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The Role of Symbol-Based Experience in Early Learning and Transfer From Pictures: Evidence From Tanzania

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Extensive exposure to representational media is common for infants in Western culture, and previous research has shown that soon after their 1st birthday, infants can acquire and extend new information from pictures to real objects. Here we explore the extent to which lack of exposure to pictures during infancy affects children's learning from pictures. Infants were recruited from a rural village in Tanzania and had no prior experience with pictures. After a picture book interaction during which a novel depicted object was labeled, we assessed infants' learning and transfer of the label from pictures to their referents. In a 2nd study, we assessed infants' learning and generalization of new names using real objects, rather than pictures. Tanzanian infants demonstrated a similar pattern of learning and generalization from real objects, when compared with infants in Western culture. However, there was a significant difference in learning and generalization from pictures to real objects. These findings provide evidence for the important role of early experience with representational media in children's ability to use pictures as a source of information about the world.

Keywords: culture, word learning, referential understanding, cognitive development, representation

Frequent exposure to picture books and other forms of representational media (e.g., videos, family photographs, television) is common for young children in Western culture, and research indicates that Western children develop pictorial competence—the full understanding of the nature of pictures and their use—in the first 3 years of life (Callaghan, 2000; DeLoache & Burns, 1994; DeLoache & Ganea, 2009; Ganea, Allen, Butler, Carey, & DeLoache, 2009; Harris, Kavanaugh, & Dowson, 1997; Preissler & Carey, 2004; Robinson, Nye, & Thomas, 1994; Troseth, Pierroutsakos, & DeLoache, 2004). Infants can perceive pictures as early as 3 months of age (Barrera & Maurer, 1981; de Schonen & Mathivet, 1990), and by 5 months of age they can detect similar-

ities between and also discriminate between two-dimensional and three-dimensional stimuli (DeLoache, Strauss, & Maynard, 1979; Dirks & Gibson, 1977; Slater, Rose, & Morison, 1984). The ability to perceive pictures does not seem to require prior experience with pictures. In an extreme experiment, Hochberg and Brooks (1962) raised their own child with no exposure to visual representations until he was 19 months of age. At that age, he was able to recognize and name objects in photographs and line drawings.

Researchers have also begun to examine the extent to which infants and young children can learn and transfer novel information from picture books to the real world (Ganea et al., 2009; Ganea, Ma, & DeLoache, 2011; Ganea, Pickard, & DeLoache, 2008; Simcock & DeLoache, 2006, 2008; Simcock & Dooley, 2007). For example, Ganea et al. (2008) found that American infants as young as 15 months extend newly learned labels from realistic photographs to their real-world counterparts following a single picture book interaction. By 18 months, infants also generalize to new real-world exemplars of the depicted objects. Iconicity of pictures has been shown to influence the extent to which infants and toddlers transfer new content from pictures to their real referents, with realistic pictures, such as photographs, leading to better transfer than less realistic pictures, such as drawings and cartoons (Callaghan, 2000; Ganea et al., 2008; Simcock & Dooley, 2007).

The evidence that children can learn from pictures and apply the new information to their real counterparts is concordant with the proposal that children develop an understanding of the referential nature of pictures in their second year of life (DeLoache & Burns, 1994; Ganea et al., 2009; Harris et al., 1997; Preissler & Carey,

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2004; Simcock & DeLoache, 2006). For example, recent studies have shown that by 15 months of age, infants understand that a label given to a picture refers to a real object in the world, rather than to the picture itself (Ganea et al., 2009; Preissler & Carey, 2004).

Although the ability to appreciate the referential nature of pictures may be in place as early as 13 months, when infants begin to learn and extend nonobvious properties of depicted objects to actual objects (Keates, Graham, & Ganea, 2010), certain aspects of explicit reasoning about pictorial symbols continue to develop during the preschool and even elementary school years (Beilin & Pearlman, 1991; Claxton, 2011; Flavell, Flavell, Green, & Korf-macher, 1990; Robinson et al., 1994; Uttal, Gentner, Liu, & Lewis, 2008; Zaitchik, 1990). It has frequently been proposed that experience with symbols aids in the development of pictorial understanding (Bovet & Vauclair, 2000; DeLoache, 1991; Deregowski, 1989; Szechter & Liben, 2004). There is also empirical evidence that directing an infant's attention to the link between pictures and their referents through repeated interactions facilitates early comprehension and production of pictorial symbols (Callaghan & Rankin, 2002).

Consistent with the view that early experience can highlight the function of "pictures as vehicles for conversation" (DeLoache & Burns, 1994, p. 106), parents talk differently to children about depicted objects than about real objects, emphasizing the generic nature of pictures—that pictures often refer to all objects of the same kind, or category (Gelman, Chesnick, & Waxman, 2005). Nevertheless, the empirical evidence for the facilitative role of early pictorial experience on infants' understanding of pictures is scarce, because the development of pictorial understanding has been examined almost exclusively with children from picture-rich societies (but see Callaghan et al., 2011; DeLoache, Pierroutsakos, Uttal, Rosengren, & Gottlieb, 1998).

Because exposure to pictures early in infancy is not common across all cultures, with infants in many non-Western cultural contexts having little or no exposure to pictorial symbols prior to entering school, it is reasonable to ask whether children everywhere develop pictorial understanding at about the same age. Cross-cultural studies of social-cognition have shown synchronous developmental trends in the age of onset of mental-state understanding across different cultural settings (Avis & Harris, 1991; Callaghan et al., 2005). Precursor skills to social cognition, such as imitation, helping, gaze following, and pointing, also show a similar developmental pattern across Western (rural Canada) and non-Western cultural settings (rural Peru and India; Callaghan et al., 2011). However, unlike the universality of social experience during infancy, early experience with representational media varies widely across cultures. It is therefore important to examine whether the homogenous pattern of development that has been observed in the area of social cognition also applies to the development of early pictorial competence and the ability to learn from symbols.

In the first cross-cultural study examining infants' pictorial competence, DeLoache et al. (1998) suggested that children growing up in different cultural settings may go through a similar developmental progression with respect to their understanding of the representational nature of pictures. The 9-month-old infants in their research in both the United States (a pictorially rich culture) and a rural village in West Africa (a culture in which pictures are

rare) manually explored realistic photographs of depicted objects, indicating a lack of understanding of the nature of pictures at 9 months of age in both cultures. However, as they reach 18 months, Western infants begin to interact with pictures differently, by pointing at and labeling them, suggesting that they have developed an appreciation of their dual nature (DeLoache et al., 1998; Murphy, 1978). This achievement may be facilitated in part by experience with pictures. For example, it has been reported that toddlers described by their parents as showing high levels of interest in picture books perform less manual exploration of pictures than toddlers with less interest (Fletcher & Sabo, 2006).

More recently, Callaghan et al. (2011) investigated children's comprehension skills across two symbolic systems (pictorial and pretense) in three cultures. Two- to 4-year-old children in India, Peru, and Canada were assessed on measures of pictorial production (a drawing task) and comprehension (a picture-matching task). The comprehension measure examined whether children understand that a picture stands for something other than itself. During the picture-matching task, the child was shown a black-and-white line drawing of a toy (for instance, a toy cat), and then when the picture was removed, the child was asked to find the one depicted from among two toy cats (the one depicted and a foil).

The results indicated that Canadian children, who had comparatively higher levels of experience with pictorial symbols during infancy, demonstrated greater abilities in representational drawing skills and in matching pictures to their referents than did the children in cultures with less pictorial exposure. According to Callaghan et al. (2011), the development of symbolic competence is dependent on particular kinds of cultural experiences with other symbol users and symbolic media. Interestingly, maternal education level was also correlated with children's ability to perform the picture-referent matching task; children whose mothers had extensive education (college level or above) were the only group who performed significantly above chance on the picture-matching task. This suggests that the pictorial comprehension task used in this research was a stringent measure of children's understanding of the referential nature of pictures and that it possibly tapped into other abilities that may be facilitated by mothers with higher education levels. Nevertheless, this research brings up many important questions about the specific abilities and cultural experiences that contribute to the development of symbolic ability, and further cross-cultural research is needed to begin to address these questions.

The current study extends upon the existing cross-cultural findings by looking at another important ability involved in mature symbolic competence, that is, the ability to use symbols as a source for learning new information about the world. In particular, here we assessed children's ability to learn a new word in relation to a picture and to then transfer this label to real-world exemplars of the depicted objects. Recent studies have shown that infants as young as 15 months in the United States can learn a new label for a picture and then transfer the label to its real referent (Ganea et al., 2008, 2009). In this set of studies, we investigated whether this early ability to learn new information about the world with pictures is also present in a culture where pictorial media is sparse.

The measure used in this research involved a label extension task, which required the child to first map a label onto a picture and then apply the label to its real referent. Unlike in prior research (Callaghan et al., 2011), we used color photographs of real world

objects, rather than black-and-white drawings of replica toys. The degree of iconicity between a picture and its referent has been shown to influence the extent to which infants and toddlers interpret the picture referentially, with realistic pictures leading to better performance on pictorial tasks (Callaghan, 2000; Ganea et al., 2008; Simcock & Dooley, 2007). Also, in the current task, the depicted object was labeled at the time children saw it, consistent with the view that labeling may cue children to take the picture as a symbol for a real referent (Preissler & Bloom, 2007).

The results will further inform us about the extent to which competence at using pictures symbolically is dependent upon specific cultural experience with pictorial media. The infants in this research were from a remote, rural village in Tanzania and had no reported prior experience with pictorial media. Thus, in Study 1, we investigated whether infants developing in a pictorially sparse culture can learn and transfer novel labels from pictures to their real-world counterparts. In Study 2, we investigated whether 20-month-olds (the youngest group of infants included in Study 1) could learn a novel name for a *real* object and generalize to novel exemplars of this object.

General Methodology

Cultural Setting

Research was conducted in the rural village of Kwala (population approximately 3,000), located in Kibaha-Pwani District of Coast Region, Tanzania. Access to the village is limited by an 18-km dirt road, making the village inaccessible to vehicles during the rainy season; however, a local dispensary provides prenatal care, immunizations, and first aid to inhabitants. The closest water source is located 7 km from the village, and water is transported by hand or electric pump to a tank in the village center. Over 70% of the homes in the area are built by hand using mud and sticks, and nearly all households have dirt floors and grass or tin roofs. Families have very few possessions, and extended family members share a single room. Only 1% of the population has electricity, and there is no Internet access. Books are only available in the secondary school library, and students are not permitted to take books home.

Prior to entering school, children are not exposed to pictorial media inside or outside the home. There are no advertisements or other forms of visual imagery in the village. The only minor exceptions are the images that occasionally appear on clothing that has been donated or purchased from outside the village. The majority of child participants were recruited from areas several miles outside of the village center. Although there is one small store located in the village center that carries a few commercial products, infants had no direct exposure to these items.

Typically, infants are held on their mother's back until they are old enough to walk. Once the child is able to walk, he or she is cared for by older siblings, and by age 4, the child takes on household tasks. In accordance with national law, all children attend primary school. However, only 15% of Kwala children continue to high school, and less than 1% of these advance further. This description is based on records obtained by a nonprofit organization in Kwala and from public records (Tanzania Population and Housing Census, 2002).

Recruitment

A nonprofit organization involved in the development of the Kwala secondary school facilitated recruitment of mothers and children with the aid of the village leader. All participants were located within 5 km of the village center. When mothers arrived at the testing sites, they met with a native Swahili speaker who obtained demographic information and conducted consenting procedures. During demographic interviews with the mothers, research assistants ensured that none of the children enrolled in the study had been exposed to picture books or other forms of pictorial media prior to their participation in the study.

Testing Site

Testing sessions were conducted outside of the village leader's private home near the center of the village. Mothers accompanied their infants during testing, and it was common for younger siblings to be brought along. When multiple children from the same family were being tested, a research assistant would take the children who were not currently being tested away from the testing area so that no child was exposed to the procedure prior to testing.

Experimenters

The research assistant was a native Swahili speaker, born in the village of Kwala, and was familiar to many of the children living there. He was trained with the experimental procedure several weeks before the research began. A second (American) researcher, who is a native English speaker fluent in Swahili, was present at all testing sessions. She had spent 6 months onsite in Kwala prior to conducting the study and was familiar with the culture, as well as ethnographic research methods.

Demographic Interviews

Demographic information was acquired via brief interviews with the mother. This information included the infant's name, mothers' education (number of years completed in school) and literacy status (ability to read and write in Swahili), estimates of the number of Swahili words that the infant comprehends and produces, and any problems experienced during pregnancy or birth. Data from children who had any complications during pregnancy or birth (regardless of severity) were not included in the study. Participants' birthdates were acquired from the village birth records with the help of the village leader and the medical dispensary. The native Swahili-speaking research assistant conducted all demographic interviews.

Study 1

The goal of Study 1 was to assess learning and transfer from pictures in a sample of infants who had no prior exposure to symbolic media. In a picture book interaction, we taught Tanzanian infants a new name for a novel object ("*blicketi*"). Pictures of the novel object appeared in a simple picture book containing both familiar and novel items. The experimenter labeled the depicted objects and directed the child's attention to each picture during the brief interaction. The study was designed to assess the role of early exposure to symbolic media on children's developing abilities to

learn the name of a novel depicted object, extend the name to the actual object, and generalize this name to novel exemplars of that object during test.

Method

Participants. A total of 48 participants were included in the study, with 13 children in the youngest age group (range = 15.4–23.0 months, $M = 20.0$, $SD = 2.4$; nine girls), 20 children in the middle age group (range = 24.0–29.8 months, $M = 27.1$, $SD = 2.1$; 12 girls), and 15 children in the oldest age group (range = 31.1–38.2 months, $M = 35.4$, $SD = 2.0$; seven girls). The age of the youngest group of participants (20-month-olds) was chosen to parallel the age of the 18-month-old infants who performed successfully on similar tasks in the United States (Ganea et al., 2008). An additional 12 children were tested but excluded from analyses. Of these excluded participants, nine children in the youngest age group and one child in the middle age group were excluded for inattention during the picture book reading or failing to respond to both familiar test items during the training phase of the experiment. Two additional children in the middle age group were excluded due to reported problems during pregnancy or childbirth.

Mothers' education varied, with 15% of mothers reporting no formal education, 80% reporting 7 years of formal education (equivalent to primary school), and 5% reporting more than 7 years (secondary schooling or university). Although researchers have previously found correlations between parent education and pictorial understanding in infants (Callaghan et al., 2011), it was not possible to assess the effect of this factor on infants' performance in our analysis due to the small amount of variance in Tanzanian mothers' education. Most (85%) of the mothers were literate in Swahili (they could both read and write in their native language). Ninety-three percent of the children spoke at least a few words in their native language (Swahili). All children were able to comprehend Swahili and follow verbal instructions.

Materials. The materials and testing procedure were designed to be identical to those used by Ganea et al. (2008). Two picture books (8 in. \times 8 in. [20.32 cm \times 20.32 cm]) were constructed, with different orders of color photographs in the two books. The depicted objects were approximately 5 in. \times 6 in. (12.7 cm \times 15.24 cm). Each 16-page book included pictures of two novel objects (a chrome wire egg holder and a blue plastic citrus reamer) and eight familiar objects. Because there were no formal toys and a very limited number of household artifacts in the village, the familiar objects depicted in the book were different from those used in the American study. They included a broom, some raw beans, a bucket, a stove, a bundle of sticks, a shirt, a chair, and a wooden spoon. Each familiar object was depicted one time, accounting for half of the pages in the book, and each of the two novel objects was depicted four times, accounting for the remaining half. The book was organized so that a familiar and a novel object were visible on opposite pages when the book was held open (see Figure 1). The novel objects each appeared twice on the left side and twice on the right side.

Ten additional items were used for the training and the three test phases of the study. For the training phase, there were two color photographs of familiar objects (chair, shirt) from the book and corresponding real objects. For the test phase, there were two color

photographs of the novel objects depicted in the book (as described above), the two novel objects themselves, and one novel exemplar of each of the novel objects (same shape but different color: bronze wire egg holder and yellow citrus reamer).

Procedure.

Picture-book reading phase. The experimenter sat with the mother and child on a mat on the ground and spent several minutes playing with the child until he or she was comfortable. During the book-reading, the child was taught a name for one of the two novel objects that appeared in the picture book. The experimenter turned through the pages of the book, engaging the child in natural interaction. All interaction was conducted in Swahili. The experimenter named each of the eight familiar items (e.g., "Look, a broom!") and pointed at the picture, ensuring that the child was attending to the book (see Figure 2).

For each of the four pages depicting the novel target item, the experimenter labeled it three times with a novel name ("Look, this is a *blicketi*. See, a *blicketi*. Yeah, that's a *blicketi*!") Thus, the children heard the name of the novel target object a total of 12 times throughout the interaction. For each of the four pages depicting the novel nontarget item, the experimenter spent an equivalent amount of time on the page, without ever labeling it ("Look at this! See this? Wow, look at this."). Half of the children were taught the novel label for the wire egg holder, and half of the children were taught the novel label for the citrus reamer. The novel label that was applied to the target item ("*blicketi*") was adjusted from the original label ("*blicker*") that was used by Ganea et al. (2008) in order to be consistent with typical Swahili phonetic patterns.

Training phase. This phase was intended to familiarize the children with the test format. At the conclusion of the book-reading interaction, the picture book was removed from view and the experimenter produced two pictures of familiar items that appeared in the book in front of the child and asked for one of them by name. The experimenter did the same with another pair of familiar objects. This was to ensure that the children were familiar with the testing procedures and were able to engage with the experimenter before the test phase. Children who failed to respond were encouraged and asked a second time. Children who still failed to respond ($n = 4$) or responded incorrectly on both of the familiarization trials ($n = 1$) were excluded from the study.

Test phase. Children who passed the familiarization trials received three tests in a fixed order immediately afterward: (a) *Recognition*—the child was shown the pictures of the target and nontarget items and asked to select the *blicketi*; (b) *Extension*—the child was asked to select the *blicketi* from the target and nontarget

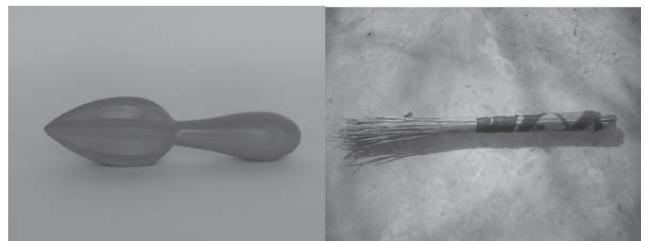


Figure 1. Sample pictures of one of the novel objects and one of the familiar objects (broom) used in the picture book.

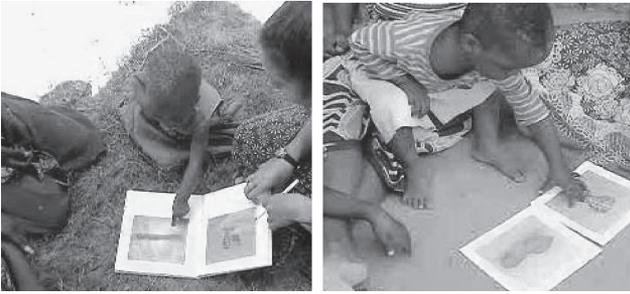


Figure 2. Photographs of the picture-book reading (left) and the recognition test (right). The authors received signed consent for the children's likenesses to be published in this article.

objects; (c) *Generalization*—the child was asked to select the *blicketi* from the two novel exemplars of the target and nontarget objects. These three tests are in line with standard word learning paradigms. The *recognition* test was used to assess whether the child had established a link between the label and the item during the picture-book interaction. The *extension* test assessed the child's ability to transfer information learned in the context of a picture book to actual instantiations of the object in the world. Finally, the *generalization* test assessed the child's ability to apply the newly learned label to other examples of the object (indicated by a change in color).

On each of the three tests, the target item appeared on alternating sides, with the first target item on the right for half of the children and on the left for the other half (see Figure 2). The experimenter drew the child's attention to each of the two novel items in turn, and then laid them on the ground in front of the child. The experimenter said, "There is a *blicketi* here. Show me the *blicketi*." This procedure was identical for the *recognition*, *extension*, and *generalization* tests, except for the type of stimuli presented (pictures, objects, and novel exemplar objects, respectively). If the child did not respond or selected both items on a given test question, the experimenter removed the items and repeated the question.

Coding. Children's responses were recorded by the second research assistant during the testing session, and all sessions were video recorded for independent coding by a third research assistant who was naïve to the hypotheses of the experiment. Interrater reliability was very high; the two coders agreed on 96% of the children's responses to the test questions. The few discrepancies were resolved by a third party. Responses on the three test trials were scored as pass/fail. Children received one point for correctly indicating the target item (pass) and zero points for incorrectly indicating the unlabeled item or for failing to indicate either item at test (fail).

Results and Discussion

Training phase. Children in each age group performed well on the training phase, indicating that they understood the format of the test questions. Almost all of them correctly identified both the familiar picture (92% of the 20-month-olds, 95% of 27-month-olds, and 100% of 34-month-olds) and the familiar object (70%, 80%, and 100% of children, respectively). Children's performance

on the familiar picture test questions indicated that they could recognize depicted objects and could use familiar labels to identify them.

Test phase. Figure 3 shows the percentage of children in each age group who answered correctly on each of the three tests. For comparison purposes, we also display the performance of the 18-month-old infants who were tested in the United States with the same procedure (Ganea et al., 2008). Although Ganea et al. (2008) reported results from both 15- and 18-month-old infants, only the data from the 18-month-olds (who are similar in age to the youngest group of Tanzanian infants tested) are included in the figure.

Results reveal substantial differences in the performance of the Tanzanian children and the 15- and 18-month-olds tested in the United States. As reported by Ganea et al., by age 18 months, the American infants learned a novel label (88% of children answered correctly), extended it to the real object (94% of children answered correctly), and even generalized it to a novel exemplar (75% of children answered correctly) following a single picture book interaction. Over half (54% of children) answered correctly on all three tests, a rate significantly above chance levels. By contrast, the Tanzanian infants who were slightly older ($M = 20$ months) did not learn the novel name from the picture book interaction. When presented with pictures of the target and distractor objects, only 31% (four out of 13 children) in the youngest age group correctly identified the target object when asked for it by name (binomial test, $p = .27$). As a result of this low level of learning from the picture book, only 23% (three out of 13 children) answered correctly on the *extension* and *generalization* tests (binomial test, $p = .09$).

Importantly, the 20-month-old infants' low performance on these tasks was not entirely due to their selection of the unlabeled item, since children were also determined to "fail" the test in cases in which they did not select either item. Five infants failed to select a picture in the *recognition* test, one infant failed to select an object in the *extension* test, and two infants failed to select an object in the *generalization* test. None of the infants failed to respond on more than one test, and all infants successfully responded during the familiarization trials. We therefore interpret the 20-month-old infants' failure to select an item as an indication of their lack of learning. By contrast, only one of the 27-month-olds and none of the 34-month-olds who passed the familiarization trials failed to select either item on the *recognition* test.

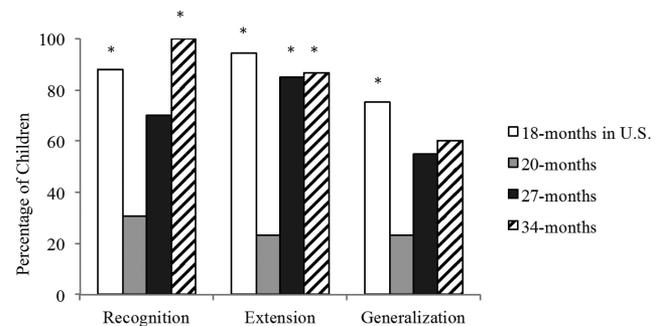


Figure 3. Percentage of 18-month-olds in the United States (as reported by Ganea et al., 2008) and 20-, 27-, and 34-month-olds in Kwala, Tanzania, who gave correct responses on each of the three tests. Asterisks indicate above-chance performance (chance performance was 50%).

Regarding older children's performance, two-tailed exact binomial tests indicated that 70% (14 out of 20) of 27-month-olds ($p = .12$; marginally significant with one-tail test, $p = .06$) and 100% (15 out of 15) of 34-month-olds ($p < .01$) correctly identified the target picture on the *recognition* test. On the *extension* test, 85% (17 out of 20) of the 27-month-olds ($p < .01$) and 87% (13 out of 15) of the 34-month-olds ($p < .01$) correctly applied the label to the real target object. Thus, like the 18-month-old American infants, the 27- and 34-month-old Tanzanian infants learned a novel label from the picture book and applied it to its real-world referent. However, unlike the 18-month-olds in the American sample, only 60% (nine out of 15 children) in the oldest group of Tanzanian children generalized the label to a novel real exemplar of the depicted object (binomial test, $p = .61$). This level of performance on the generalization test is similar to the performance of 15-month-old infants tested in the United States (not included in Figure 3), who did not readily generalize (50% correct) to a novel exemplar.

To further examine the Tanzanian children's understanding of the relation between picture and referent, we examined the performance of individual children across the three tests. None of the 20-month-olds responded correctly on all three tests. However, 45% (nine out of 20) of the 27-month-olds (binomial test, $p < .01$) and 60% (nine out of 15) of the 34-month-olds (binomial test, $p < .01$) selected the correct picture, extended the label to the correct object, and also generalized to a novel exemplar (chance = 12.5%). There was therefore high consistency in individual performance across the three tests in the two older age groups.

To examine differences in performance on the three tests as a function of age, a repeated measures logistic regression using a generalized estimation equation (GEE) model was conducted with test as the repeated measure. There were two significant main effects: age, $\chi^2(2) = 242.01$, $p < .01$, and test, $\chi^2(2) = 400.92$, $p < .01$. There was also a significant interaction between age and test, $\chi^2(3) = 1263.34$, $p < .01$.

Post hoc analyses were therefore performed to assess age-group differences in performance on each of the three tests, using two-tailed Fisher's exact tests. On the *recognition* test, the 34-month-olds performed better than the 27-month-olds ($p < .05$), who performed better than the 20-month-olds ($p < .05$). Similarly, there was a significant age difference in children's extension of the newly learned label to its real referent, with the 27- and 34-month-olds performing equally well on the *extension* test and both groups performing significantly better than the 20-month-olds ($p < .01$). Finally, there was a marginally significant difference in children's generalization to a novel exemplar, with children in the oldest age group performing better on the *generalization* test than children in the youngest age group ($p = .06$).

To summarize, these results provide evidence for increased pictorial competence with age in a population of young children with no prior pictorial exposure. By 27 months, the Tanzanian children applied the novel label learned from a brief picture book interaction to its real referent, and more than half of the 34-month-olds (60%) also generalized the label to a novel exemplar. The pattern of performance across all three tests displayed by the 34-month-olds in Tanzania is comparable to the pattern shown by infants as young as 15 months tested previously in the United States (Ganea et al., 2008).

While the results of Study 1 demonstrate developing pictorial competence in 2- to 3-year-old children without prior experience with symbolic media, these results also indicate a *lack* of competence in infants under 2 years of age. This result is particularly striking given the previous research that has shown that these abilities are developing between 15 and 18 months in infants tested in the United States (Ganea et al., 2008). These findings provide evidence for the important role of early experience with pictures and picture-based interactions in children's ability to learn and transfer new information from picture books to the real world.

However, given the novelty of the experimental setting and testing conditions, it is possible that these young Tanzanian infants failed due to an inability to learn from the experimental paradigm. It is also possible that the infants' failure was due to a general difficulty to learn new information. Although the younger infants performed successfully on familiarization trials, suggesting that they could respond to test questions in relation to pictures of familiar objects, it is important to assess the extent to which children's delay with the pictorial task was due to a general difficulty in learning new names in a new experimental context. Study 2 was designed to address this issue.

Study 2

The results of Study 1 established that by 27 months of age, Tanzanian infants with no prior experience with pictures and picture-based interactions with others can learn a label for a depicted object and extend that label to the real referent, and by 36 months of age, infants in Tanzania begin to demonstrate more flexible use of pictorial symbols, generalizing labels to novel exemplars of the referent more than half the time. However, unlike children in the United States, 20-month-old Tanzanian infants failed to map new labels onto pictures and to transfer them to their real referents. In Study 2 we examined whether children of this age could learn new labels in a *nonsymbolic* version of the task used in Study 1.

Accordingly, in Study 2, we asked whether 20-month-olds in Tanzania are able to learn novel labels in relation to real *objects* (rather than pictures of those objects) in an otherwise identical context. The procedure was similar to the one used to assess the behavior of infants in the United States (see Study 2 in Ganea et al., 2008), in which children were first taught a novel name for a novel object, and they were then asked to recognize that object and generalize the newly learned label to novel exemplars of that object.

Method

Participants. The participants included twelve 20-month-old infants (range = 15 to 23 months, $M = 19.7$; six girls). All children were able to successfully complete the task, and no children were excluded from the study. None of the children participated in Study 1. Children were randomly assigned to learn the label for one of two novel target objects.

Eleven out of 12 mothers reported 7 years of formal education (equivalent to primary school), and one mother reported 9 years (some secondary schooling). All but one of the mothers were literate in Swahili. All children were able to comprehend Swahili and follow verbal instructions, and all but one child produced some words.

Materials. Four objects were used during the training phase of the study: two familiar objects (a broom and a plastic bucket) and two novel objects (a gold S-shaped hook and a black plastic folding picture frame). According to their mothers, none of the children had ever seen the novel objects before. Each novel object served as the target object for half of the children.

Two additional objects were used during the generalization question of the test phase of the study. These objects were novel exemplars of the novel objects introduced during the training phase (a silver S-shaped hook and a blue plastic picture frame).

Procedure. The procedure for Study 2 was very similar to that in Study 1, with two exceptions. First, the children were taught a label for an actual object rather than a picture of an object. Second, there were only two familiar objects presented alongside the novel objects during the training phase. This procedure is identical to the training phase used in Study 2 of Ganea et al. (2008).

Object labeling phase. Similar to the picture book training in Study 1, the objects were presented to the infant in pairs, which were laid on the ground in front of the infant. The object pairs were presented out of the infants' reach to avoid their grasping or handling of the objects. The order of presentation of the pairs was as follows: (a) Familiar Object A/target novel object, (b) nontarget novel object/Familiar Object B, (c) target novel object/nontarget novel object, (d) nontarget novel object/Familiar Object A, and (e) Familiar Object B/target novel object.

As in Study 1, the child heard the target novel object labeled a total of nine times (three times for each presentation of the object). The nontarget novel object was not labeled but was referenced three times for each presentation (e.g., "Look at this. Yeah, see this? Wow, look at this!"). Familiar objects were each labeled one time for each presentation. The target object was presented on the left on the first trial for half of the children and on the right for the other half. The novel objects were presented on alternating sides across training pairs, and they appeared equally often on the left and right side.

Training phase. Again, as in Study 1, this phase was intended to familiarize the children with the test format. At the conclusion of the object labeling phase, all objects were removed from view and the experimenter produced two of the familiar items, laid them in front of the child, and asked for one of them by name. Children who failed to respond were encouraged and asked a second time. Unlike in Study 1, no children were excluded from Study 2 for failure to respond to the training items.

Test phase. Immediately after training, each child was given two tests: (a) *recognition*—target versus nontarget objects; (b) *generalization*—new exemplars of target versus nontarget objects. As in Study 1, these tests were always given in the same order. However, unlike in Study 1, we did not include an *extension* test, as the goal of Study 2 was to assess performance on infants' learning and transfer from objects to objects, rather than across domains. To this end, no pictorial representations were presented during the experiment.

For the *recognition* test, the experimenter first drew the child's attention to the two test objects while holding them out of reach. After the child had attended to both, the experimenter asked for the target object (e.g., "I see a *blicketi* here. Where is the *blicketi*?") and placed both objects on the ground within reach of the child. If a child was hesitant to respond or picked up both objects at once,

the experimenter presented both objects and asked the question again.

For the *generalization* test, the experimenter first drew the child's attention to the target and nontarget new exemplars while holding them out of reach. After the child had attended to both, the experimenter placed the objects on the ground within reach of the child and asked for the target object, as described above. All responses were recorded by the experimenter immediately and video recorded for scoring by a second blind experimenter.

Results and Discussion

Training phase. Similar to the pattern of results in Study 1, 92% (11 out of 12) of the 20-month-olds in Study 2 correctly identified the familiar object from the pair of familiar objects presented (binomial test, $p < .01$). Children's performance in the training phase indicated that they understood the test format and that they were able to use familiar labels to identify objects in this experimental setting.

Test phase. Unlike the performance of 20-month-olds in Study 1 with pictures, the infants in Study 2 learned the object name from the brief interaction with an adult experimenter and generalized this label to a new exemplar of the novel object. When infants were presented with *real* target and distractor objects, all of the children correctly identified the target object when asked for it by name during the *recognition* test (binomial test, $p < .01$). Further, 83% of children (10 out of 12) were able to generalize the label to a new exemplar of the target object in the *generalization* test (binomial test, $p < .05$). These results indicate that Tanzanian infants can learn novel labels and further generalize them to novel exemplars when the training requires them to map the label onto a real object. By comparison, the failure exhibited by the 20-month-olds in Study 1 is not due to a general failure to acquire new words or by a failure to acquire information in a novel setting.

General Discussion

As shown in previous research, at 9 months of age, infants growing up in two extremely different cultures, with either high or very low prior exposure to pictures, begin treating pictures similarly, as "objects of action," by grasping, banging, and scratching on them, showing a lack of understanding of their referential nature (DeLoache et al., 1998). In industrialized cultures, however, infants rapidly progress to treating pictures referentially, and by 15 months, they begin to use pictures as sources of information about the world (Ganea et al., 2008, 2009; Preissler & Carey, 2004). However, due to universal high exposure to symbolic media that is common in Western cultures, it has not been possible to empirically examine the role of experience in the development of competence in learning novel information from pictures.

The present research, which examined young children's learning from picture books in a population with no exposure to pictorial media, demonstrated that experience plays an important role in children's learning and transfer of labels from pictures to the real world. The studies presented here corroborate previous research documenting delays in pictorial comprehension in infants from traditional cultures with minimal experience with symbols (Calaghan et al., 2011) and extends this work to examine effects of cultural exposure on word learning from pictures.

In Study 1, Tanzanian children under 2 years demonstrated no learning from the picture book interaction, suggesting that they had difficulty mapping new information (a novel word) onto a picture. This was not due to an inability to *perceive* pictures, as shown by their recognition of familiar depicted objects. Further, this was not due to an inability to learn from the particular experimental paradigm used, as shown by the fact that children of the same age could map a novel label onto a real object and further extend it to a novel exemplar (Study 2). Thus, the 20-month-old children tested in Tanzania could successfully solve the word-learning task involving real objects, and yet, at the same age, children had difficulty relating a label with an object when the label was initially provided in relation to a picture. If children already have an understanding that words stand for referents and, thus, can learn novel words in relation to real objects, it is possible that the lack of experience with others using words in relation to referents from a variety of domains (real objects, depicted objects, televised images of objects, etc.) may, in part, explain why the younger children in this study were limited in their mapping of the word to a depicted object.

By 27 months, the Tanzanian children learned the novel label they heard in relation to a picture and applied it to its real referent. At 34 months, 60% of the children learned the new label, applied it to its real target, and generalized to a novel exemplar of the depicted object, indicating a richer understanding that information learned from pictures applies to a set of possible referents in the world. Taken together, these results indicate that, despite significant delays in pictorial understanding (see also Callaghan et al., 2011), children growing in a culture where pictorial media are almost absent can begin to use pictures as a source of information about the world by the end of their third year of life.

What factors may contribute to the achievement of referential understanding of pictures in a culture with little or no pictorial media present? It has been previously proposed that language and social-cognitive skills can function as bootstrapping mechanisms for the development of referential understanding of pictures (Callaghan, 2000; Ganea et al., 2009; Preissler & Bloom, 2007). When we point to a picture and label it, we are cuing the child to take it as a symbol for a real object, and previous research has demonstrated that by 2 years of age, children understand that labels refer to depicted objects, not to the picture itself (Preissler & Bloom, 2007). Further, because common nouns are interpreted to refer to object kinds, labeling may serve to highlight a picture's symbolic status (Bloom, 2000). Consistent with this view, a series of studies conducted by Callaghan (2000) have shown that until 2.5 years of age, children may only succeed in identifying the referents of pictures when the pictures have been labeled for them, or the labels are previously known. In these studies, Callaghan (2000) pointed to depicted objects and instructed children aged 2.5 and 3 years to "find this one" (without labeling). When children were then shown two real objects, one of which had been depicted in the picture, the younger children were not able to identify the depicted object when labels were not provided.

In the current research, 27- and 34-month-old children from a picture-sparse culture were able to use pictures referentially to some extent, when the pictures were initially labeled for them. They extended the label that was initially used for a picture to its real exact referent but did not generalize it further to a novel exemplar. In line with the view that labeling facilitates symbolic

use of pictures, children from Peru and India in Callaghan et al.'s (2011) recent study could not match pictures to their referents in the absence of labeling until around 4 years of age. Although the presence of language was not sufficient for the younger Tanzanian children, it is possible that superior language skills and more sophisticated understanding of the intentional nature of communication in the older children facilitated their performance on the pictorial task. Another factor that may have contributed to the Tanzanian children's ability to transfer information from a picture to its real referent in this study has to do with the iconicity of the pictures. Higher levels of iconicity involve more perceptual detail and hence more information in common between three-dimensional objects and two-dimensional depictions. The information about the referent object provided in the photographs used here may have contributed to a more robust representation of the depicted object and thus facilitated older infants' performance when presented with the real objects. As with other types of symbolic artifacts, higher levels of perceptual similarity between symbol and referent make the referential relation more transparent, thereby helping children transfer information between symbol and referent (Callaghan, 2000; DeLoache, Kolstad, & Anderson, 1991; Ganea et al., 2008; Simcock & DeLoache, 2006).

Future cross-cultural work will be important to determine whether the successful performance of the older Tanzanian infants in Study 1 was based on associative mapping between the representation of the depicted object and the real referent, rather than on symbolic understanding of the picture as a representation. Clearly, the older children in this study learned the mapping between a word and a picture, and when tested with two real objects, they applied the word to the picture's real world referent. Nevertheless, it is possible that they considered the real object to be the best of two bad options for the word they learned in relation to a picture (Ganea et al., 2009), without an understanding that a novel word applied to a picture refers to an object in the real world. In other words, they simply applied the label to any stimulus that was perceptually similar to their stored representation. When given a choice between a picture and the real object it stands for, toddlers tested in Western cultures reject the picture alone as a referent for the word, despite the fact that the word was repeatedly associated with the picture (Ganea et al., 2009; Preissler & Carey, 2004). This response pattern has been taken as evidence that by 15 months of age, children know that both words and pictures refer to objects. It will be important to know if the Tanzanian children tested in this research would show the same pattern of behavior, rejecting the picture when given a choice between the labeled picture and its referent. Additionally, using pictures with different levels of iconicity (photographs vs. black-and-white line drawings) would further inform about the role of pictorial fidelity in children's symbolic choices. In general, children have more difficulty with cross-medium transfer (i.e., transfer between a 2D representation and a 3D object) than within-medium transfer (i.e., transfer between a 2D representation and another 2D representation or transfer between a 3D object and another 3D object), and the degree of overall similarity in features among the items (objects and objects; pictures and objects) can impact transfer of information from one medium to another (Barr, 2010; Hayne, 2004).

To summarize, the research reported here provides evidence for the important role of experience in the early development of an understanding of pictures. It also shows that, despite significant

delays in learning and transfer of information from picture books, children from a pictorially sparse culture begin to treat pictures referentially, as a source of information about the world, by the end of their 3rd year of life. There have been a variety of proposals regarding the particular types of experiences that may be necessary for the early development of pictorial understanding during infancy, ranging from early exposure to two-dimensional images (e.g., Bovet & Vauclair, 2000; DeLoache et al., 1979; Deregowski, 1989), independent exploration of pictures (e.g., DeLoache, 1991; DeLoache et al., 1998; Fletcher & Sabo, 2006; Murphy, 1978), cultural experiences with other people using pictures and other symbols to communicate information about the world (e.g., Callaghan et al., 2011; Callaghan & Rankin, 2002; DeLoache & Burns, 1994; Gelman et al., 2005), or some combination of these factors. Future cross-cultural research examining the specific skills involved in the development of referential understanding of pictures and the type of experiences that affect these skills could reveal important information about mechanisms underlying symbolic development.

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