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Young Children's Knowledge of the Representational Function of Pictorial Symbols: Development Across the Preschool Years in Three Cultures

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Three- to 5-year-old children's knowledge that pictures have a representational function for others was investigated using a pictorial false-belief task. In Study 1, children passed the task at around 4 years old, and performance was correlated with standard false-belief and pictorial symbol tasks. In Study 2, the performance of children from two cultural settings who had very little exposure to pictures during the first 3 years (Peru, India) was contrasted with that of children from Canada. Performance was better in the Canadian than Peruvian and Indian samples on the picture false-belief task and drawing tasks but not on the standard false-belief measure. In all settings, children passed drawing and standard false-belief tasks either concurrently with, or prior to, passing the picture false-belief task. The findings suggest that children's explicit knowledge of the representational function of pictorial symbols matures in the late preschool years and develops more rapidly in cultures that strongly promote the symbolic use of pictures early in life.

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Infants are immersed in the symbolic systems of their cultures from an early age, in some symbolic domains as early as birth (e.g., infant-directed language). However, a fully mature understanding of the shared representational function of symbols may take some time to develop (Callaghan, 2008; Nelson, 2006, 2007; Rochat & Callaghan, 2005; Tomasello, 1999, 2008). Researchers from a range of theoretical perspectives have proposed a developmental shift from lesser to fuller symbolic functioning during the preschool years. The terminology may change, but the basic idea of a move toward reflective understanding of the representational process is similar across the domains of language (e.g., referential vs. representational knowledge; Nelson, 2007; Nelson & Kessler-Shaw, 2002), pretense (e.g., situational to mentalistic interpretations of pretend; Jarrold, Mansergh, & Whiting, 2010), thought (e.g., conscious or reflective awareness of the representational function; Carlson & Zelazo, 2008; Zelazo, 2004), and communication in general (e.g., motive to share a communicative intention; Tomasello, Carpenter, Call, Behne, & Moll, 2005). In the current studies, the development of an explicit understanding of the representational function of pictorial symbols was explored. To assess the role of cultural supports in the development of this representational knowledge, two cultural contexts that varied in the extent to which young children were exposed to pictorial symbols were included.

Representational Understanding of Pictorial Symbols

A developmental shift in understanding is evident in research with pictorial symbols, where vastly different age estimates of the onset of representational understanding of pictorial symbols are reported. Research using picture-supported word-learning paradigms with novel objects estimates that representational understanding emerges by 15 months (Ganea, Allen, Butler, Carey, & DeLoache, 2009; Ganea, Pickard, & DeLoache, 2008; Preissler & Bloom, 2007; Preissler & Carey, 2004). Relatively early estimates of representational understanding are also found with imitation tasks. When an experimenter narrated the actions, 13-month-olds (Keates, 2010) and 18-month-olds (Simcock & DeLoache, 2006; Simcock & Dooley, 2007) imitated those actions from a series of color photographs. In contrast, research involving the use of pictorial symbols to search for depicted objects suggests that important components of representational understanding develop somewhat later. For example, knowledge that a picture is both a representation of something and an interesting object in its own right (i.e., dual representation) is not evident until around 30 months in search tasks (DeLoache, 1991, 2002; DeLoache & Burns, 1994; Preissler & Bloom, 2007).

In addition to these task differences, two factors appear to influence the relative success of infants and young children across pictorial symbol tasks. The redundant use of language to label pictures and greater perceptual similarity between pictorial symbols and their referents both lower the age at which children pass the tasks (for object search tasks, see Callaghan, 1999, 2000; Callaghan & Rankin, 2002; Pierroutsakos & DeLoache, 2003; for word-learning and imitation tasks, see Ganea et al., 2009; Simcock & DeLoache, 2006). In summary, pictorial symbol research suggests that appreciation of the representational relation between a picture and its referent may be dawning relatively early in life, particularly in situations where it is possible to bootstrap onto an existing (linguistic) symbol system, but representational understanding undergoes further development throughout childhood.

Discrepancies in estimates of the age of onset of pictorial representational understanding and a desire to formulate a developmental framework for this understanding motivated the present studies. Clearly, discrepancies in estimating when infants attain representational insight could stem from differences in task demands. In particular, it is difficult to assess in most pictorial symbol tasks whether the infant or child possesses knowledge that pictures have a representational function or they are bootstrapping their performance with language or perceptual matching abilities. However, the discrepancies may also reflect differences in researchers' conceptualizations of representational insight and understanding. Researchers need to identify precisely what children understand about pictorial symbols at various points along the developmental trajectory. Symbolic development ranges from an implicit, action-based understanding in early infancy (i.e., mimesis) to an explicit, conceptual understanding of representation in the late preschool years.

Our primary aim in the current studies was to investigate development of the explicit understanding that pictorial symbols have a representational function. Based on the standard false-belief task (Wimmer & Perner, 1983), designed to assess metaknowledge of beliefs as mental representations of reality (Perner, 1991), we developed the picture false-belief task, designed to measure children's metaknowledge (i.e., explicit understanding) of pictures as representations of reality. In the pictorial version of the task, children sorted two types of toys into two identical boxes with an experimenter (E1). E1 highlighted her favorite toys and then drew and posted a simple line drawing on each of the boxes to indicate their contents before leaving the room. When E1 was out of the room, a second experimenter (E2) asked children if they wanted to play a trick and then switched the pictures. Children passed the task when they correctly predicted that E1 would look in the (wrong) box that had the picture of her favorite toys on the front. To succeed on the picture false-belief task, two processes must be invoked. Children must understand that they and others use pictures as representations (i.e., explicit knowledge of the shared representational function), and they must understand what the consequences will be when E1 holds a false belief (i.e., false-belief understanding).

Pictures and False-Belief Understanding

Standard verbal tests of false-belief understanding employ either a change of contents (Smarties task; Perner, Leekham, & Wimmer, 1987) or a change of location (Maxi chocolate task; Wimmer & Perner, 1983) as a means of setting up the false-belief scenario. In the Smarties task, children are shown the box depicting the contents on the label but for which the contents have been deceptively switched and are asked what they think is inside. Once they are shown the true contents of the box (e.g., pencils), children have to predict what another person will think is inside the box. Children typically pass this task between 4 and 5 years old (see meta-analysis by Wellman, Cross, & Watson, 2001), but 3-year-olds pass the task when they are actively engaged in switching the contents (Sullivan & Winner, 1993) and when language terms more explicitly mark the timing referred to in the test question (e.g., "before I take the top off"; Lewis & Osborne, 1990). Without these supports, individual performance on the Smarties task typically lags behind that on a standard change-of-location (Sally-Anne) task (Krachun, Carpenter, Call, & Tomasello, 2010).

False-belief understanding has also been measured using deceptive markers in versions of the change-of-location task (Wimmer & Perner, 1983). Chandler and colleagues (Chandler, Fritz, & Hala, 1989; Hala, Chandler, & Fritz, 1991) trained children to deceive an experimenter by using inky footprints that led away from a hiding place (one of five upturned buckets) where a reward was to be found. Even 3-year-olds in this study effectively deceived the experimenter by erasing footprints that led to the hiding place or by adding misleading footprints that led away from the hiding place (see Sodian, Taylor, Harris, & Perner, 1991, for an alternative view). Carlson, Moses, and Hix (1998) also trained children to deceive an experimenter, either by pointing to the wrong container or by placing a marker on the wrong container. Three-year-olds were able to deceive the experimenter with the marker (e.g., green circle to denote green ball), but not by pointing. In a related study, Couillard and Woodward (1999) showed that when responding to cues given by others, 3-year-olds more easily interpret the deceptive markers (a nonrepresentational yellow disk) compared with the deceptive points of others. In both studies, children's greater experience with using points compared with markers to indicate the true location of objects was invoked to explain the relative difficulty of deceptive pointing. It is more difficult to inhibit pointing to the correct location than to inhibit marking the correct location. In contrast to the relatively early use of deceptive markers in these studies, 3-year-olds failed, but 4-year-olds passed a false-belief location task when arrows indicating the location of a hidden truck were changed to misinform about location (Parkin & Perner, 1996, as cited in Perner & Leekham, 2008; Sabbagh, Moses, & Shiverick, 2006). Differences across the tasks in demands, language usage, and type of markers make it difficult to interpret discrepancies in the ages at which children are reported to pass the marker tasks.

In most of these studies, the markers (i.e., inky footprints, yellow disks, and arrows) are signs that point to a location, rather than symbols that represent the contents. Failure on the deceptive marker tasks may be due to a general process-based inability to read markers as representations, or to a problem with reading the meaning of the particular markers that were used. Children's conceptualizations of the function of markers are also difficult to discern from the one task previously mentioned that employed simple representational drawings to miscue location (Carlson et al., 1998). When a green circle was put on one of two distinct boxes to indicate the location of a ball in Carlson et al., (1998), children could have used a variety of cues to location to answer the test questions, without comprehending the symbolic function of the cue at all. The boxes were distinct, and those distinct properties may have cued location of the toy (e.g., look in the red box). The presence of a paper on one but not the other box, regardless of what was on the paper, could have signaled the location (e.g., go to the marked box). Finally, the actual spatial position of the container hiding the toy, which was not altered, was a redundant cue to the location of the toy (e.g., go to the left).

To control for these potential confounds, children's knowledge of the representational function of pictures must be investigated in a task where they cannot use the picture as a simple marker of where to look but rather have to use it as a symbol of the contents of the box. Having distinct pictures symbolizing the contents in two otherwise identical boxes accomplishes this in the pictorial version of the false-belief location task developed for the current study. Given the success that children as young as 3 years old have with pictorial symbols in search tasks, we reasoned that using representational pictures within the false-belief location task could identify when children have more explicit metaknowledge of the symbolic function of pictures—specifically, the knowledge that pictures are conventionally used to represent and that they can be misused to deceive another person. If children are able to make this inference, it is presumed that they have explicit knowledge of the representational function of pictures.

Representational Development Across Cultures

One of the interpretive problems with the picture false-belief task comes with interpreting failures: If children pass, they must understand the shared representational function of pictures and the consequences of holding false beliefs; however, if they fail it is not clear why they fail. Do they lack meta-knowledge of pictures or beliefs, or both? Cultural comparisons utilizing a multitask approach offer a unique opportunity to disambiguate the causes of failure.

Callaghan et al. (2011) examined the onset of social cognitive precursors thought to underlie symbolic functioning (e.g., imitation, joint attention, perspective taking, helping, and cooperation) and examined symbolic functioning itself (pictorial, pretense) across three cultural settings (villages in India, Peru, and Canada). Within these cultures, children had either very minimal (India, Peru) or extensive (Canada) exposure to these symbolic systems early in their lives. The authors reported synchrony across the three cultural contexts in the onset of the social-cognitive precursors to symbolic functioning. However, there was more rapid development of symbolic competence in the Canadian setting, where children were heavily immersed in pictorial and pretense symbol systems early in life. Training studies have also demonstrated that exposure and engagement in symbolic systems are linked to competence in pictorial symbol systems (Callaghan & Rankin, 2002).

Children who have received little exposure to pictures in their early environments will have had less opportunity to learn the cultural conventions for those symbols and will therefore be less likely to possess explicit understanding of the representational function. It was argued that delayed pictorial and pretense competence reported in Callaghan et al. (2011) was due to lesser cultural support for those symbol systems. Other evidence exists to suggest that lower levels of performance were not due to generally lower levels of representational abilities across the three cultural settings. When children were actively involved in the deception for a false-belief location task (Avis & Harris, 1991; Callaghan et al., 2005), they passed between 4 to 5 years across a wide variety of cultural settings (Baka, Samoa, Canada, Peru, Thailand, India). Although these cross-cultural studies separately examined general representational abilities (Callaghan et al., 2005) and pictorial symbolic capacity (Callaghan et al., 2011), they did not provide information on how the two processes may be interrelated. Thus, in the second study, we investigated the development of both pictorial competence and false-belief understanding across cultures that varied in early exposure to pictorial symbols. Support for the view that the picture false-belief task measures explicit understanding of the representational function of pictures in addition to general false-belief understanding will come from the finding that children who do not have exposure to pictorial symbol systems early in life pass standard false-belief location tasks but fail the picture false-belief task.

Summary of the Current Studies

To examine the dual-process account of the picture false-belief task, we contrasted performance on the picture false-belief task with that on the standard false-belief and pictorial competence tasks in Study 1. To assess developmental trends, we included children aged between 3 and 5 years old, the typical age range used for investigations of the developmental shift in representational ability. To demonstrate that the picture false-belief task did indeed require explicit knowledge of the representational function of pictures, we compared patterns of performance across cultural settings that varied in exposure to pictorial symbols early in life in Study 2. The rationale was that for cultural settings with little exposure to pictures, children's understanding of the representational function of pictures would be delayed and would manifest in poor performance on the pictorial, but not on the standard, false-belief tasks.

STUDY 1

Study 1 provides a baseline of performance on the picture false-belief task for children aged 3 to 5 years old and compares performance across a battery of representational tasks. Simple line drawings similar to those used successfully by 3-year-olds in previous picture–object matching and search tasks (Callaghan, 2000; Callaghan & Rankin, 2002; DeLoache & Burns, 1994) were used to indicate the contents of two identical boxes for the picture false-belief task. False contents and false-belief location tasks provided standard measures of false-belief understanding, were presented within scenarios where the experimenter and child actively participated in deception, and are typically passed when children are aged 4 to 5 years old. To obtain a broadly based measure of symbolic understanding and production abilities, three tasks assessed pictorial competence. In the picture–object matching task, children chose the object that matched the picture in a two-choice test. Both choice objects had the same verbal label to eliminate language supports. In the picture-sorting task, children were asked to put away two types of toys into one of two boxes that were labeled with generic exemplars of the toy types but were otherwise identical. The drawing task asked children to make drawings of objects that could be represented using circles, lines, or a combination of both. Children typically pass the picture–object matching and picture-sorting tasks before 3 years old and the drawing task close to 4 years of age. When children use pictures to facilitate searches and sorting, there is no evidence that the tasks require explicit understanding that pictures function as representations in a shared symbol system. Even when they produce a drawing, children's explicit understanding of the shared nature of the representational function is not guaranteed, although it may be tenuously at hand. Children often make ambiguous drawings (e.g., a simple circle to depict a ball, a maraca, and a dumbbell), suggesting that they do not have "others in mind" even when they have productive capacity. The other can be brought to mind by confronting children with the ambiguity inherent in their drawings. Five-year-olds but not 4-year-olds improved their depictions of people when adults could not distinguish gender (Sitton & Light, 1992), and even 3-year-olds can disambiguate their drawings of simpler objects when adults indicate they cannot tell what was represented (Callaghan, 1999, Study 3). We expected that performance on the picture false-belief task would be related to false-belief reasoning, as measured in the standard false-belief tasks, as well as to pictorial competence, as measured in the three pictorial symbol tasks.

Method

Participants

A total of 37 children aged 2.5 to 5 years old participated in this study. All were recruited from day cares through letters to parents. Participants included: 3-year-olds (seven girls, six boys; $M_{age} = 3;5$; age range = 2;8–3;9), 4-year-olds (six girls, six boys; $M_{age} = 4;3$; age range = 3;11–4;9), and 5-year-olds (six girls, six boys; $M_{age} = 5;4$; age range = 4;11–5;9). Owing to the demographics of the Canadian rural community, the sample was predominantly Caucasian and middle class.

Stimuli

For the picture false-belief task, materials included two sets of plastic replica toys (cars and dishes), two identical photo boxes (32 cm $\times$ 16 cm $\times$ 16 cm), and Post-It notes (7.5 cm $\times$ 7.5 cm). Post-It notes were used because they could easily be placed on the fronts of the boxes by the experimenter once she made the drawings. For the sorting task, two additional sets of plastic replica toys (snakes, bugs), two Ziploc bags, and two additional photo boxes having predrawn line drawings of a snake or a bug affixed to the front were used. For the picture–object matching task, laminated black-and-white perspective drawings of four replica toys (two trucks, two cats) with the corresponding replica toys were used. In the drawing task, children were presented with four items that could be drawn using the components of circles and lines (ball, stick, maraca, jingle bell wrist strap). The false contents task employed a Crayola crayon box containing wooden clothespins, and the false-belief location task involved a replica tractor toy and two differently colored upturned bowls as potential hiding locations.

Procedure

All children participated in all six tasks (picture false-belief, false contents, false location, picture-sorting, picture–object matching, drawing) in a single 20-minute session. Half of the children started the session with the picture false-belief task, and the remainder ended the session with this task. The remaining tasks alternated between pictorial and false-belief tasks in the following order: picture–object matching, false-belief location, picture-sorting, false contents, and drawing. Preliminary analyses indicated that the order of presenting the picture false-belief task (first vs. last) did not influence the tendency to pass the task (Fisher's exact probability, 2-tailed =.54). Order of tasks was not considered in subsequent analyses. Two experimenters were involved in testing. E1 was the main facilitator of testing and conducted the picture–sorting, picture–object match, and drawing tests. E1 was also tricked on the picture false-belief and false contents tasks. E2 entered responses on the score sheets, was tricked for the false-belief location task, and served as the trickster for the picture false-belief and false contents tasks.

Picture false-belief task. Both sets of toys were presented to children during free play, and two identical containers were used to sort the toys following play. Generic line drawings of a prototype of each type of toy were drawn on Post-It notes, which served as pictorial symbols on the fronts of containers. For all trials, E1 sat beside the child and served as the play partner, made the drawings to label boxes, and was tricked on false-belief trials. E2 sat opposite and presented stimuli, engaged children in the trickery, and asked test questions. In free play, E1 played with the child and remarked on the toys, while encouraging but not directing play during this period. After approximately 2 minutes, E2 placed two identical boxes on the table and suggested that they put the toys away for now so they could play another game and added that they could play with them later. Holding up one exemplar from each set (e.g., one of the dishes or cars) in turn, she said, "Can you put all the toys like this one in this box (placing the exemplar from the first set in one box), and all the toys like this one in this box (placing the exemplar from the second set in the other box)?" Children then placed the remaining items in the appropriate boxes. E1 then picked up one set of toys and emphasized her preference and intention to play with those toys as soon as she returned from an errand. Following this, she said to the child, "Hey I have a good idea. Watch this!" while she drew and then placed a generic line drawing representing the contents on the front of each of the two boxes in turn. Once the Post-It notes were affixed to the appropriate boxes, E1 tilted the boxes so that children could see the contents and the picture before the tops were placed on the boxes. E1 then left the room, saying, "We'll play with my favorite toys when I get back." E2 moved the boxes to one side and stacked them on top of each other to destroy absolute and relative location cues and to encourage a focus on the picture as a cue to toy location. She then asked the child to indicate where E1's favorite toys were, pushing the boxes within reach of the child. Then, she asked if the child wanted to play a trick on E1. Once children indicated that they wanted to trick E1, E2 switched the pictures from one box to another. Following the switch, she asked the child the false-belief and control questions (i.e., "Where will Bethany look for her toys when she comes back?" and "Where are Bethany's favorite toys really?"). Children were encouraged to point to the appropriate box in answer to these questions. To pass the task, children had to indicate that E1 would look in the wrong box (i.e., in the box having the picture of E1's favorite toys) and correctly answer the control questions. When E1 reentered the room she reached in the general direction of the boxes and asked the child to pass her the box with her favorite toys.

False contents task. With E1 out of the room, E2 held up the crayon box, shook it, and asked the child, "What's in this box?" When the child replied, E2 handed over the box and asked the child to look inside. Once the child had seen the contents, E2 asked what was really inside and then held it closed in front of the child and asked the test question (i.e., "When Bethany comes back and we show it to her, what will she think is in the box?") and the control questions (i.e., "What is really inside?"; "When you first saw the box, what did you think was inside?"). Children passed the task when they predicted that E1 would think there were crayons in the box and they correctly answered the control questions.

False-belief location task. The roles of the experimenters (tricked vs. trickster) were switched relative to the false contents and false-belief picture tasks. Children interacted with E2, who showed them the toy, played with the child and toy for a few minutes, and then said she was going to leave for a short errand. Before leaving, she indicated that she would put the toy under the bowl until she came back in the room to play with it. When she left the room, E1 asked the child where E2's favorite toy was and whether the child wanted to play a trick. When children indicated they wanted to trick E2, E1 switched the location of the toy and then asked the child to show her where E2 would look for her toy when she returned. Finally, she asked where the toy really was. Children passed the task when they pointed to the location where E2 had left the toy in answer to the test question and when they correctly answered the control questions.

Picture-sorting task. After playing for a few minutes with two intermingled sets of toys, E1 asked the child to put all the toys of one type into one Ziploc bag and all the toys of the second type into another bag. Then two boxes with the lids in place, each having a generic line drawing on the front (snake or frog), were centered on the table in front of the child. E1 held up one bag at a time, centered over the covered boxes, and asked the child which box they should put the toys in. Once chosen, the child was asked to put the toys into the box and replace the cover. Then the second bag was held up and the question repeated. All but one of the children performed perfectly on this task and placed the toys in the boxes according to the label on the front. This suggests that children in the age range of this study consider pictorial labels on the front of otherwise identical boxes to be informative about the contents of the boxes. However, because performance was at ceiling, these data were not analyzed further.

Picture–object match task. Children were presented with a realistic line drawing of an object for 4 seconds and were then asked to find the object that was depicted from a choice of two objects. E1 held the picture up while she pointed to the depicted object and asked the child to "find me the one from this picture." As soon as the picture was removed, the two choice objects were pushed toward the child. These two objects were perceptually distinct, but had the same verbal label (i.e., two trucks or two cats). Thus, children had to make their choices on the basis of the pictorial, rather than the verbal, symbol. There were four trials for this task.

Drawing task. For the drawing task, E1 held up one of the four objects at a time and asked the child to make a drawing of the item while she held it for them to see. All of the four objects (ball, stick, wrist strap with bells, and maraca) could be drawn with the components of circles and lines. Drawings were scored by a coder who was told what the four possible objects were and who asked the children to indicate for each picture the object that it represented. Children were given 1 point for each drawing the coder could correctly identify. If a child's drawing did not represent any of the objects, or if all drawings were indistinguishable (e.g., all circles), the child was given a score of 0.

Interrater Reliability

The entire session was videotaped to allow for reliability coding of 25% of the participants' responses by an assistant naïve to the hypotheses of the study. There was 100% agreement in the scoring for all tasks.

Results

There were two main questions addressed in the analyses for Study 1. First, we assessed developmental trends in children's performance on individual tasks. Second, we examined the relation between picture false-belief and standard false-belief tasks and between picture false-belief and pictorial symbol tasks.

Individual Tasks

Although we analyzed performance on the tasks separately, we present data for standard and pictorial false-belief tasks in the same graphs for ease of comparison. All false-belief tasks were scored as a pass/fail according to whether children correctly predicted that the experimenter would err (i.e., hold a false belief) after deception.

Picture false-belief task. The mean proportion of children passing each of the false-belief tasks in the three age groups is given in Figure 1. To assess

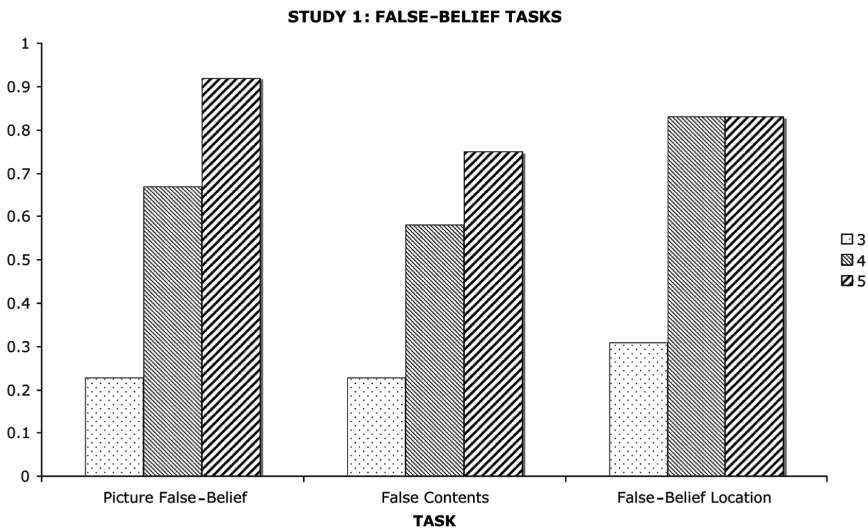

FIGURE 1 Proportion of children passing the picture false-belief, false contents, and false-belief location tasks across three ages in Study 1.

age effects on the picture false-belief task, Fisher's exact probabilities were calculated and indicated that 3-year-olds were less likely to pass the picture false-belief task compared with 4- and 5-year-olds, whereas the older groups did not differ from each other (Fisher's exact probabilities =.04, .16, and .001, for the contrasts of 3 vs. 4 years, 4 vs. 5 years, and 3 vs. 5 years, respectively).

Although passing the picture false-belief task was determined by where children pointed when asked the false-belief test question, we noticed that older children tended to "double trick" the experimenter. When the experimenter returned and asked the child to pass her favorite toys, children often gave the experimenter the box with the correct picture but wrong toys (laughing heartily when the experimenter opened the box). "Double tricking" was subsequently coded for all children, and age effects were evident. Three-year-olds rarely ($M_{\text{proportion}} = 0.08$) engaged in "double tricking," half of the 4-year-olds ($M_{\text{proportion}} = 0.50$) tricked the experimenter in this way, and all but one of the 5-year-olds ($M_{\text{proportion}} = 0.92$) "double tricked" (Fisher's exact probabilities =.03, .03, and .0001, for the contrasts of 3 vs. 4 years, 4 vs. 5 years, and 3 vs. 5 years, respectively).

False contents task. As with the picture false-belief task, responses were coded as pass/fail, and the mean proportions of children passing the task are given in Figure 1. Three-year-olds were less likely to pass the false contents task compared with 4- and 5-year-olds, who were equally likely to pass (Fisher's exact probabilities =.08, .33, and .01, for the contrasts of 3 vs. 4 years, 4 vs. 5 years, and 3 vs. 5 years, respectively).

False-belief location task. As with the other false-belief tasks, responses were coded as pass/fail, and the mean proportions of children passing the task are given in Figure 1. Three-year-olds were less likely to pass the false contents task compared with 4- and 5-year-olds, who did not differ (Fisher's exact probabilities =.01, .70, and .01, for the contrasts of 3 vs. 4 years, 4 vs. 5 years, and 3 vs. 5 years, respectively).

Picture–object matching task. The mean proportions correct for the pictorial symbol tasks (picture–object matching and drawing) are found in Figure 2. Performance on the picture–object matching task was examined by a one-way analysis of variance (ANOVA) of age (3, 4, or 5 years) on the number of correct choices out of four. The ANOVA determined that there was no significant age effect, $F(2,34) = 0.10$, *ns*. Performance was high at all ages.

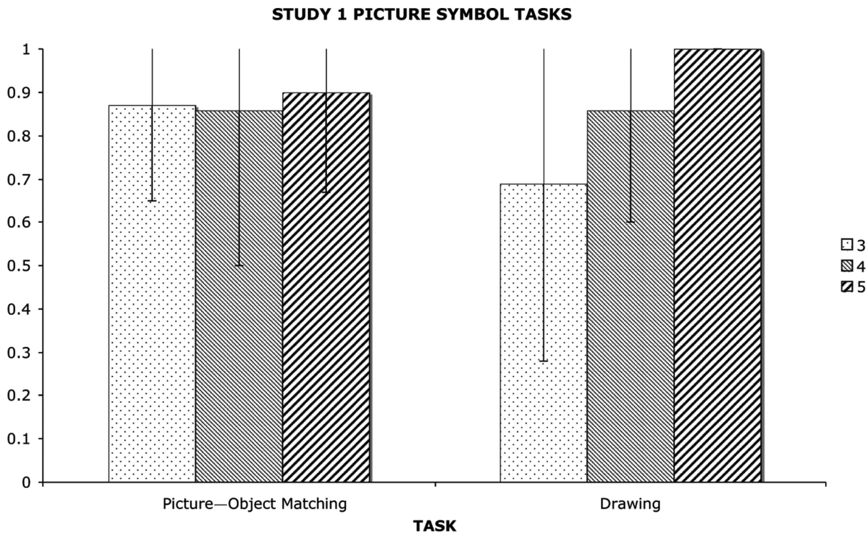

FIGURE 2 Mean proportion of trials passed on picture–object matching tasks and mean proportion of representational drawings made on the drawing task of Study 1.

Drawing task. Performance on the drawing task was examined by conducting a one-way ANOVA of age (3, 4, and 5 years) on the number of representational drawings produced by the child (total possible = 4). The ANOVA revealed a significant effect of age for this task, $F(2, 34) = 4.51$, $p < .02$. Post-hoc Tukey's Least Significant Difference (LSD) tests revealed that 3-year-olds produced fewer representational drawings than 5-year-olds ($p < .05$), and that 4-year-olds did not differ significantly from either the younger or older children (see Figure 2).

Comparisons Across Tasks

The main question of interest in comparisons across tasks was whether there was a relation between performance on the picture false-belief task and performance on the standard false-belief or pictorial symbol tasks. Three types of analyses were conducted to provide converging evidence for a relation across the false-belief and pictorial tasks. Probability analyses were conducted on frequency data (i.e., numbers of children passing/failing tasks), and correlations and *t*-tests were used for performance measures (i.e., pass/fail vs. number correct or pass/fail vs. age of child). Because the hypotheses predicted significant relations among tasks, in all cases, one-tailed tests were used.

Fisher's exact probability tests indicated that the number of children passing/failing the picture false-belief task was similar to the number of children passing/failing the false contents ($p = .002$) and false-belief location ($p = .001$) tasks. Correlations (phi and point biserial, see summary in Table 1) between the picture false-belief and other tasks indicated that performance on the picture false-belief task was significantly correlated with the false contents, false-belief location, and drawing tasks. The correlation with the picture–object matching task was marginally significant.

Calculation of overall scores on standard false-belief and pictorial competence tasks allowed us to examine whether passing/failing on the picture false-belief task was related to general performance on standard false-belief and pictorial tasks. False contents and location scores (total possible = 2) were combined, and picture–object matching and drawing scores (total possible = 8) were added to obtain the overall scores. The combined scores were analyzed with independent *t*-tests, with data grouped according to pass/fail on the picture false-belief task. Compared with children who failed, children who passed the picture false-belief had significantly higher overall standard false-belief scores ($M_{\text{numbers}} = 1.59$ vs. 0.53), $t(35) = 4.53$, $p < .0001$, and significantly higher overall pictorial symbol scores ($M_{\text{numbers}} = 7.36$ vs. 6.13), $t(35) = 2.04$, $p < .03$.

Estimates of the age of passing tasks also provided converging evidence for the relation across tasks. The ages of passing the tasks were calculated by first establishing a criterion for passing each task and then calculating the mean age of children passing the task. The criterion for passing the

TABLE 1
Summary of the Fisher's Exact Probability and Correlation Tests Conducted to Compare Performance in Study 1 Between the Picture False-Belief Task With Other False-Belief Tasks and With Pictorial Symbol Tasks

	Picture False-Belief			
	Pass	*Fail*	*Fisher's Exact Probability*	*Correlation Coefficient*
False Contents				
Pass	16	3	.002	$r_{\varnothing} = .52$ (.005)
Fail	6	12		
False Location				
Pass	19	5	.001	$r_{\varnothing} = .55$ (.003)
Fail	3	10		
Picture–Object Matching				$r_{pb} = .26$ (.06)
Drawing				$r_{pb} = .33$ (.02)

Note. Significance levels are given in brackets (all are one-tailed). Point biserial correlations are indicated by r_{pb}, and phi correlations are indicated by $r_{\varnothing}$.

picture–object matching task was set at three out of four using the following rationale: For this task, chance = 2 out of 4, and from post-hoc analyses of the one-way ANOVA of these data, we calculated the difference needed to be significantly different from chance ($LSD = 0.71$, $p < .05$; and $LSD = 1.10$, $p < .01$). To pass the drawing task, children had to distinguish between the ball and stick by drawing a circle and line and had to draw at least one representational drawing of the objects that required a combination of a circle and line to depict. For all of the false-belief tasks, a pass was defined as correctly predicting that the experimenter would hold a false belief after deception. In all cases, the mean age of passing was slightly greater than 4 years old ($M_{age} = 4.6$, 4.5, 4.6, 4.3, 4.4 years for the picture false-belief, false-belief location, false contents, picture–object matching, and drawing tasks, respectively).

Discussion

The results from Study 1 confirm that children pass the picture false-belief task at around 4 years of age, at approximately the same age that they perform well on standard false-belief and pictorial symbol tasks. We have argued that success on the picture false-belief task requires that children explicitly understand the conventional, representational function of pictorial symbols and can reason about the consequences for another's beliefs when they fool them by switching pictures. Thus, to succeed on the task, children must have metaknowledge of beliefs and of pictorial symbols. They need to know that they and others commonly use pictures as representations of a state of reality (in this case, the contents of the boxes), and they need to understand how another person's false belief will impact their behavior. The results from Study 1 converge to support this dual-process account of the picture false-belief task. Children passed individual tasks at approximately the same age, and comparisons across standard false-belief and pictorial symbol tasks confirmed significant relations across the tasks.

It is necessary to clarify why 3-year-olds fail the picture false-belief task. Clearly, they lack metarepresentational understanding of beliefs at this age, and that alone could account for their failure. However, we hold the view that young children fail the task not only because they lack an understanding of false belief but also because they lack explicit understanding of the representational function of pictures. Two trends from Study 1 support this view: significant relations across picture false-belief and other pictorial competence tasks and the synchrony in the age of passing the tasks. Although Study 1 has illuminated developmental trends and suggested a role for pictorial knowledge given the interrelationships among picture false-belief and related tasks, the design cannot unambiguously confirm the role of explicit knowledge of the representational function of pictures. To address this ambiguity, we need to examine performance on the picture false-belief task in a sample of children who possess false-belief understanding but not representational knowledge of pictures. Such a sample can be found in cultural settings where, due to a lack of exposure to pictorial symbols in their everyday environments, children develop false-belief understanding along a typical developmental trajectory but develop knowledge of the symbolic function of pictures relatively late. Study 2 compares children's performance on multiple false-belief and pictorial symbol tasks across diverse cultural settings where pictorial exposure and competence varied widely.

STUDY 2

Multiple tasks were used across distinct cultural contexts to assess our claim that the picture false-belief task requires pictorial competence *and* false-belief understanding, as well as the proposal that cultural supports are needed to develop representational knowledge of pictures (Callaghan, 2008; Callaghan et al., 2011; Callaghan & Rankin, 2002; Rochat & Callaghan, 2005). Two cultural settings where exposure to pictorial symbols is rare in the environments of infants and young children (rural small villages in India and Peru) were contrasted with a rural Canadian sample having extensive exposure to pictorial symbols. Callaghan et al. (2011) investigated precursors and symbolic development across the same three rural cultural settings (India, Peru, Canada) that were included in Study 2. In the Callaghan et al. (2011) study, direct experience in symbolic interactions with others using pictures began during infancy in the Canadian setting, as is typical in North American middle-class settings. Children's early exposure to pictorial symbols included interactions with others using infant and early childhood books, family photographs, family wall art, and the ubiquitous and varied packaging graphics on child-directed and other household products. In contrast, children in both the Indian and Peruvian village settings had little exposure to pictorial symbols early in life, either passively or interactively. In Peru, minimal contact with pictorial symbols typically came through occasional exposure to family photographs or to packaging graphics on a few household items. In interviews, mothers reported that they only rarely interacted with their babies using pictorial stimuli, and when they did, the most common interaction was to try to settle an upset infant by showing them a family portrait or calendar on the wall. In the Indian villages, when there was a pictorial symbol in the home, it was most commonly a calendar with a Hindu god, and like Peru, the most typical interaction was using the calendar to distract an upset infant. In the Callaghan et al. (2011) study, children across the three settings were given the same pictorial symbol comprehension (picture–object matching) and production (drawing) tasks used in Study 1. Both comprehension and production of pictorial symbols were delayed in the Indian and Peruvian settings relative to the Canadian setting by approximately 1 year—providing evidence that when there is very little interaction using pictorial symbols in their early environments, children's representational understanding is delayed.

On the basis of Callaghan et al.'s (2011) findings that there is considerably less early pictorial experience in the Indian and Peruvian settings and that pictorial competence is less advanced, we predicted that success on the picture false-belief task for children from these same villages would be delayed relative to the Canadian sample. In contrast, because false-belief understanding has been found to develop along the same trajectory across non-Western rural village settings (including India and Peru) when compared with a Canadian setting (Callaghan et al., 2005), we expected performance on standard false-belief tasks to develop around the same time in all three settings. Thus, we expected a pattern of differential onset of picture false-belief understanding along with synchronous onset of standard false-belief understanding across these cultural settings. If confirmed, this pattern would strengthen our claim that knowledge of the representational function of pictures is critical to success on the picture false-belief task, which cannot be passed solely on the basis of false-belief understanding.

Method

Participants

A total of 89 children from three cultural settings (Canada, India, and Peru) participated in Study 2.

Canada. Thirty-four 3- to 5-year-old children (14 girls, 20 boys; $M_{\text{age}} = 4;3$; age range $= 3;1–5;3$) were recruited from letters to parents sent home to day cares in a rural town in Eastern Canada. The town also has a regional hospital and vibrant farming and fishing sectors. Parents were employed in a wide variety of occupations, ranging from seasonal labor to professional. Owing to the demographics of the community, the sample was predominantly middle class and Caucasian. Early exposure to pictorial symbols was extensive and varied, as is common in North American middle-class settings. Children were tested in a quiet room at their day cares.

Peru. Twenty-seven children from two age groups were included from this setting: children 3 to 5 years old (9 girls, 6 boys; $M_{age} = 4;3$; age range = 3;1–5;3) and children aged 6 years old (5 girls, 7 boys; $M_{age} = 5;10$; age range = 5;5–6;3). Children were recruited through a network of women who were village leaders for a variety of social development programs funded by government and non-governmental organizations (NGOs) in the rural Montaro Valley area, located in the Central Highlands of Peru. Experimenters attended mothers' meetings to explain the nature of the research and arranged individual appointments in community centers or private homes for mothers and their babies who volunteered to participate. Birth records were obtained from mothers and were verified with files from the social development programs. The primary occupations in the villages were craft production, subsistence farming and seasonal farm labor, and migrant labor. The villages in this valley were within a 40-kilometer radius of the city Huancayo, the largest city in the region, but children from the villages rarely traveled outside of their communities. Exposure to pictorial symbols in the child's home environment was rare. Children were tested in a quiet space in their homes or community centers.

India. Twenty-eight children from two age groups were included from this setting: those aged 4 years old (9 girls, 8 boys; $M_{age} = 4;5$; age range = 3;5–5;1) and those aged 5 years old (5 girls, 6 boys; $M_{age} = 5;10$; age range = 5;5–6;4). Children were recruited through the field offices of a local NGO that provided a variety of social programs in the area located approximately 70 kilometers from Vijayawada, Andhra Pradesh, India. A network of field officers explained the general purpose of the study to mothers in surrounding villages, obtained lists of volunteers, and arranged individual appointments in community child care centers or private homes. Birth records were available because of a birth registration project initiated by the NGO several years earlier. The primary occupations in the villages were subsistence farming and seasonal farm labor. Children from the villages rarely traveled outside of their communities. Exposure to pictorial symbols in the child's home environment was rare. They were individually tested in a quiet room in a community center or school.

Stimuli

Most of the materials used in the tasks were the same as those used in Study 1; however, a few changes were made when necessary to make the stimuli culturally relevant.

Picture false-belief task. The same materials used in Study 1 for the picture false-belief task were employed in this study.

False contents task. In Canada, we used a Crayon package with birthday candles inside in the false contents task. In India, we used a package of Frootie mango juice with rice inside. In Peru, we used a tin of Gloria brand condensed milk with rice inside.

False-belief location task. A colorful key chain was used as the item to be hidden across all cultural settings, and the same two plastic bowls of different colors used in Study 1 were used as hiding locations.

Drawing task. Six objects that could be rendered with circle and line components were presented for the child to draw in Study 2 (ball, stick, jingle bell wrist strap, maraca, chime magnet, toy dumbbell).

Procedure

Three female experimenters (one for each setting), who were native speakers of the child's language, tested children in quiet locations. All tasks were conducted in a single 20-minute session. We began this study in India, and partway through the data collection, we found that some of the children could not identify the contents of the package that we chose for the false contents task (in total 8/28 failed to identify contents). We addressed this problem in the field by adding the false location task to our battery of tasks (initially, we planned to only use false contents) and in the analyses by assigning a false-belief score of 1 if children passed one or both of the false content or false-belief location tasks. We do have complete data sets for both tasks in the Peruvian and Canadian settings. Children in Canada and Peru and those in India who received all tasks received the tasks in the following order: picture false-belief, false-belief contents, false-belief location, and drawing. In India, the ordering for children receiving three tasks was similar: picture false-belief, false-belief contents or false-belief location, and drawing. Preliminary analyses confirmed that there were no task order effects; thus, this factor was not included in the analyses that follow.

Picture false-belief task. The procedure used in this study was common across cultural settings and identical to that for Study 1. In Canada, all children were tested in their day cares at a child-sized table in a quiet room. E1 sat beside the child and E2 sat across from the child. In Peru and India, children sat just in front of their mothers, across from E1 and beside E2, on a mat on the floor of a secluded room.

False contents task. The procedure used in this study was common across cultural settings and was the same as that used in Study 1.

False-belief location task. The procedure used in this study was common across cultural settings and was the same as that used in Study 1.

Drawing task. Six drawings were collected and scored in the same manner as in Study 1.

Results

There were two main questions addressed in the analyses for Study 2. First, we examined whether performance on the individual picture false-belief, standard false-belief, and drawings tasks was influenced by cultural setting. Second, we addressed the dual-process account of the picture false-belief task by exploring the relations among tasks across cultures. In particular, we were interested in whether the patterns of relations found between tasks with Canadian children in Study 1 would shift in the cultural settings in which children had little exposure to pictorial symbols (i.e., India, Peru).

Individual Tasks

In Study 2, we extended the age range in the Indian and Peruvian settings to include older children than those sampled in the Canadian setting to enable us to assess when children in the Indian and Peruvian settings develop representational abilities with pictorial symbols, given that their understanding may be delayed because they receive less exposure to pictures early in life. For analyses of the individual tasks, we restricted the ages to the typical range used in studies that explore development of theory of mind—3 to 5 years old—and compared performance across cultural settings. When estimating the age at which children achieved competence on the task in analyses of the relations across tasks, the children across the entire age range for India and Peru were included.

Picture false-belief task. Figure 3 presents the mean proportions of children passing the picture and standard false-belief tasks across the cultural settings and ages. We first conducted an overall chi-square analysis of the number of children passing/failing the picture false-belief task in the age range of 3;1 to 5;3 across the three cultural settings to examine the impact of early exposure to pictorial symbol systems on performance on this task. This analysis revealed a significant overall cultural setting effect, $\chi^2 = 10.08$, $p < .007$. Fisher's exact probabilities determined that Canadian children were more likely to pass the picture false-belief task compared with Peruvian children and that Indian children did not differ significantly from either Canadian or Peruvian children (Fisher's exact

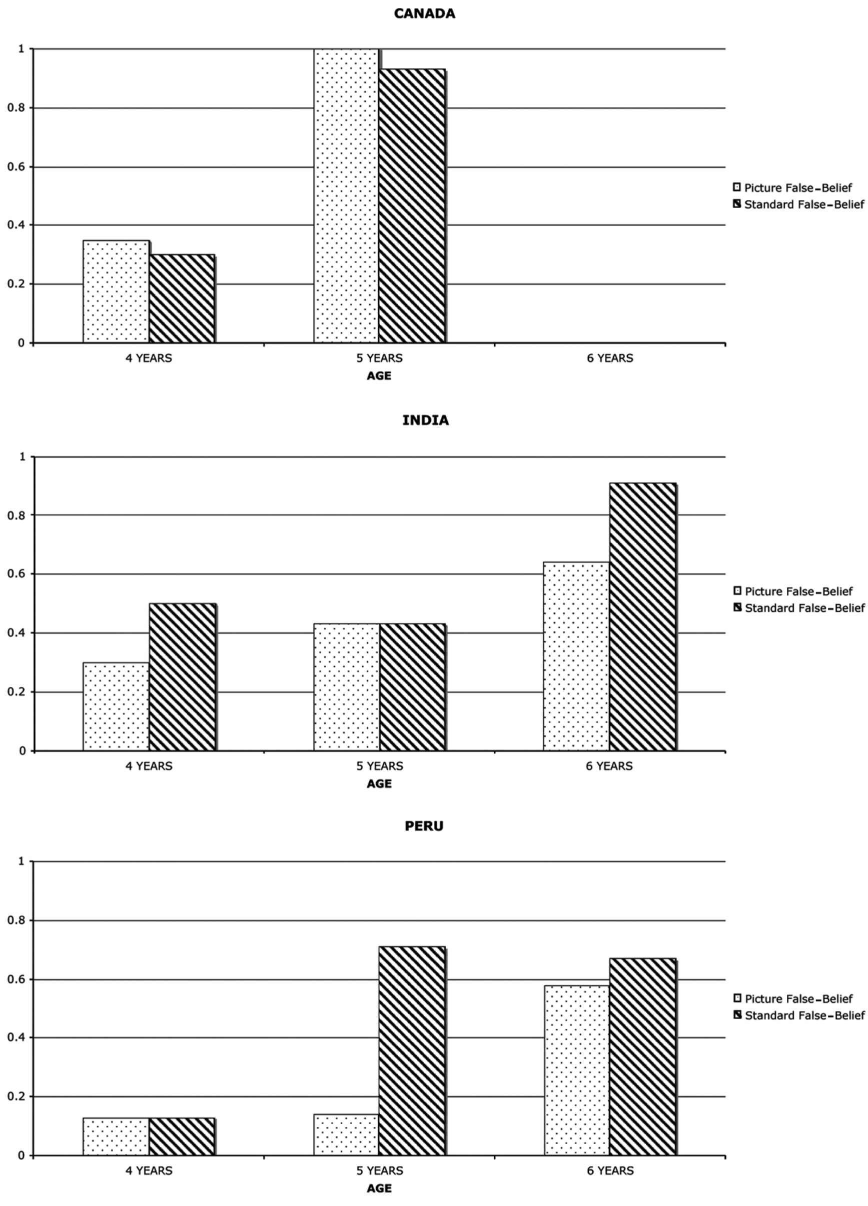

FIGURE 3 Comparisons of proportions of children passing picture and standard false-belief tasks across age for each cultural setting in Study 2.

probabilities = .002, .14, and .11, for the contrasts of Canada vs. Peru, Canada vs. India, and Peru vs. India, respectively).

To further examine performance on this task, and assess whether culture effects were consistent across the age range, we separated the children into two age groups (4 years old, $M_{age} = 3;10$; 5 years old, $M_{age} = 4;11$). Separate chi-square tests of the numbers of children passing/failing were conducted for each age group. There was no significant difference across cultures in the number of 4-year-olds passing the task, $\chi^2 = 1.41$, $p < .49$. However, a marginally significant culture effect was evident for 5-year-olds, $\chi^2 = 2.80$, $p < .09$. Fisher's exact probabilities determined that Canadian 5-year-old children were more likely to pass the picture false-belief task compared with 5-year-olds in India and Peru, with the latter two cultural settings not differing (Fisher's exact probabilities = .006, .0001, and .28, for the contrasts of Canada vs. India, Canada vs. Peru, and India vs. Peru, respectively).

Standard false-belief task. For the false contents task, an initial control question asking children what was in the container as it was held up determined whether children knew what was supposed to be in the container. Knowledge of the contents was only a problem in the Indian setting. We added a false-belief location task in this setting and used both tasks from the outset in Peru and Canada. Of the total of 28 Indian children who participated, 16 children received only the false contents task (these children were tested before adding the false-belief location task and answered the contents question correctly), 8 received both tasks but did not answer the contents question correctly, and 4 children were given both tasks and passed the contents question. To be confident that the two false-belief tasks we used would yield similar assessments of false-belief understanding, we calculated a phi correlation using data from Canada and Peru, where all children received both types of false-belief tasks. There was a significant correlation, $r_{\varnothing} = .61$, $p < .003$. Additionally, we determined that children in India who received both false-belief tasks were no more likely to receive a pass on the combined false-belief score than children who received only one false-belief task (Fisher's exact probability = .52). Given these results, we were confident that a single standard false-belief score based on whether children passed at least one of the false-belief tests was an appropriate measure of general false-belief understanding.

Figure 3 presents the proportions of children passing the standard false-belief criterion in the three cultural settings. As with picture false-belief, we examined whether there were cultural differences in passing the standard false-belief criterion separately for the 4- and 5-year-olds and found a significant effect for the older, $\chi^2 = 6.29$, $p < .04$, but not the younger children, $\chi^2 = 2.94$, $p < .23$. Fisher's exact probability tests determined that the only significant effect found across cultures was that 5-year-old Canadian children were more likely to pass the standard false-belief task compared with Indian children of the same age (Fisher's exact probabilities for 5-year-olds were .03, .24, and .29, for the contrasts of Canada vs. India, Canada vs. Peru, and India vs. Peru, respectively). We examine trends across the entire age range in the next section; however, we note here that the proportion of children passing standard false-belief in India increased to close to ceiling in the 6-year-old group and was not different from the number of children passing in Peru at this age, $\chi^2 = 0.81$, $p < .37$.

Drawing task. The mean proportions of drawings produced by children across cultural settings across the entire age range (3;0–5;3) and in the younger age range (3;0–4;0) are presented in Figure 4. A one-way ANOVA was conducted for the mean number of representational drawings produced by children in the age range of 3;0 to 5;3 across cultural settings (Canada, India, Peru). Cultural setting was not found to be significant, $F(2,63) = 2.05$, *ns*, in this analysis. However, an analysis across the entire age range masks the fact that most Canadian children were making representational drawings between 3 and 4 years of age, while children in India and Peru began to make representational drawings closer to 5 years old. Thus, we reanalyzed the data and restricted the age range to younger than

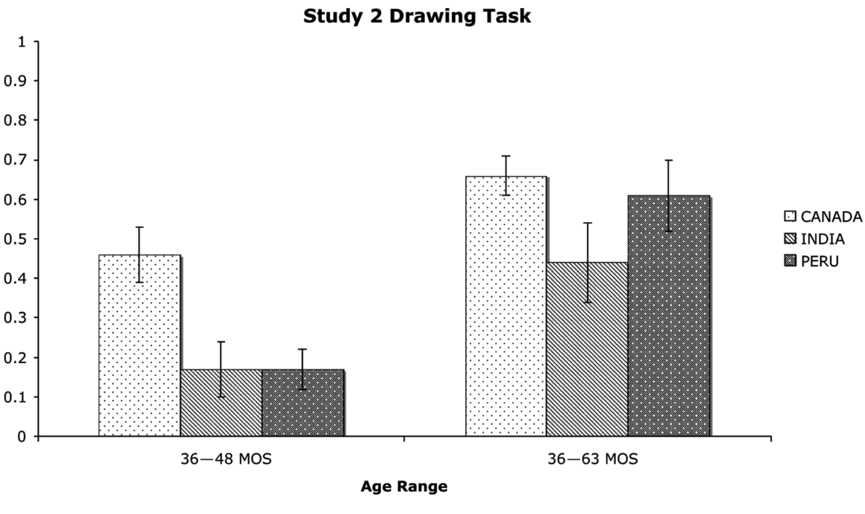

FIGURE 4 Mean proportion of representational drawings made by children across three cultural settings and two age ranges in Study 2.

4 years old. There was a significant cultural setting effect, $F(2, 18) = 3.66$, $p < .05$, in the number of representational drawings produced in the age range of 3;1 to 4;0.

Comparisons Across Tasks

Recall that in Study 1 we found a relation among picture false-belief and both standard false-belief and pictorial symbol tasks. These relations suggested that both processes are required for the picture false-belief task. However, it is not clear whether younger children fail the task because they lack representational understanding of false belief or of pictorial symbols, or both. Thus, in Study 2, the important contrast is between children from cultural settings where representational understanding of pictures is delayed because children receive little exposure to pictorial symbols in the first few years (India, Peru) compared with those who are engaged in pictorial systems from birth (Canada). Finding that children who are not exposed to pictures pass the standard false-belief task but manifest a delay in passing the picture false-belief task will support the dual-process view of the picture false-belief task.

To analyze relations across tasks separately for each cultural setting, we sorted data across the entire age range on whether children passed/failed the picture false-belief task. We then conducted chi-square analyses when analyzing standard false-belief performance and *t*-tests when examining drawing performance. In addition to these analyses, we estimated the age at which children began to pass each of the tasks (picture false-belief, standard false-belief, drawing) using linear regression analyses.

Picture false-belief versus standard false-belief tasks. Figure 3 plots the proportions of children passing the false-belief tasks for each cultural setting. The numbers of children passing/failing the picture false-belief and standard false-belief tasks were analyzed separately, using chi-square tests for each cultural setting, and are presented in Table 2. Performance on the picture false-belief task was significantly related to the standard false-belief task only in Canada, $\chi^2 = 13.62$, $p < .0002$ ($\chi^2 = 0.20$, *ns*, in India; $\chi^2 = 2.24$, *ns*, in Peru). Thus, Canadian children were more likely to either pass both tests or fail both tests. In India and Peru, children who passed the standard false-belief task were equally likely to pass or fail the picture false-belief task.

Picture false-belief versus drawing tasks. The relation between drawing and picture false-belief performance was examined by sorting drawing data (number of representational drawings, see Figure 5) on passing/failing

TABLE 2
Comparisons of Numbers of Children Passing/Failing Picture False-Belief and Standard False-Belief Tasks Across Cultures in Study 2

	Picture False-Belief				
	Pass	*Fail*	χ^2	*df*	*p*
Standard False-Belief					
Canada					
Pass	18	2			
Fail	3	11	13.62	1	.0002
India					
Pass	9	6			
Fail	3	10	0.20	1	*ns*
Peru					
Pass	7	7			
Fail	2	11	2.24	1	*ns*

the picture false-belief task and conducting separate independent *t*-tests for each cultural setting. In general, children who passed the picture false-belief task produced more representational drawings than those who failed the task. This effect was significant in Canada ($t = 3.90$, $df = 32$, $p < .0002$) and Peru ($t = 2.75$, $df = 22$, $p < .006$) and was marginally significant in India ($t = 1.52$, $df = 26$, $p < .07$).

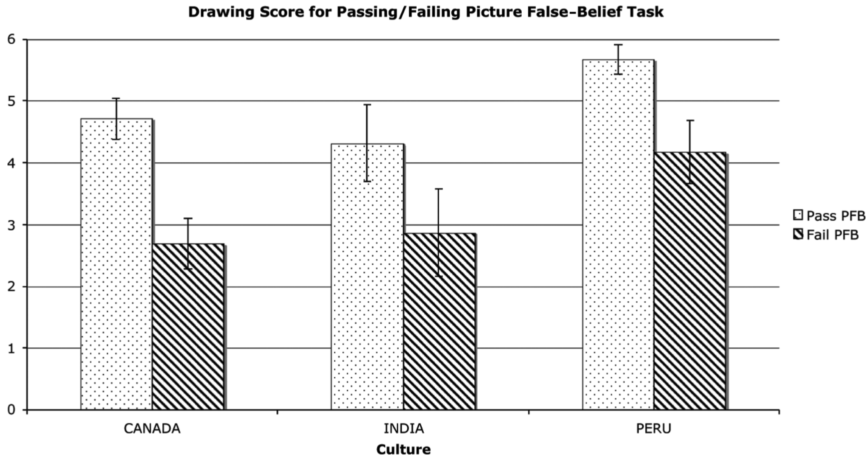

FIGURE 5 Mean number of representational drawings across cultures according to whether children passed or failed the picture false-belief task.

TABLE 3
Estimates From Linear Regression Analyses for the Mean Age (Years) of Passing the Midpoints of Score Ranges Across Cultures and Tasks

Task	*Canada*	*India*	*Peru*
Picture False-Belief	4.1	5.2	5.7
Standard False-Belief	4.1	4.1	4.9
Drawing	3.7	4.3	4.0

Estimates of the age of passing tasks. When performance levels differ across cultural settings, as they do on the pictorial tasks in Study 2, it is useful to estimate the age at which children would achieve a comparable level of performance. Our samples in India and Peru included children older than the Canadian sample so that we could estimate when children would begin to pass the tasks. Linear regressions plotting performance against age of children were calculated for each culture. The midpoint of the possible range of scores was taken as the indicator that children had begun to pass the tasks, and age of passing was then estimated from the regression line. For picture and standard false-belief tasks, the midpoint of the possible scores is 0.50 (range = 0 to 1), and for the drawing task it is 3.0 (range = 0 to 6). These age estimates help to describe the relative onset of success on each task across cultural settings (see Table 3 for estimates).

Looking at individual cultural settings, it is evident that Canadian children passed the midpoint in the drawing task approximately 5 months before the standard and picture false-belief tasks. In India, children passed standard false-belief and drawing tasks a full year before the picture false-belief task. Peruvian children passed the drawing task first, followed approximately 11 months later by the standard false-belief task, and then, close to 10 months later, the picture false-belief task. In general, competence on the picture false-belief task was achieved at a later age (India, Peru) or concurrently (Canada) compared with the standard false-belief and drawing tasks in all cultural settings.

Discussion

The findings from Study 2 suggest that level of cultural exposure to pictorial symbols early in life influenced performance on the picture false-belief task. Only in the Canadian cultural setting, where extensive early exposure to pictorial symbols was common, did the majority of children pass the picture false-belief task, and they did so by 4 years of age. The "manipulation" of level of exposure to pictorial symbols in the early environments of children that was provided by the cross-cultural comparison allowed us to provide converging evidence regarding the role that pictorial symbol knowledge played in the picture false-belief task. Children were more likely to pass the test when they were raised in cultures that engaged children in the pictorial symbol system at an early age, which strengthens the interpretation, posited in Study 1 and elsewhere (Callaghan et al., 2011; Callaghan & Rochat, 2008), that early social experience with pictorial symbols is an important foundation for developing explicit knowledge of the representational function of pictures.

Canadian children also performed at higher levels for the drawing task compared with Indian and Peruvian children early in the preschool years. Frequency analyses for the standard false-belief measure indicated that the majority of Indian children may develop competence slightly later than Canadian and Peruvian children; however, age estimates from regression analyses suggest a synchrony in the onset of competence in this measure. Examination of the relations across tasks and cultures helps to disambiguate the findings.

Passing the picture false-belief task was related to passing the standard false-belief measure in the Canadian setting but not in the Indian and Peruvian settings. These findings suggest that false-belief understanding alone does not guarantee competence on the picture false-belief task and suggest that competence with pictorial symbols was also a necessary foundation for the picture false-belief task. Passing the picture false-belief task was significantly related to the level of performance on the drawing task in all cultural settings. Additionally, the age estimates for onset of competence were relatively early in the drawing task relative to the picture false-belief task across all cultural settings. These consistent patterns for picture-based tasks across cultures suggest that children do need to have representational competence with pictorial symbols prior to exhibiting explicit understanding of the shared nature of those symbols in the picture false-belief task. Further, the age estimates from regression analyses show that in all settings, standard false-belief tasks were passed concurrently or prior to passing the picture false-belief task. These trends underscore the fact that although possessing false-belief understanding does not guarantee success on the picture false-belief task, it does need to be in place before success on the picture false-belief task is achieved.

Clearly, there are many differences, in addition to experience with pictorial symbols, across the cultural settings sampled in this study. Although we did not assess maternal education levels for the participants in this study, Callaghan et al. (2011) reported a link between maternal education and performance on pictorial symbol tasks in the same communities sampled in Study 2. Maternal education has also been linked to the extent of infant-directed language (Richman, Miller, & LeVine, 1992). Mothers with higher education levels may be more likely to engage their infants and young children in all forms of symbolic interaction, and this may provide the context wherein meaningful experience with pictorial symbols occurs in the environments of young children. In the future, cross-cultural research that documents both the extent to which, and the varieties of ways in which, individual children are exposed to pictorial symbols by parents needs to be documented. Additionally, cultural practices outside of the home environments (e.g., educational materials and practices, symbolic religious practices) that may influence general symbolic competence need to also be documented to help clarify the variety of supports that can impact children's development of pictorial symbol competence.

GENERAL DISCUSSION

A host of studies have now addressed when toddlers and young children "understand" the symbolic function. Age estimates for this insight vary from 13 to 30 months old. A major issue in resolving the discrepant estimates centers on defining what constitutes "understanding." In the current research, we tapped into explicit knowledge that others use pictures as symbols using the following logic: If children understand that others use pictures in the conventional way, as representations, then, when pictures used as symbols for contents of boxes are deceptively switched, children will understand that the person will hold a false belief about the contents and will look in the wrong box for their toys.

In the first study, we used simple generic line drawings to represent the contents of boxes and determined a baseline of when children between the ages of 3 to 5 years pass the picture false-belief task. Children were reliably passing the task at approximately 4 years of age, and performance was related to that on standard false-belief and general pictorial functioning tasks. In the second study, we extended our investigation to include settings where children had very little exposure to pictorial symbols early in life, in contrast to a setting where exposure was extensive. Only Canadian children, who had extensive early engagement with pictorial symbols, reliably passed the picture false-belief task in the 3- to 5-year age range. Additionally, passing the picture false-belief task was significantly related to passing the standard false-belief measure and to performance on the drawing task. Although Peruvian children passed standard false-belief tasks around the same age as Canadian children and Indian children passed slightly later, neither Peruvian nor Indian children passed the drawing or picture false-belief tasks until much later in development.

The findings reported here support the view that symbolic development undergoes a qualitative shift during the preschool years, from implicit to explicit understanding of the representational function. In the domain of pictorial symbols, this perspective (Callaghan, 2008; Rochat & Callaghan, 2005) suggests that there is considerable development in the nature of understanding the symbolic function of pictures throughout infancy and early childhood. During infancy, action-based knowledge of pictures develops and is closely linked to the tendency of infants for social referencing and imitating actions that others take toward unfamiliar artifacts (Callaghan, Rochat, MacGillivray, & MacLellan, 2004). Later, perceptual-based understanding allows toddlers to use pictures to guide retrieval and matching responses when there is iconicity between pictorial symbols and their referents. Young preschoolers can go beyond perceptual matching and typically use pictures as effective symbols, both when they use others' pictures in a matching task and when they produce their own. However, this understanding may still be implicit, and it is not until the late preschool period that children understand that they share a representational convention with others when they use pictures. The current task required children to predict another person's behavior on the basis of knowledge of this shared, representational convention of pictorial symbols. The findings support the proposal that by the late preschool years, children are not only capable of implicitly using the symbols of others in search and matching tasks, or in producing drawings that can be decoded by others, they can predict how others will respond to deception involving pictures. In effect, they have explicit knowledge of the representational function that pictures serve in their culture.

The picture false-belief task, when used in a multitask cross-cultural design, can help to identify the nature of general and pictorial-specific processes involved when children must make a decision about how others conceptualize pictorial symbols. The strength of the task lies in using it as one of a number of converging operations designed to tap explicit understanding. We have noted that the reasons for failure are ambiguous when considering performance on the picture false-belief task alone. In the future, researchers need to continue to include other measures of pictorial competence and general representational understanding along with the picture false-belief task. Future research on children's explicit representational understanding would also benefit from measures of verbal rationale in the picture false-belief task (e.g., asking why the experimenter will look in the wrong box) and the inclusion of other tasks to tap explicit understanding of pictures (e.g., asking children to improve their ambiguous drawings).

In line with a cultural learning view, we propose that the ability to appreciate the shared representational convention of pictorial symbols is founded on understanding the shared nature of communicative intentions

(Tomasello, 2008; Tomasello et al., 2005). We used the picture false-belief task to measure this understanding in the context of pictorial symbols and asked children where an experimenter would look for hidden toys after pictorial labels depicting the contents had been deceptively switched. We deliberately used a task that did not involve training or feedback on performance because our aim was to measure the extant knowledge of pictorial representations, which children typically learn through practicing the conventions they infer when others use pictorial symbols in everyday environments. We know that children perform better on picture–object matching and drawing tasks as a result of highlighting the link between pictures and referents (Callaghan & Rankin, 2002). In future research, it would be informative to contrast a training group with a natural apprentice group, where the shared nature of pictorial symbols is highlighted and the impact on performance in the picture false-belief task is assessed, to further explore the shift from implicit to explicit representational knowledge in the domain of pictorial symbols.

Our findings are also in line with the cultural learning claim that cultural supports are necessary for the acquisition of symbolic systems. Only one study has directly tested this claim across cultures (Callaghan et al., 2011), and their results indicate that when cultures provide very little engagement in symbolic systems, children of those cultures are delayed in their understanding and productive use of those symbolic systems, even though the requisite foundational skills develop along a similar trajectory across the cultural settings. That even older children in cultural contexts that do not extensively support pictorial symbol understanding failed to pass the picture false-belief task, but did pass standard false-belief tasks, suggests that understanding of the conventional representational function of pictures may be largely built on shared experience with others who use pictures as symbols.

Further research is needed to clarify the processes underlying developmental shifts in representational knowledge. If they are not explicitly taught, how are children learning the conventions of pictorial symbols? A likely candidate is through the social learning mechanisms identified in other symbolic domains: joint attention, understanding communicative intentions, and the motive to share in those intentions (Tomasello, 2008).

Nelson (2007) used the term referential understanding to refer to children's ability to match words with their referents (e.g., as in the original name game of Brown, 1958) and distinguished it from representational understanding, which is achieved when children can begin to use language to achieve their communicative goals in conversations with others. With the terms implicit and explicit knowledge of the representational function, we are making a similar distinction in the context of pictorial symbols.

When children make matches between pictures and objects in search or word-learning tasks, they are simply identifying the referent of the picture under fairly ideal conditions supported by perceptual similarity and/or linguistic labeling. When they make a drawing that can, in itself, direct others to the referent, they have begun to represent the world with pictorial symbols. When they engage in deception to fool another person who is looking to a pictorial symbol for guidance in a search task, their understanding has left the private world of action and entered the community of symbol users.

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