5 year-olds were also coded in this manner. No significant correlations with age were found.[2] Children talked more about the source of their knowledge and the process of learning, as they grew older. In general, 14% of the *learn/teach* utterances made by 2.5–3-year-olds were about the source of their knowledge, while 57% of the utterances made by 4–5-year-olds were coded in this manner. As the children grew older, their talk about learning tended to be more about

[2]In these analyses (and in the analyses on the process codes for desire and attention below) age (in months) was correlated with whether each utterance was coded as being about the content, source or process of learning. Since utterances and not children were the level of analysis, we first factored out of these correlations a measure of the child's individual variance. These partial correlations are reported in the text. Since the independent variable in these analyses was binary (whether an utterance was coded as content, source, or process, or within the process codes, for desire and attention), we replicated this analysis using a logistic regression (again, factoring out the variance explained by the individual children). The results of these analyses are no different from the results reported in the text.

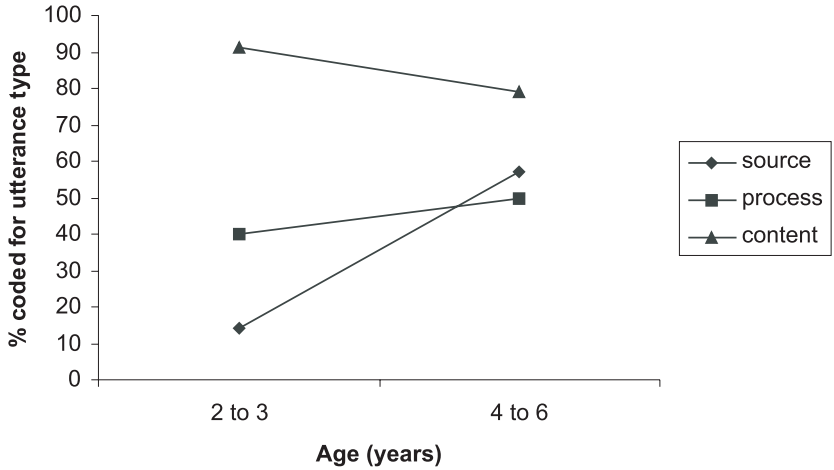

FIGURE 1 Percentage of utterances coded as Source, Process, and Content across children in Study 1.

where the child learned or taught something, $r(85) = .376, p < .001$. Similarly, 40% of the utterances at age 2.5–3 and 50% of the utterances at ages 4–5 contained information about the learning process. As they grew older, children's talk about learning tended to be more about how learning occurred, $r(85) = .290$, $p < .01$.

Nonparametric analyses supported these findings. Chi-squared analysis of the content utterances by age (broken up into the two age groups described above) revealed no difference between the age groups, $\chi^2(1, N = 91) = 2.59$, *ns*. Analyses of source and process utterances by age revealed significant differences between the age groups, $\chi^2(1, N = 91) = 16.39$ and 4.07 respectively, both p-values $< .05$. These results suggest that from the time children begin to talk about learning, they talk about what they learn; between the ages of three and five; children begin to talk more about where and how learning occurs.

We next examined the process utterances in more detail. Twenty-nine percent of these utterances were about desire, and 29% were about attention. Forty-five percent of the process utterances were coded as being about neither desire nor attention (note, these codes were not mutually exclusive). When these codes were examined by age, desire was negatively correlated with age, $r(33) = –0.355$, $p < .05$. In particular, 44% of the process utterances made by the 2.5–3-year-olds involved desire, while only 15% of the process utterances made by the 4–5-year-olds involved desire. No relationship with age was found for the attention code, $r(33) = –0.049$, *ns*.

To summarize, spontaneous utterances about learning and teaching emerged at a relatively early age, but were quite infrequent. Much of this talk was about what

was learned. Young children rarely talked about where or how they learned, but the frequency of these utterances did increase between the ages of 3 and 5. The development of source utterances is unsurprising given that source memory abilities develop significantly during these ages (e.g., Gopnik & Graf, 1988). The development of utterances related to the learning process suggests that young children potentially comprehend the relations among learning and other mental states. The development we observed—that children talked less about their desire to learn or about the relation between learning and desire suggests that desire is important for children's early understanding of learning, and that as children grow, they begin to understand learning in terms of other mental states in addition to desire. Study 2 investigates this possibility.

One difficulty with this conclusion is that we only analyzed explicit utterances about learning—utterances that contained a word with the root *learn* or *teach* in it. There might be other examples of utterances that contain the same meaning (e.g., "show how"), which are not represented in our analysis. We did reexamine the data for this particular utterance, and found that children only used it twice in the transcripts, one of which did appear to be indicative of the learning process.[3] It is possible that children did use other linguistic utterances that demonstrate a greater understanding of learning than observed here.

A more general concern is that children's failure to talk about learning does not indicate that they lack an understanding of the learning process. In Study 2, we examined children's judgments about whether someone is learning to investigate their understanding of the role that desire, intention, and attention plays in learning. The goal of this study was to examine whether children conceptualize learning in a manner that is coherently organized around these mental states, and whether that conception develops between ages 4–6. Specifically, by examining cases where a character's desires conflict with other mental states, we can examine whether young children rely more on desire than these other mental states when making judgments about whether learning takes place.

STUDY 2

We asked children to consider potential learners in a particular environment—learning how to sing a song. We used singing a song instead of other tasks (e.g., learning to ride a bike or learning a mathematical concept) for three reasons. First, children could learn it in a group setting, which permitted us to examine different combinations of mental states while keeping the task constant. Second, a teacher was teaching, which is a prototypical-learning scenario familiar to children. Third, learning to sing a song afforded well-balanced opportunities for desire, attention,

[3]Specifically, Ross(4;4): "It was on that comedy show where they (1)*show* (1)*how* they make all sorts of of cartoons."

and intention to influence the learning process. In contrast, we speculate that learning many physical activities requires more practice than desire or attention, and learning many facts requires more attention than desire or practice. We will consider this issue further in the general discussion.

In each story, 4- and 6-year-olds were asked whether a character would learn given two of those character's mental states, which allowed us to contrast the potential learners' desire, intentional, and attentional states. We chose these age groups because they reflected a sample of children who would be in the middle of the language analysis we considered in Study 1 and a sample of children who would be slightly older than this sample. This experimental design also allowed us to control the frequency of characters that were and were not learning. In some stories, the two mental states of the character were consistent with one another: for example, the character wanted to learn and paid attention or did not want to learn and did not sing along with the teacher (a measure of the intention to learn). Here, answers to the learning question should be clear-cut. The more critical stories involved conflicts of these mental states. For example, would a character that wants to learn the song, but does not pay attention to the song, learn it? If younger children relied on a particular mental state to conceptualize learning, we would expect a developmental difference between the responses of the younger and older children on these stories. Specifically, we hypothesize that younger children might respond based on the character's desires, with less regard for the other mental state of the character.

Method

Participants

The final sample consisted of 24 four-year-olds (13 girls, $M = 56.63$ months, range 47–64 months) and 23 six-year-olds (12 girls, $M = 76.78$ months, range 69–89 months). Six other children (all from the 4-year-old group) were tested, but not included in the final sample. Two did not complete the procedure; two were non-native speakers of English; two were excluded because of experimenter error. All children were recruited from flyers posted at preschools and after-school programs in the Providence, RI area. We did not collect specific data on children's ethnicity, but most of the children were Caucasian.

Materials

Participants were shown ten nondescript pictures of children, and one picture of a teacher singing a song. Each was drawn on 10.2cm 15.2cm index cards mounted on a 12cm 19cm blue cardboard background.

Procedure

Children were tested in the laboratory or at their preschool/day care center by an experimenter with whom they were familiar.. Children were given the following instructions: "Here are some children with their teacher at circle time. They are all sitting in a circle. Teacher is singing a song. She sings this song every day. Let's see what each of them is doing." Children were shown pictures of ten characters and read a story about each, one at a time.

Children were told about two mental states of each character. There were two types of stories: stories in which the mental states consistently suggested the character was or was not learning, and stories in which the mental states were in conflict. We will refer to the first type of story as either *positive consistent* stories or *negative consistent* stories. For example, a positive consistent story (Desire+/Attention+) was about a character who wanted to learn the song and sat next to the teacher and heard the song. A negative consistent story (Desire-/Attention-) was about a character who did not want to learn the song, nor heard it. The other stories—the *inconsistent* stories—were about learners whose mental states were in conflict. For example, one story (Desire+/Attention-) was about a character who wanted to learn the song, but sat on the other side of the classroom and did not hear it.

Since each story presented two out of three mental states, there were six consistent stories: three positive consistent stories in which the character had positive combinations of desire, attention, or intention, and three negative consistent stories in which the characters had negative combinations. There were only four inconsistent stories. It did not seem plausible for a character not to want to learn the song or not to hear the song, but practice it. The ten stories were presented in a random order. The wording of each story is shown in Table 4.

For each story, children were asked two control questions that required them to recapitulate the two mental states that were presented in the story. Children received corrective feedback on these questions if necessary. Then children were asked the test question: whether the character learned how to sing the song. No corrective feedback was provided here. Children were then asked to justify their responses.

Coding. For each story, we recorded whether children responded that each character would learn the song. We also coded the justifications in terms of what response the child gave. This resulted in a seven category coding system: (a) "I don't know" or no response, (b) desire ("she wanted to learn the song"), (c) attention or perception ("she hears the song", "she was paying attention"), (d) intention or actions ("she tries to learn", "she sings along with the teacher"), (e) Other behavioral state ("he was playing with something else"), (f) Other mental state ("because she knows it), and (g) Other irrelevant response ("because it's good.").

TABLE 4
Stories read in Study 2

Mental States Tested	*Consistent or Inconsistent*	*Text*
Desire+ Attention+	Positive Consistent	This is Jenny. Jenny wants to learn the song. She's sitting by the teacher listening. She hears the song.
Desire+ Intention+	Positive Consistent	This is Brian. Brian wants to learn the song. He sings along with the teacher. He sings along with the teacher when teacher sings the song.
Intention+ Attention+	Positive Consistent	This is Amanda. Amanda sits with the teacher listening to the song. She hears the song. She sings along with the teacher when teacher sings the song.
Desire- Attention-	Negative Consistent	This is Andy. Andy does not want to learn the song. He's sitting on the other side of the classroom drawing at the art table. He does not hear the song.
Desire- Intention-	Negative Consistent	This is Thomas. Thomas does not want to learn the song. He does not sing along with the teacher. He never sings along with the teacher when teacher sings the song.
Intention- Attention-	Negative Consistent	This is Charley. Charley is sitting on the other side of the classroom playing with the trucks. He does not hear the song. He never sings along with the teacher when teacher is sings the song.
Desire+ Attention-	Inconsistent	This is Bobby. Bobby wants to learn the song. He's sitting on the other side of the classroom playing with the blocks. He does not hear the song.
Desire- Attention+	Inconsistent	This is Alison. Alison does not want to learn the song. She's sitting by the teacher listening to the song. She hears the song.
Desire+ Intention-	Inconsistent	This is Sally. Sally wants to learn the song. She does not sing along with the teacher. She never sings along with teacher when teacher sings the song.
Intention- Attention+	Inconsistent	This is Kim. Kim sits with the teacher listening to the song. She hears the song. She never sings along with the teacher when teacher is singing the song.

Notes. All stories were followed by two control questions that asked whether the child remembered the two mental states presented in the story. Then children were asked whether each character learned the song and to justify their response.

The data were coded by an undergraduate research assistant, blind to the hypotheses of the experiment. A second research assistant, also blind to the hypotheses coded 160 of the 470 stories (eight children from each age group, or 34% of the data). Neither of these undergraduates were coders in Study 1. Overall agreement was 93%. Disagreements were resolved through discussion with the first author.

Results and Discussion

Children required corrective feedback on 8.7% of the control questions, in which they were asked to recapitulate the character's two mental states. A preliminary chi-squared analysis revealed that on each story the number of control questions children answered incorrectly had no relation to their answer to the learning question. This suggests that children remembered the content of the stories. Table 5 shows responses to the learning questions on the ten stories. These data were first analyzed by a 10 (story) × 2 (age group) mixed Analysis of Variance. Responses among the ten stories differed, $F(9, 405) = 43.22$, $p < .001$. Responses also differed among the two age groups, $F(1, 45) = 4.95$, $p < .05$. A significant interaction between story and age was also found, $F(9, 405) = 2.95$, $p < .005$. Because these analyses were based on categorical data, we performed nonparametric analyses to support these findings. These analyses also demonstrated that responses differed among the ten stories, Cochran's $Q(9) = 200.05$, $p < .001$. This finding held for each age group individually, Cochran's $Q(9) = 88.08$ and 124.41 for the younger and older children respectively, both p-values < .001.

No differences between the age groups were found on the consistent stories except one: When the character did not attend to or intend to learn, the older children were more likely to say that the character did not learn than the younger children,

TABLE 5
Percentage of "Yes" Responses to the Learning Question in Study 2

	Four-year-olds	*Six-year-olds*
Consistent Stories		
Desire+/Attention+	92	91
Desire+/Intention+	100	100
Intention+/Attention+	100	100
Desire-/Attention-	17	4
Desire-/Intention-	29	17
Intention-/Attention-	29	4
Inconsistent Stories		
Desire+/Attention-	58	22
Desire-/Attention+	63	61
Desire+/Intention-	79	39
Intention-/Attention+	42	57

Fisher Exact Test, $p < .05$. Two out of the four inconsistent stories did show age differences. Older children were more likely to say that the character who wanted to learn but did not hear the song would not learn, Fisher Exact Test, $p < .05$. Similarly, older children were more likely to say that the character who wanted to learn but did not sing along with the teacher would not learn, Fisher Exact Test, $p < .01$.

Responses were also compared against chance performance (50%). Positive responses to the positive consistent stories were all significantly greater than chance values, binomial tests (based on z approximations), all p-values < .001. Positive responses to the negative consistent stories were all significantly lower than chance, binomial tests (based on z approximations), all p-values < .001. These findings also held when the data were separated into the two age groups, binomial tests (based on z approximations), all p-values < .01. Responses to each of the four inconsistent stories did not differ from chance levels, binomial tests (based on z approximations), all p-values *ns*. When the age groups were considered individually, 4-year-olds said that the character who wanted to learn but did not practice learned the song more often than chance, binomial test, $p < .01$ and the older children said that the character who wanted to learn but did not attend to the song learned the song less often than chance, binomial test, $p < .05$.

To examine whether children were biased towards making either "yes" or "no" responses throughout the procedure, we also considered individual patterns of responses. No child responded "yes" or "no" to the learning question on all stories. Twenty-two out of the 24 four-year-olds and 21 out of 23 six-year-olds said that the characters in all three positive consistent stories were learning, not a significant difference, $\chi^2(1, N = 47) = .002$, *ns*. In contrast, only 11 out of 24 four-year-olds said that the three characters in the negative consistent stories were not learning (i.e., responded no), compared with 19 of 23 six-year-olds, $\chi^2(1, N = 47) = 6.88$, $p < .01$. This suggests the possibility that the younger children had a bias to respond "yes." However, few children responded "yes" on all four inconsistent stories (five 4-year-olds compared to two six-year-olds, not a significant difference, Fisher's Exact Test, *ns*). This suggests that the 4-year-olds were not simply responding yes. Rather, this suggests that the older children were more accurate in their responses, not that a particular response bias was eliminated with development.

We next examined how children justified these stories. The distribution of justifications to these stories is shown in Table 6. On the consistent stories, there were several cases in which the distribution of justifications differed between the age groups. When desire and intention were consistently positive, the two age groups generated a different distribution of justifications, $\chi^2(4, N = 47) = 12.52$, $p < .05$.[4] The same was true when these mental states were consistently negative, $\chi^2(5, N = 47) = 11.78$, $p < .05$. In both cases, inspection of Table 6 reveals that 4-year-olds

[4]Degrees of Freedom for these analyses were taken from the data. If children generated no response of a particular type, it was not included in the distribution.

TABLE 6
Distribution (Percentage of Responses) of Justifications to Learning Questions in Study 2

Story Type	*IDK*	*Desire*	*Attention*	*Intention*	*Other Mental State*	*Other Behavioral State*	*Other Response*
Desire+/Attention+							
4-year-olds	0	29	21	17	8	25	0
6-year-olds	0	13	57	13	0	17	0
Desire+/Intention+							
4-year-olds	0	33	13	25	8	21	0
6-year-olds	0	9	35	52	0	4	0
Intention+/Attention+							
4-year-olds	0	25	21	29	4	17	4
6-year-olds	0	0	43	39	4	13	0
Desire-/Attention-							
4-year-olds	4	38	29	0	8	21	0
6-year-olds	0	4	52	13	0	30	0
Desire-/Intention-							
4-year-olds	4	46	17	8	8	17	0
6-year-olds	0	13	35	30	0	22	0
Intention-/Attention-							
4-year-olds	0	29	29	13	8	21	0
6-year-olds	0	4	52	13	0	30	0
Desire+/Attention-							
4-year-olds	4	25	33	8	8	21	0
6-year-olds	9	9	56	4	0	22	0
Desire-/Attention+							
4-year-olds	0	38	25	4	8	25	0
6-year-olds	0	22	35	22	0	17	4
Desire+/Intention-							
4-year-olds	4	33	17	13	4	25	4
6-year-olds	0	9	35	39	0	13	4
Intention-/Attention+							
4-year-olds	4	29	25	4	13	25	0
6-year-olds	0	4	49	30	4	9	4

Notes. Responses presented as percentages. IDK = I don't know.

tended to generate more desire justifications, whereas 6-year-olds tended to generate more explanations that appealed to the attentional or intentional states of the characters. When desire and attention were consistently negative, the distribution of justifications also differed between the age groups, $?^2(5, N = 47) = 14.03$, $p < .05$, and when desire and attention were consistently positive, this difference in distributions was marginally significant, $?^2(4, N = 47) = 7.68$, $p = .10$. In both cases, the younger children tended to generate more desire explanations while the older children tended to generate more explanations based on attention.

On the inconsistent stories, only one story showed a reliable difference between the distribution of 4- and 6-year-olds' justifications: when the character heard the song, but did not intend to sing along with the teacher, $?^2(6, N = 47) = 15.46$, $p < .05$. Again, younger children tended to generate desire-based justifications while older children had more justifications based on the character's attentional and intentional states.

Finally we compared the distribution of justifications on the inconsistent stories between children who said the character was learning and who said the character was not learning. These data are shown in Table 7. When the character wanted to learn the song, but did not pay attention to it, the distribution of children's justifications differed between those who said the character learned and those who said the opposite, $?^2(5, N = 47) = 28.00$, $p < .001$. The majority of children who said that the character learned justified their response based on the character's desires, while those who said the character did not learn relied on the character's attentional state, or generated a behavioral response, such as "he's playing at the art table". A similar difference was found for the story in which the character did not want to learn the song, but did hear it, $?^2(5, N = 47) = 22.01$, $p < .005$. Children who said that the character did not learn often justified their response based on the character's desire, whereas those who said the character did learn often relied more on the character's attentional state. In these cases, children whose judgments about learning were based on whether the learner wanted to learn generated more desire-based justifications than children whose judgments were based on other mental states.

Responses to the learning question also indicated different distributions of justifications on the stories in which there was a conflict between practice (i.e., intention) and another mental state. This was true for the story where the character wanted to learn, but did not sing along with the teacher, $?^2(6, N = 47) = 13.83$, $p < .05$. In this case, children who said that the character learned tended to make desire-based justifications, whereas children who said that the character did not learn tended to make intention-based justifications. Similarly, when the character paid attention to the song, but did not practice it, the distributions of responses were significantly different, $?^2(6, N = 47) = 20.37$, $p < .005$. Children who said that the character learned tended to justify their responses based on the attentional state, whereas those who said the character did not learn relied more on the character's desires or intentions.

TABLE 7
Number of Children in Study 2 who Justified Inconsistent Stories in Each Manner Based on How They Responded to the Learning Question

Story Type	*IDK*	*Desire*	*Attention*	*Intention*	*Other Mental State*	*Other Behavioral State*	*Other Response*	*Total*
Desire+/Attention-								
Is learning	3	8	2	1	2	3	0	19
Is not learning	0	0	19	2	0	7	0	28
Desire-/Attention+								
Is learning	0	3	12	2	1	10	1	29
Is not learning	0	11	2	4	1	0	0	18
Desire+/Intention-								
Is learning	1	8	8	2	1	7	1	28
Is not learning	0	2	4	10	0	2	1	19
Intention-/Attention+								
Is learning	1	1	12	0	3	6	1	24
Is not learning	0	7	5	8	1	2	0	23

Notes. IDK = I don't know.

These data suggest that young children's understanding of learning relies on knowledge about a person's desire to learn, and develops from this conception to a more sophisticated understanding based on an interaction among a set of mental states. Responses and justifications to the learning questions revealed different patterns of performance on the two types of stories. When a character's mental states consistently indicated he/she would or would not learn, children showed relatively few developmental differences in their responses to the learning questions, and responded correctly above chance levels. Younger children tended to justify these responses in terms of the character's desire, whereas older children relied on other mental states mentioned in the stories – attention and intention. When the stories presented characters with conflicts between the mental states, more developmental differences in response to whether learning occurred were observed between 4- and 6-year-olds. Further, those children who claimed that learning would take place mostly relied on the character's desires as a justification. Children who claimed that learning would not take place tended to justify their response in terms of the characters' other mental states. This difference is particularly interesting on the story in which the character's attention and intentions conflicted and desire was not mentioned. Children who responded that the character would not learn justified their response almost as often on the character's desires as they did the character's intentions. This is also important on the consistent stories in which desire is never mentioned, but where the younger children appealed to the character's desire to justify their response.

GENERAL DISCUSSION

In order for children to understand whether learning is taking place, they must bring together their understanding of knowledge with their understanding of other mental states. Children's initial comprehension of learning appears related to a learner's desires. Children at the youngest ages in the language analysis generated desire-based process utterances, but such utterances became less frequent with age. In the experiment, children understood that all other things being equal, those who wanted to learn were more likely to do so than those who did not. These data suggest that children's early conceptualization of learning is "desire-based", paralleling other findings in theory of mind (e.g., Bartsch & Wellman, 1989; Wellman, 1990).

This conceptualization appears to change between the ages of 4 and 6. The amount of spontaneous language children produced that concerned the process of learning increased with age. When asked to explain stories in which characters' mental states consistently indicated that they were or were not learning, most 4-year-olds responded based on the character's desire—even in cases in which the character's desire was not explicitly mentioned. Older children often indicated different mental states. Finally, when the character had the desire to learn, but lacked another mental state also critical to learning, more 4-year-olds than older children

stated that the character would learn, and referred to the character's desires in their justification. These data suggest that children come to recognize the importance of mental states other than desire for learning during the early elementary school years.

These data suggest that children's developing conception of learning moves from a "desire-psychology" to a psychological conception that integrates mental states more broadly. Paralleling Strauss and Shilony (1994), these data are also consistent with the movement from a "copy"-oriented conception of mind to a more "homunculus"-oriented conception, in which the learner becomes a more active participant in the learning process. In particular, younger children appeared to rely mainly on the learner's desires to indicate whether information was acquired, while older children relied less on this one principle, and were more likely to integrate information together.

That said we wish to discuss a set of limitations with the present study, which also suggest a variety of new empirical investigations. First, the present work only investigates learning one particular piece of information (how to sing a song). We reexamined the language analysis, specifically the utterances that were given a content label, and found that children's talk about learning motor skills did not differ from their talk about learning mental skills: Children generated similar numbers of utterances about learning a motor skill (e.g., how to swim) as learning a mental skill (e.g., how to read). However, this does not examine whether children's understanding of learning generalizes across different types of knowledge. Do children conceptualize how one learns to sing a song the same way as how one learns to tie shoes or read a book? It is important to investigate whether children see learning as a general process or whether children believe that different mental states and capacities are involved for different types of skills or facts being learned (see Esbensen et al., 1997, for a discussion of this issue).

Also, we have not examined every aspect of learning that might be relevant to developing theory of mind. For example, an important conception of the learning process is whether learning required a teacher. The present research also provided no direct account of "incidental" learning. We used the song-learning example because it is possible that one could imagine learning a song without desire, intention, or even conscious attention (e.g., one often learns radio jingles without any of these mental states). However, no child generated a reference to any kind of learning in this manner. An examination of even older children and adults might reveal an emerging concept of exposure to a stimulus as necessary for learning whereas explicit attention, in contrast, might only facilitate learning. Again, this might also differ when a learner is learning a song as opposed to a physical skill or mental fact.

More generally, what is the relation between children's developing concepts of learning and their metacognitive awareness? Researchers in education, especially science education, have suggested that 4–7-year-olds lack particular metacognitive abilities that prevent them from engaging in hypothesis testing and other kinds of scientific reasoning (e.g., Kuhn, 1989). In the present experiments, children could explain learning events at early ages. These explanation abilities seemed guided by

some understanding of the learning processes. It is possible that other measures of mental state understanding would correlate with children's emerging conceptions of the learning process. Similarly, a question for future research is whether there is any connection between children's developing conceptions of learning and their actual learning abilities. Do children who recognize the importance of the various mental states and capacities use that knowledge to learn or to teach (e.g., in research by Strauss's et al. [2002])? If so, how is this carried out? Are these children genuinely better learners, or more motivated to learn? Are they more motivated to learn? The present investigation cannot answer these questions directly, but does offer a framework to begin addressing them and other related issues.

The present research also opens the possibility that children in different cultures may develop differential sensitivity to different elements of learning. We have limited our sample to European-American children, but there is little reason to believe that children's conceptions of learning are free of cultural influences. Research by Li (2004) has shown that while European-American kindergartners show a stronger sensitivity to learning as a task that involves the mind (e.g., ability and strategy use), their Chinese peers showed a stronger sensitivity to the learner's personal dispositions (e.g., diligence and concentration). Due to socialization differences, Chinese children may recognize the importance of intention and related action such as practice and effort earlier. In contrast, European-American children may appreciate the importance of mental capacities like how much and how fast one can learn earlier. This is a clear topic for further investigation.

To conclude, what we have shown is that preschool children's understanding of the learning process is not randomly construed, but potentially organized around a particular mental state (i.e., desire). This parallels aspects of children's theory of mind developing, specifically the notion that they are "desire psychologists" in the way in which they interpret behavior (Wellman, 1990). As children move into the early elementary-school years, this conception appears less desire-based, and more integrative among a variety of mental states. Children appear to also understand the importance of one's attentional focus and intentional stance when making judgments about whether people are learning. This development also parallels children's developing knowledge of intention and attention as mental states (e.g., Flavell et al., 1995; Schult, 2002). Finally, what this investigation does is present a novel framework for examining children's conceptions of the learning process, which in turn may be used to address many of the open questions we have described.

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