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Do Both Pictures and Words Function as Symbols for 18- and 24-Month-Old Children?

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In Experiment 1, 24-month-old toddlers were taught a new word (*whisk*) through the labeling of a picture of a whisk. After repeated pairings of the word and picture, participants were shown the picture and a real whisk and asked to indicate the whisk. They took the word to refer to the real object rather than to the picture. Experiment 2 established that children were not biased to select any novel real object in the test trial. Rather, the results from Experiment 1 reflected the child's interpretation of the word as referring to the pictured kind. A third study confirmed that a novelty preference within a perceptually specified category could not account for the results of Experiment 1. A final study (Experiment 4) examined whether 18-month-old infants also understand pictures and words as symbols, and results were comparable to those of Experiments 1 and 2. Taken together, these results confirm that the mapping between words and objects for 18- and 24-month-olds is a referential relation, as opposed to an associative one. Furthermore, these results show that children as young as 18 months begin to understand the symbolic nature of pictures.

In adult human mental life, both pictures and words function as symbols. Many words and pictures stand in a representational relation to entities in the world; these symbols have referential content. The word *dog* refers to dogs in general or to a particular dog (as in, "my dog, Domino"). Similarly, a picture of a dog may represent dogs in general or a particular dog. The referential relation is fundamentally

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intentional; the intentions of a symbol's maker or user determine its content (see Bloom & Markson, 1998).

In discerning the nature of representational understanding, we must consider whether every creature for whom there is a mapping between a word/picture and some set of entities in the world grasps the symbolic nature of the word/picture. This question is trenchant in cases of lexical representations in nonhuman primates; see the debate between Seidenberg and Petitto (1987) on one hand and Savage-Rumbaugh and colleagues (Savage-Rumbaugh, 1982; Savage-Rumbaugh & Brakke, 1985; Savage-Rumbaugh, McDonald, Sevcik, Hopkins, & Rubert, 1986; Savage-Rumbaugh, Shanker, & Taylor, 1998) on the other. It also arises when considering the nature of the mapping between pictures and objects, and between words and objects, constructed by low-functioning children with autism who have been taught to use pictures of objects as a means of requesting objects in the world (Bondy & Frost, 1998; Lancioni, 1984). The question also arises in the case of young infants.

An alternative interpretation of the mapping between words/pictures and their referents is that it is merely associational (e.g., Plunkett, 1997; Smith, Jones, & Landau, 1996). Associative mappings may be created between any arbitrary stimuli, as when a tone signals shock or predicts reward following a bar press. Associative mappings reflect frequency and temporal contiguity of pairings. They are created by classical laws of association (see Rescorla & Wagner, 1972) or by mechanisms that determine causally relevant contingencies (see Gallistel, 1990; Heyes & Dickinson, 1990). When a bee learns that red flowers with a certain odor contain sweet nectar, we do not think that the bee considers the flower to be a symbol of nectar; rather we consider the bee to have learned a predictor of nectar.

In terms of word learning, an associative account of the mapping between words and objects in the world holds that it is established through sensitivity to statistical covariation. On this account, words are nonreferential and nonsymbolic. Children learn words such as *car* through repeated pairing of the verbal label with experience of cars (e.g., Richards & Goldfarb, 1986). Connectionist treatments of word learning, drawing on statistical relations between words and objects in the environment, are in this tradition (Plunkett, 1997). Indeed, children's initial word learning can certainly be seen as consistent with the associative view; their first words are often things one can see, and information provided by parents tends to be overt (i.e., picking up a cup and repeatedly labeling the item for the child). On the surface, the input conditions for word learning would seem to be consistent with associationist principles. However, deeper analyses question this assumption (Bloom, 2000; Harris, Jones, & Grant, 1983) and experimental evidence also undermines this view.

There are many empirical studies that suggest infants as young as 18 months understand that words are representations with referential content, for toddlers of this age seek evidence from the word's introducer as to his or her referential intent.

Baldwin (1991, 1993b) conducted a series of experiments in which 18- to 19-month-old children used the gaze of an adult to map a novel label to an item. One condition explicitly contrasted the symbolic and associationist points of view. The experimenter waited until the infant was attending to an unfamiliar object, and then exclaimed, "Look, it's a modi." The experimenter, however, was looking in a bucket, at an unseen object. The children did not map the term *modi* to the item they themselves were looking at and playing with, but rather they looked to see what the experimenter was staring at and applied the word to the item within the bucket. Baron-Cohen, Baldwin, and Crowson (1997) replicated these findings with 24-month-olds and found that children with autism of the same mental age failed to use the speaker's gaze in mapping a newly heard word onto an object. These results suggest that typically developing toddlers of this age know that a speaker's referential intention provides evidence for an object label's content. Mere associative pairing, at least for typically developing children, does not determine the mapping.

Baldwin et al. (1996) provided additional evidence that the mapping between words and objects is not determined by the laws of association. Infants heard novel labels when they were investigating a single novel object. In one condition, the speaker was seated within the infant's view and displayed concurrent attention to the novel toy when verbalizing the novel label (coupled condition); in the other condition, the label was given by a speaker seated out of the infant's view (decoupled condition). Infants mapped the label to the object in the coupled condition but not in the decoupled condition, despite that covariation between label and object was equivalent in both cases.

Baldwin and colleagues' (1996) conclusions from such data have not gone unquestioned. Those who believe that the mapping between words and objects is associative might reply that joint attention is a condition on the child's making the mapping. This may be so, but for this reply to have some force, one would need an account of how this condition comes to be learned through associative mechanisms. The experiments presented here approach the issue in a different way, seeking convergent evidence for Baldwin's conclusions from a very different paradigm and a very different reflection of the distinction between associative mapping and referential mappings.

From Baldwin and colleagues' (1996) work, we have evidence consistent with the claim that words are symbols for children, then, at least by 18 months of age (see also Tomasello, Strosberg, & Akhtar, 1996). What about pictures? Pictures are significant stimuli in the conceptual life of young American infants, as they are frequently surrounded by books and photographs. Mature pictorial competence involves appreciating the representational nature of pictures (DeLoache, 1991). Despite the fact that a realistic picture is perceptible and occupies its own space, its purpose is to depict something else in the real world. As adults, we have the knowledge that pictures refer, but do toddlers share this understanding?

When we show a toddler a picture of an aardvark or a dump truck and label it *aardvark* or *dump truck*, we assume the child takes us to be providing information about the entities in the world that are so named. We assume neither that toddlers assume that these words refer only to the pictures nor that the facts we tell them about aardvarks or dump trucks are facts about the pictures themselves. But are we right in this assumption? DeLoache and Burns (1993) termed the awareness of the symbolic relation between the picture and what it stands for "representational insight," and they suggested that in at least one context in which pictures represent a current situation children do not show representational insight into pictures until 2.5 years of age[1] (DeLoache, 1987, 1989, 1991).

The question of when infants understand pictures as representations must be distinguished from two other questions about picture perception. First, when do children recognize the perceptual similarity between pictures and the real items to which they refer? Second, when do children recognize the differences between pictures and real objects that are consequences of the two-dimensional (2D) nature of pictures? With respect to the first question, habituation studies show that very young infants (5 month olds) appreciate the perceptual similarity between pictures and objects. For example, after being habituated to a face (Dirks & Gibson, 1977) or real object (DeLoache, Strauss, & Maynard, 1979), 5-month-old infants generalized habituation to pictures of the same face or object and dishabituated to pictures of novel faces or objects. Hochberg and Brooks (1962) showed that prior experience with pictures is not necessary for infants to recognize the similarity between 2D representations and three-dimensional (3D) objects. They meticulously kept their participant away from pictured images until 19 months of age. The participant had no trouble identifying pictured objects when finally presented with picture books. These studies illustrate that children of 5 to 19 months of age perceive pictures and real objects in ways that capture perceptual similarity, but they do not examine whether infants understand pictures as representations.

With respect to the second question, it appears that infants fail to fully appreciate the consequences of the 2D nature of pictures until the middle of the 2nd year of life, although they can discriminate between pictures and real objects (DeLoache et al., 1979; Slater, Rose, & Morison, 1984). In a study of infants looking at picture books consisting of one small photograph per page, DeLoache, Pierroutsakos, Uttal, Rosengren, and Gottlieb (1998) showed that 9-month-old in-

[1]Here we are concerned with pictures that resemble their referents: Although an artist may intend an abstract painting to have meaning, even to refer to entities in the world, the referential potential of abstract art is not our focus here. Bloom and Markson (1998) asked 3- and 4-year-old children to draw pictures; later these children were able to readily identify the pictures they had drawn based on what they intended them to be even though the pictures could not be identified as depicting that referent by naïve adults. By those ages then, pictures need not resemble their referents to have symbolic content.

fants reach and explore photographs as if they were trying to pick up the items depicted in the pictures. Even infants from a nonliterate West African community, the Beng of Côte d'Ivoire, displayed the same pattern, showing that this is not a culturally specific phenomenon. There have been many informal accounts of similar behavior (Beilin & Pearlman, 1991; Murphy, 1978). Perner (1991) reported that his son, aged 16 months, tried to step into a picture of a shoe, and Ninio and Bruner (1978) described an 8-month-old trying to pick up pictures in a child's book. In Ninio and Bruner's report, as in DeLoache et al. (1998), this behavior ceased by about age 19 months, by which age infants apparently distinguish pictures from real objects with respect to appearance versus reality. This distinction is necessary but not sufficient for understanding pictures as representations.

The earliest age at which an understanding of pictures as representations has been demonstrated is 30 months by DeLoache and Burns (1994). They presented toddlers with a photograph of a room and indicated on the photo where an object was hidden (e.g., pointing to a couch and stating, "It's under here."). Although 24-month-old children were unable to utilize the information in the photo to locate the object in the real room, 30-month-olds succeeded at this task. DeLoache and Burns took this as evidence that children aged 30 months understand the relationship between the picture and its referent, specifically that the picture refers to the real room, whereas younger children do not.

Could it really be true that children do not understand that pictures are symbols until 2.5 years of age, a full year after they understand words as symbols? Perhaps this failure is restricted to the unusual case in which a picture represents a specific current situation. The hypothesis that the failure of 24-month-olds in the DeLoache and Burns (1994) study reflects a general lack of mature pictorial competence has consequences for how we understand young toddlers comprehension of picture books. If they do not take pictures as symbols for real objects in the world, then how do they understand the adult practice of naming pictures, "That's a giraffe," and providing facts about giraffes, "giraffes live in Africa"? Do young toddlers think that the labels and facts map onto the pictures and perhaps onto other entities perceptually similar to the pictures? Or do they understand that both the word and picture refer to real entities in the world? Experiment 1 explores this question.

In Experiment 1 an experimenter taught toddlers a novel word (*whisk*) for a novel object depicted only in a picture. During the teaching phase of the study, the word was repeatedly paired with the picture. The experimenter then offered the children a choice between the picture and a real whisk (previously unseen) and asked the children to show her a whisk. If the mapping between a word and the stimulus it is paired with is associative, we would expect the children to pick the picture alone or both the picture and the real object because of generalization based on perceptual similarity. If, however, the children understand that both words and pictures are symbols for real-world entities, then they should map the word *whisk* onto a previously unseen object and should choose the real whisk alone or both the picture and the real object, because pictures are often labeled elliptically. We say, pointing to a picture, “That's an elephant,” not “That's a picture of an elephant.” Of course, the selection of both the picture and real object could support either hypothesis.

If children choose the real whisk under these circumstances, various controls are needed to rule out the possibility that real objects are so much more salient than are pictures that 2-year-olds would choose a real object over a picture no matter what was asked. Therefore, in the Real Item Bias Control Phase of Experiment 1, participants were shown a series of familiar entities, one a real object (e.g., a cup) and one a picture (e.g., a picture of a flower). They were asked to show the experimenter one of the entities; half of the time the pictured entity was requested and half the time the real object was requested. Also, to ensure that children of this age would accept both a real object and a picture of an object as correct choice for “Show me a/an *X*”, in the Picture Choice Control children were shown pairs of familiar objects, a real object and a picture of that object (e.g., a spoon and a picture of a spoon). They were asked to show the experimenter a spoon. Additional controls were introduced in Experiments 2 and 3, and Experiment 4 examined whether 18-month-old children also understand pictures as representations.

Thus, this experiment had two goals. First, we sought evidence from a new method that would converge with results in the literature that indicate that young children understand words as symbols and that the mapping between words and objects is a referential, meaning-determining relation, as opposed to an associative mapping. Second, we sought evidence that children younger than 30 months understand the symbolic nature of pictures.

EXPERIMENT 1

Method

Participants. Twenty typically developing, native English-speaking children (*M* age = 24.02 months, range = 20.28–29.02 months) were included in the study. There were 10 boys and 10 girls. Five additional participants were excluded due to fussiness, and 3 additional participants were excluded because they knew the “novel” item to be taught in the experiment. Participants were recruited through the New York University Infant Cognition Center infant database. Parents were reimbursed up to $10 for travel expenses, and children received a T-shirt or small toy for participation.

Stimuli. The stimuli used 3D objects, including some toy models, and 2 in. × 2 in. (5 cm × 5 cm) laminated black and white line drawings modeled after Mayer-Johnson stimuli (picture icons utilized within a symbolic system of communication for individuals with autism; http://www.mayerjohnson.com).

Procedure

One or both of the child's parents were present throughout testing. Participants sat next to or in the lap of a parent, separated from the experimenter by a 24 in. (61 cm) wide table. Items were placed within the participants' reach. Each session was videotaped, with parental consent.

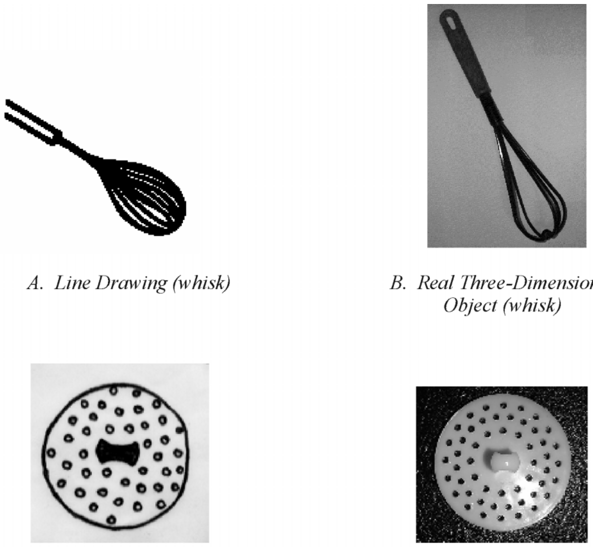
Pretraining phase. Participants were taught a new word paired with a picture. We first needed to demonstrate that the word was indeed novel to the participants. Participants were shown one 8.5 in. × 11 in. page with seven familiar pictures of foods; they were asked to identify a highly familiar object (apple) from the display to ensure that they could discriminate from a pool of seven items. Participants were then shown an 8.5 in. × 11 in. page with seven unfamiliar pictures of tools and utensils; they were asked to identify an unfamiliar object (whisk) from the display. Participants were expected to fail on this trial, showing they did not know the word *whisk* referred to the pictured object, thereby qualifying it as novel. Parents were also asked whether their child knew the word before the session began.

Training phase. The participants were taught the new word *whisk*, mapped to the picture of a whisk. The participants were presented with the picture of the whisk in isolation and were told, "This is a whisk. Can you touch the whisk?" All participants complied with this instruction. The whisk picture was then presented to the participants with an apple picture. The participants were instructed, "Can you show me a whisk?" This was repeated until the participants correctly identified the whisk (by touching the picture or handing it to the experimenter) on three consecutive trials, randomized for side of presentation and with the same instruction to the participants. This teaching procedure is used to teach children with autism novel symbols, in an associative fashion (Bondy & Frost, 1998). If participants failed to correctly discriminate the whisk on consecutive trials, the training procedure was reimplemented from the initial step (presenting the picture in isolation).

The participants were then shown one 8.5 in. × 11 in. page with five pictures (four unfamiliar pictures and the whisk picture) and were asked, "Can you show me a whisk?" Positive verbal feedback was given for each trial. This trial was performed to ensure that the participants had indeed learned the new word and could discriminate between the whisk picture and other pictures not used in the teaching procedure.

Test phase. This was the crucial phase of the experiment, in which participants were presented with the whisk picture and a real whisk. If the participants learned the word through a paired association, without understanding the symbolic role of both words and pictures, they should choose the picture of the whisk when questioned by the experimenter, or they should choose both items due to perceptual similarity between the real whisk and the picture. The word *whisk* had been paired with the picture for a minimum of five mappings (and never paired, or associated, with the real item). If, however, the children understood that both words and pictures refer, they should always include the real whisk in their choice. A choice of both items would also be consistent with referential understanding, as words refer to both pictures and objects.

The participants were presented with the whisk picture and a real 3D whisk (Figure 1) and were instructed, "Can you show me a whisk?" The measure of interest was the response of the child (which item the participant pointed to or gave to the experimenter). Responses were coded as the child's individual touches of the picture and the real whisk. Only intentional responses were coded (giving a picture or object to experimenter, sliding item to experimenter, pointing to item, or picking up and showing to experimenter with eye contact). If the child played with or explored a picture or object without clearly indicating it as a response, this was noted but not included in the final coding. For instance, if a child indicated that an object was correct (by pointing at it or giving it to the experimenter) and then merely played with the picture, this was coded as a "real



A. Line Drawing (whisk) *B. Real Three-Dimensional Object (whisk)*

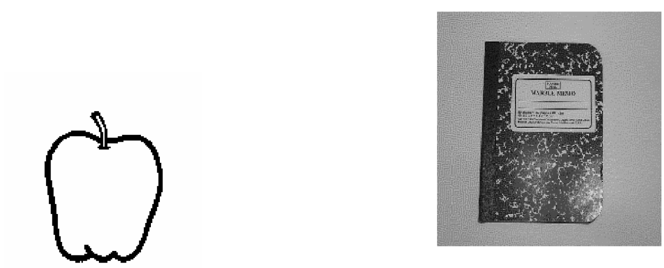
C. Line Drawing (ziff) *D. Real Three-Dimensional Object (ziff)*

FIGURE 1 Stimuli for test phase, Experiments 1, 2, and 4 (A and B); real-item preference probe of Experiments 1 and 4 (A and D); test phase of Experiment 3 (C and D).

object alone" response. Conversely, if the child indicated the picture (by pointing at it or giving it to the experimenter) and then merely played with the object, this was coded as a "picture alone" response. The children's behavior may provide clues about why they respond to an item, as pointing or handing over an item is clearly different from manipulating without referential intent. Two coders independently coded the videotapes. Agreement on response classification was 92%. Disagreements were settled by discussion.

Real-item bias control. This phase of the experiment required participants to choose an item requested by the experimenter, either a picture or real object. This procedure was performed to ensure that participants could choose an item at the request of the experimenter, whether it was a picture or real item, and would not simply be drawn to the real, potentially more salient, item. Participants were presented with one real-world item (e.g., a book) and one picture (e.g., an apple) and were instructed to "Show me a/an *X*" (Figure 2). There were 10 trials of this type. Order and side of presentation were randomized. The measure of interest was the intentional response of each child (which items the child pointed to, picked up and showed, or gave to the experimenter). If the child did not respond after five verbal prompts by the experimenter (or approximately 1 min), the next trial was introduced, and "no response" was recorded.

Picture choice control. Participants were presented with real items and pictures of those items (e.g., a picture of a spoon and a real spoon) and were instructed to show the experimenter a spoon. There were four trials of this type (spoon, dog, button, car). Order and side of presentation were randomized. The measure of interest was the response of child (which items the child pointed to or gave to the experimenter). Responses were coded as the child's individual touches of picture and real item. If the child did not respond after five verbal prompts by the experimenter (or approximately 1 min), the next trial was introduced, and "no response" was recorded. The goal of this control phase was to determine which item (picture, ob-



Line Drawing *Real Three-Dimensional Object*

FIGURE 2 Example of stimuli for real-item bias control, Experiments 1 through 4.

ject, or both) the children paired with a known label for familiar objects. Specifically, this phase would determine if, like adults, children accept words as referring both to real and depicted objects.

There were two types of stimuli used in this phase: real items (button and spoon) and models (stuffed dog and toy car, which are individual objects but still representations of other objects, viz., a living dog and a real car). These two types of stimuli were selected to examine if there was a difference between real, functional referents of a familiar word (e.g., spoon) and models that are, after all, representations of other items (e.g., toy car). In other words, we wished to determine whether the children interpreted the real items as truer referents than models.

Order of procedures. The real-item bias control phase was administered first (to give children exposure to both pictures and objects as correct responses), followed by the picture choice control phase and subsequently the pretraining, training, and testing phases of the experiment. Results are reported in the order as presented in the Procedure section.

Results

The responses we report are intentional acts of indicating the requested items (pointing, showing, giving to the experimenter). Nonreferential exploration or playing with an item was not included.

Pretraining phase. For the pretrials of the novel-word-training procedure, all participants correctly discriminated the apple picture from among a seven-icon sample, showing that they could pick a named entity from an array of seven. One parent reported knowledge of the word by the child, and 2 additional children chose the whisk; therefore, 3 children were excluded from the study. Twenty participants failed to choose the whisk, which confirmed the word as novel for these participants.

Training phase. All participants were able to discriminate the whisk picture from the apple picture for three consecutive trials and to successfully select the whisk from an array of five items, ensuring that they indeed learned the new word. There was an average number of 5.2 pairings between the verbal label and picture. Sixteen participants required the minimum number (5 pairings), 3 children required 6 pairings, and 1 child required 7 pairings.

Test phase. In the last (test) trial, no participants (0%) chose the picture alone, 11 (55%) chose the real item alone, and 9 (45%) chose both items. One child who indicated the real object also explored the picture, but this was not a clear intentional response, hence the trial was coded as "real alone." All other responses were intentional. Of the 9 children who selected both items, 5 chose the real object first and 4 indicated the picture first. Thus, 16 of 20 children indicated the object first or exclusively. They indicated it by pointing to it or handing or sliding it to the experimenter. There was a significant difference between picture and real-item choice ($p < .01$, two-tailed paired t test); all children (100%) included the real item in their choice, whereas only 45% included the picture in their choice.

These results suggest that although the children were taught the new word in a manner consistent with associative learning (verbal label *whisk* paired repeatedly with the picture), they took the word to refer to a real whisk rather than to the picture. The children had no prior experience with the real whisk, and yet all selected the real item when asked to indicate a whisk. None chose the picture alone, in spite of the teaching experience. This action suggests that they took the pictures to serve as representations of real objects.

Some of the verbal responses accompanying the trials were also quite revealing. Seven children made spontaneous verbal responses. Of these, 5 children labeled the real item *whisk*. One additional child who selected both the picture and real whisk held up the real whisk and commented, "This is a whisk," and subsequently presenting the picture, added, "And this is a picture of a whisk!" Another child picked up the real whisk and made a declarative statement ("Ta-da!") when asked to indicate a whisk. There were also some informal comments at the end of the trial; when questioned, "What is that?" by the experimenter, pointing to the whisk, a child holding the real item pointed to the picture and said, "That's a picture of it." These comments provide further suggestive evidence that the children knew that a picture refers to an object in the real world.

Real-item bias control. Here, children were presented with 10 trials, each consisting of one real, familiar object and one picture of a familiar entity; they were asked to show the experimenter one of the items. The overall accuracy for the real-item bias control phase was 96% correct, with an average of 97% accuracy for trials in which the real item was correct, and 95% accuracy for trials in which the picture was correct. There was no significant difference between trial types, and there were no item effects. These results show that children of this age are quite good at the item request task and have no difficulty with selecting either the picture or the real item. Notably, the children were not more preoccupied with a real, potentially more interesting, familiar object.

The children accepted a picture of an apple as a referent for *apple*, at least when the only other choice was a real book. Conversely, the participants correctly accepted a real item (such as a cup) as a referent for *cup* when provided with a picture of a flower as an alternative choice.

Picture choice control. In this control, children were presented with 4 trials consisting of one real, familiar object and one picture denoting the respective object; they were asked, for example, to show the experimenter "a spoon." There was no response on 1 (1.3%) of the trials. Of the 79 remaining trials, summed across all children, children selected both the picture and the object on 57% of the trials, the object alone on 40.5% of the trials, and the picture alone on only 2.5% of the trials (Figure 3). There was a significant difference between picture and real-item choice ($p < .05$, two-tailed paired t test).

There was no significant difference between responses for real items and those for toy models, showing that participants chose the 3D item at the same rate whether it was a real object, such as spoon, or a model that represents another entity, such as a toy car.

These results demonstrate that children know that a real (3D) item is the primary referent of a familiar word, such as *spoon*. The children in the study virtually never chose the picture alone, but in 40.5% of the trials they selected the real item alone. However, these results also demonstrate that the children accepted that the word *apple* applies to the depicted entity, as evidenced by the high proportion of both responses within trials. Adults use language in this manner—when looking through a picture book with a child, we often point to a picture of a monkey and say, “That’s a monkey,” not “That is a picture of a monkey.”

Experiment 1 provides convergent evidence for Baldwin’s (1991, 1993b) conclusion that young language learners appreciate the symbolic nature of words. The process of word learning involves meaning assignment; it is not merely a matter of association. If word learning were simply a process of making an associative mapping, then children whose only experience with a word was repeated pairing with a specific picture would be expected to take that picture as the central stimulus mapped to that word. This was not the pattern observed here. The toddlers never

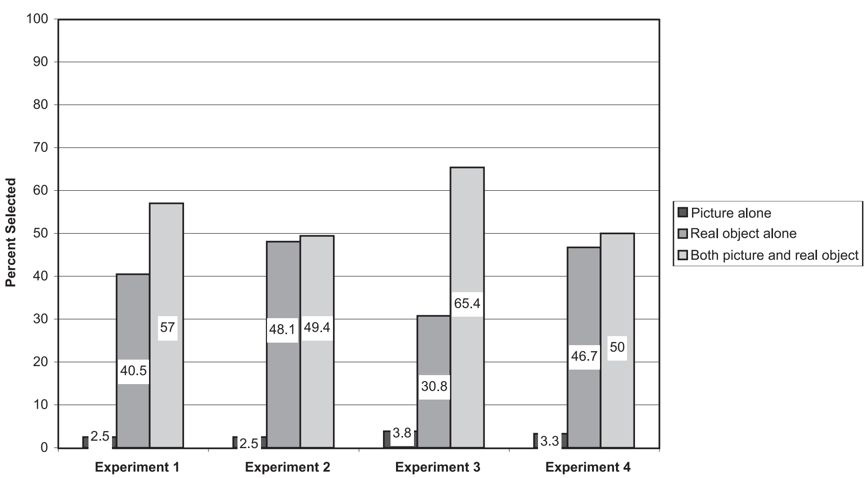


FIGURE 3 Results from picture choice control across Experiments 1 through 4.

chose the picture alone when asked to indicate a whisk. Half the time they picked the real object alone and half the time they picked both the picture and the object. Rather, the pattern observed was that expected if the children understood the picture as a symbol for a real-world object, and understood also that the word referred to that object. The results from the picture choice control confirmed that children consider real objects canonical referents for words, but that, as for adults, it is permissible to directly name a picture with the label of the object pictured. This could explain why they indicated the picture as well as the real whisk when asked to show the experimenter a whisk.

The results from the real-item bias control show that children of this age are perfectly capable of ignoring a real, familiar object in favor of a picture under these circumstances. Thus, the findings from the test trial are not due to overwhelming salience of the real whisk relative to a picture. In addition, the way in which the children interacted with the real whisk, namely pointing or giving it to the experimenter and not merely playing with it, suggests the children viewed it as the primary referent of the word. However, perhaps when the label is a newly learned word, the mapping is fragile and a preference for real objects over pictures determines the response. This real-item preference explanation for the choice of the whisk predicts that children taught the word *whisk* mapped to a picture of a whisk would choose a real item over the picture on the test trials irrespective of the identity of that item—whether it is a whisk or not. Experiment 2 explored this possibility.

EXPERIMENT 2

This experiment was performed to ensure that children were not drawn to the real whisk in the test phase of Experiment 1 simply because it was a real object. After all, children were presented with a picture for many consecutive trials in the teaching phase of Experiment 1. Perhaps any novel real object would be extremely salient under these circumstances. Children may be biased toward the real object, no matter what its identity and regardless of the experimenter's question. To address this question, we performed the same experiment, this time adding a single control trial before the test phase that offered children a choice between the whisk picture and a new novel object, a garbage disposal crusher. Children were asked to show the experimenter a whisk. The control phases, training, and final test trial of the experiment were identical to Experiment 1.

Method

Participants. Twenty typically developing, native English-speaking children (M age = 24 months, range = 22–26 months) participated in the study. There were

10 boys and 10 girls. Two additional participants were excluded due to fussiness, and 2 others knew the word *whisk*. Participants were recruited through the Harvard University Laboratory for Developmental Studies database. Parents were reimbursed up to $5 for travel expenses, and children received a T-shirt or small toy for participation.

Stimuli. The stimuli for the real-item bias control, picture choice control, pretraining, training, and test phases were identical to those used in the same phases of Experiment 1. In addition, a garbage disposal crusher was used as the novel object for the real-object preference probe (Figure 1).

Procedure

The procedure was identical to Experiment 1 with a single exception: after the training phase (word *whisk* paired with the novel picture of a whisk), children were presented with a real-item preference probe. Children were then given the test trial of Experiment 1.

Real-item preference probe. Participants were presented with the whisk picture and a novel object (garbage disposal crusher) and asked to show the experimenter a whisk. This control trial sought to establish whether children were simply drawn to new objects in the test phase. If the fact that a novel object was simply more salient or interesting than was a previously seen picture accounted for the choice of the whisk in Experiment 1, then children should select the object in this trial. If, however, children had mapped the word *whisk* onto the kind whisk, they should reject the garbage disposal crusher in favor of the pictured whisk in this trial. Performance on the test trial in Experiment 2 would then bear, as in Experiment 1, on whether this mapping was associative or referential.

Results

Pretraining phase. All participants correctly discriminated an apple from a seven-object sample, showing that they could pick one picture from an array including six distracters. All participants failed to choose "whisk," ensuring there was no prior knowledge of the word *whisk*, which was also verified by parental report.

Training. All participants were able to discriminate the whisk picture from the apple picture for three consecutive trials and to successfully select the whisk from an array of five items, to ensure they indeed learned the new word. There was an average number of 5.2 pairings between the verbal label and object. Eighteen participants required the minimum number (5 pairings), 1 child required 6 pairings, and 1 child required 7 pairings.

Real-item preference probe. Three participants did not respond to this trial. One handled neither of the objects, and 2 played with both without indicating either to the experimenter. Of the remaining 17 children, all selected the picture alone (100%). Twelve of these 17 children clearly indicated the picture and then additionally explored the novel object. Thus, very few children followed the pattern we might expect if children's behavior toward a novel object in this experimental setting is merely play or exploration. Most children clearly indicated the picture—pointing at and showing it to the experimenter. Later, some children also explored the object. This differential way in which they interacted with the items supports the conclusion that the children understood the word's referent as the picture. These results, therefore, confirm that the children were not simply selecting the real whisk in the test trial because it was a salient, real, object.

Test phase (picture of whisk/real whisk trial). In the test trial, 1 participant (5%) chose the whisk picture alone, 8 (40%) chose the real novel object alone, and 11 (55%) chose both items. One child who indicated the real whisk also explored the picture (nonintentionally), and the single child who indicated the picture also explored the real object (unable to determine if intentional). Of the 11 children who selected both items, 5 indicated the real object first and 6 selected the picture first. There was a significant difference between picture and real item choice ($p < .01$, two-tailed paired t test). See Figure 4 for the pattern of responses on the test trial and on the real-item preference probe trial.

Real-item bias control. The results were identical to those of Experiment 1. The overall accuracy when asked to indicate a familiar object from two choices was 96% correct, with an average of 97% accuracy for trials in which the real item was correct, and 95% accuracy for trials in which the picture was correct.

Picture choice control. These results were also virtually identical to the control phase of Experiment 1 (Figure 3). Shown a picture of a spoon and a real spoon and asked to indicate "a spoon," toddlers take a 3D object as more canonical referent of a familiar word, and to a lesser extent use the word directly to refer to a pictured object. There was no significant difference between responses for real items and toy models (as in Experiment 1).

Conclusions

Experiment 2 shows that the salience and desirability of a real novel object cannot account for the choice of the whisk in the crucial (whisk/whisk) test trials of Exper-

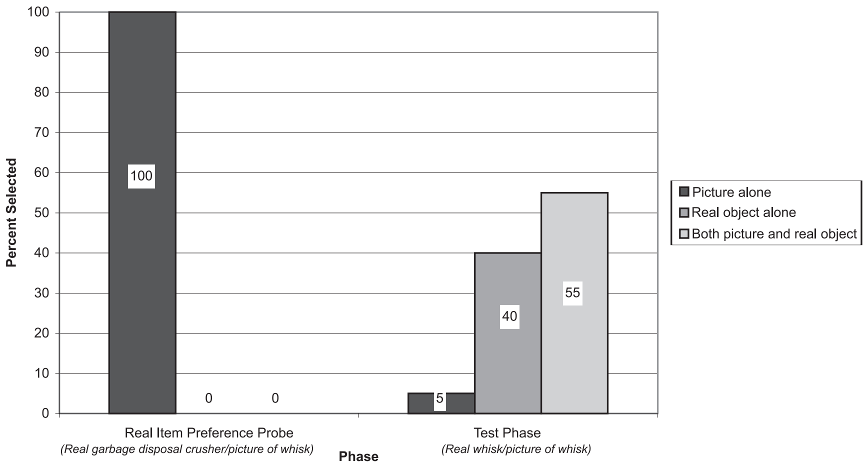


FIGURE 4 Results from Experiment 2, 24-month-old children: real-item preference probe and test phase after word/picture (whisk) training.

iments 1 and 2. If our participants indicated the real whisk alone because it was a salient real object they had never seen before, they should also have chosen the real garbage disposal crusher because it too was a salient real object they had not previously seen. Instead, children clearly indicated the whisk picture was the correct response on the real-item preference probe trial.

Another version of a novelty preference may account for the choice of the real item in the test (whisk/whisk) trial. Perhaps the word is indeed mapped associatively onto the picture, and the real object is included in the mapping due to stimulus generalization and not referential understanding. The children could have selected the real object because it was a novel within-category perceptual match, not because they understood the symbolic relationship between the two stimuli. If this were true, then if we were to teach the children a novel word for a novel object, repeatedly pairing the word with the object, and then offer the same choice as in Experiment 1 (the object and a picture of the object), the children should make the picture the primary choice, for now the picture would be relatively salient because of novelty. Experiment 3 explored this possibility.

EXPERIMENT 3

To ensure that a within-perceptual class novelty preference was not responsible for the whisk test phases of Experiments 1 and 2, children were taught a novel word applied to a novel object. The control phases of the experiment were identical to the first and second studies; the test phase of the experiment probed whether children, when taught a novel word for a novel object, would apply that word only to a picture of that object (indicating a within perceptual category novelty bias).

Method

Participants. Twenty typically developing, native English-speaking children (*M* age = 24.08 months, range = 20.18–27.10 months) participated in the study. There were 8 boys and 12 girls. Four additional participants were excluded due to fussiness. Participants were recruited through the New York University Infant Cognition Center infant database. Parents were reimbursed up to $10 for travel expenses, and children received a T-shirt or small toy for participation.

Stimuli. The stimuli for the real-item bias control and picture choice control were identical to those used in the same phases of Experiments 1 and 2. The stimuli used in the pretraining, training, and test phases were unfamiliar kitchen items and familiar toys. The garbage disposal crusher used in Experiment 2 was here used as the object to be labeled in the training phase. A novel, unfamiliar item was used because 5 children had familiarity with the whisk in Experiments 1 and 2, and we wanted to minimize loss of participants.

Procedure

This procedure was identical to Experiment 1, with the following exceptions: (a) In the training phase, children were taught to pair a novel word (*ziff*) with a novel object (garbage disposal crusher) with the same criterion for learning the word–object pairing (minimum of five correct pairings); (b) the pretraining phase involved discrimination between novel objects rather than pictures; (c) in the test phase, children were presented with the novel object they had just learned a label for and a picture that depicted the same item, and were asked to indicate a ziff.

After learning this mapping, it would be appropriate for children to select the real object on the final trial if they had successfully learned the word–object mapping, either as a symbolic relation or as an association. This choice is also consistent with the view that the children had referential knowledge of the symbolic relationship. In addition, if the children knew that the picture was a symbol for the newly learned object and accepted this relationship, selecting both items would also be appropriate. If, however, children selected only the picture on this trial, it would imply that they were drawn to a novel, perceptually similar item and would suggest that the results from the whisk trial might have been due to a novelty preference for items within the same perceptual category.

Results

As in Experiments 1 and 2, the responses we reported were intentional acts of indicating the requested items (pointing, showing, giving to the experimenter). Nonreferential exploration or playing with an item was not included.

Pretraining phase. All participants correctly discriminated the duck from a seven-object sample, showing that they could pick one object from an array including six distracters. All participants failed to choose ziff, ensuring there was no existing bias to apply the novel label to that particular item.

Training phase. All participants were able to discriminate the ziff from the toy duck for three consecutive trials and to successfully select the ziff from an array of five items, to ensure they indeed learned the new word. There was an average number of 5.5 pairings between the verbal label and object. Fifteen participants required the minimum number (5 pairings), 4 children required 6 pairings, and 1 child required 10 pairings.

Test phase. In the test trial, no participants chose the picture alone, 3 (15%) chose the real item alone, and 17 (85%) chose both items. Of the 17 children who selected both items, 11 chose the object first, 3 selected the picture first, and 3 chose both items simultaneously. One child who selected the real object also explored the picture, although it was not an intentional response. There was no significant difference between picture alone and real-item alone choice. The children were not simply selecting the novel item (picture of ziff on test trial). This finding rules out the within-perceptual category novelty bias hypothesis. In Experiments 1 and 2, the real whisk was the novel of the two whisk-shaped stimuli, and children chose it alone 48% of the time across both experiments. In Experiment 3, the picture of the ziff was the novel of the ziff-shaped stimuli, and children never chose only the picture.

There is another significant difference between the responses on the test trials of Experiment 3 compared with the whisk/whisk trials from Experiments 1 and 2. In Experiment 3, participants selected the real item alone only 15% of the time, compared with 48% across Experiments 1 and 2, $\chi^2(1, N = 60) = 5.5, p < .02$. That is, in Experiment 3, children were more likely to choose both items. Our interpretation of this result is that in Experiment 3 there was no ambiguity as to the primary referent of the word *ziff*, so the children selected the object. Then, because the picture was novel, it captured the children's attention, and they noticed the similarity between picture and object. Thus, the response to novelty contributed to, but cannot by itself explain, the children's intentional responses to the presented entities. Verbal comments made by the children during this trial support this idea. Although there were many fewer verbal comments during Experiment 3 than during Experiment 1 (three in total), 2 children, when presented with the ziff and picture of ziff exclaimed, "They're both the same!" One child, after showing the experimenter the real item, pointed out that the picture was a "ziff too."

Real-item bias control. The results were identical to those from this control phase in Experiments 1 and 2, with an average of 99% accuracy for trials in which the real item was correct, and 98% accuracy for trials in which the picture was correct. When both entities are familiar, there is no bias to indicate a real object rather than a picture.

Picture choice control. Again, these results were virtually identical to those from the same phase of Experiments 1 and 2 (see Figure 3). Note that children in Experiment 3 were more likely than those in Experiments 1 and 2 to pick both items in this phase of the experiment, which preceded the test trials. The greater tendency of this group of children to apply the word directly to a pictured object may also have contributed to the greater number of both choices on the test trial. There was no significant difference between responses for real items and toy models (as in Experiments 1 and 2).

Conclusions

The results of Experiment 3 are not surprising—both the referential hypothesis and the associative hypothesis predicted that when a novel label, *ziff*, is paired with a novel object, a novel kitchen implement in this case, the mapping will be between the word and the object. Nonetheless, Experiment 3 rules out the hypothesis that a novelty bias operating within a perceptual category might have accounted for the results of the test trials of Experiments 1 and 2. If the participants in Experiments 1 and 2 selected the real whisk alone because they had never seen it before and it was perceptually similar to the learned picture, they should have chosen the picture of the ziff alone in this Experiment 3 because it too was novel and a perceptual match to the taught object. Instead, the responses were consistent between both variations; our 24-month-old children preferred the real item, or noted that both items were exemplars of the newly learned word. When taught a new word for an object, children almost always selected both the object and the picture in the final trial.

Experiments 1 through 3, together, suggest that the relations between pictures and objects and between words and objects are symbolic and referential for 24-month-olds, rather than associative. When asked to indicate a whisk, the children in both Experiments 1 and 2 indicated a real object, a whisk, when given the picture they had been taught on and a real whisk. Of 40 children in both experiments, only 1 indicated the picture alone, whereas about half (19, or 48%) indicated the real whisk alone. Whereas the choice of both the picture and the real object is consistent with both the referential and associative mapping hypothesis, for different reasons, the choice of the real object alone is not consistent with the associative mapping hypothesis. The real-object preference probe of Experiment 2 rules out a real-object salience account of the choice of real whisk. When asked to show the experimenter a whisk on this probe trial, none of the children included the novel object (the crusher) in their response, whereas 98% of the participants in Experiments 1 and 2 included the real whisk when it was a choice. Experiment 3 rules out the explanation that the choice of a real over a pictured whisk is merely a within-perceptual class novelty preference: Taught on the real garbage crusher, children never chose a pictured crusher alone, but when they were taught on a pictured whisk, they chose a real whisk alone half of the time.

In Experiment 4 we extended this enquiry to 18-month-olds. This is the youngest age at which toddlers have completely ceased attempting to interact with pictured objects as they would with real objects (DeLoache et al., 1998). By 18 to 19 months of age, children have firmly differentiated the 2D quality of pictures from the 3D quality of real objects. Experiment 4 asked whether they also have begun to understand the referential relations between pictures and the objects they depict. It also brought the present method for studying whether toddlers make a referential mapping between pictures and real objects and between words and real objects into the same age range as Baldwin's (1991, 1993b) studies of the referential relations between words and objects.

EXPERIMENT 4

Experiment 4 replicated Experiment 2 with 18-month-olds, with two differences. Pilot testing revealed that the full paradigm of Experiment 2 was too long to engage this younger population. Therefore, the control phases were shortened. The word learning training and test trials (pictured whisk/real crusher; pictured whisk/real whisk) were identical to those of Experiment 2. Second, the order of the test trial (pictured whisk/real whisk) and the real-item preference probe (pictured whisk/real crusher) were counterbalanced to account for any possible interference effects and keep the procedure consistent with Experiments 1 and 2.[2]

Method

Participants. Fifteen typically developing, native English-speaking children (*M* age = 18 months, range = 17–19 months) participated in the study. There were 8

[2]This was not done in Experiment 2 because 20 participants had been run in Experiment 1 where the test trial immediately followed the training trials. Across Experiments 1 and 2 the crucial test trial (whisk/whisk) immediately followed the training trials half of the time.

boys and 7 girls. Four additional participants were excluded due to fussiness, and 1 additional child knew the word *whisk*. Participants were recruited through the Laboratory for Developmental Studies at Harvard University database. Parents were reimbursed up to $5 for travel expenses, and children received a T-shirt or small toy for participation.

Stimuli. The stimuli used throughout the experiment were identical to those used in Experiments 1 and 2.

Procedure

The procedure was identical to Experiments 1 and 2 with the following exceptions: (a) The test trial and real item preference probe were both presented, counterbalanced for order of presentation; (b) the real item bias control was shortened to four trials; and (c) the picture choice control was shortened to two trials.

Results

Pretraining phase. All participants correctly discriminated the apple from a seven-object sample, showing that they could pick one picture from an array including six distracters. All participants failed to choose the whisk, ensuring there was no prior knowledge of the word *whisk*. This was confirmed by parental report.

Training. All participants were able to discriminate the whisk picture from the apple picture for three consecutive trials and to successfully select the whisk from an array of five items, to ensure they indeed learned the new word. There was an average number of 6.7 pairings between the verbal label and object, which was statistically different from the number of pairings required in Experiment 1 (5.2; $p = .02$, t test, two-tailed) and in Experiment 2 (5.2, $p = .02$, t test, two-tailed) but not Experiment 3 (5.5, $p = .09$, t test, two-tailed). Not surprisingly, the younger children needed more pairings to establish the mapping. Seven participants required the minimum number (5 pairings), 2 participants required 6 pairings, and 6 children required between 8 and 11 pairings to learn the word–picture mapping.

Test phase: Real-item preference probe. Two children did not make an intentional response, exploring both the picture and the novel object, the crusher. All of the remaining 13 children (100%) indicated the whisk picture alone as a whisk. Of these 13, 10 children also explored the real novel object but made an intentional response only toward the picture (e.g., pointing at, showing, or handing it to the experimenter, with eye contact). This pattern replicates exactly what was seen in Experiment 3 with older children and shows that the verbal request guided the children's choice and that they were not swayed to indicate a real object over a picture because of the salience of or preference for a real object.

Test trial (pictured whisk/real whisk). Five children did not provide scorable responses, as they played with the items without clearly indicating either to the experimenter. Three of these played with the real item alone and 2 with both items. Of the remaining 10 children, 6 (60%) indicated the real item alone and 4 (40%) indicated both. Figure 5 graphs the patterns of responses in the real-item preference probe (pictured whisk/real crusher) and the test trial (pictured whisk/real whisk). As in Experiments 1 and 2, these patterns were completely different. Children always indicated the picture alone in the former trials and never indicated the picture alone in the latter.

Real-item bias control. The overall accuracy for the picture versus real item was 95% correct, with an average of 97% accuracy for trials in which the real item was correct, and 93% accuracy for trials in which the picture was correct. There was no significant difference between trial types, there were no item effects, and the results were virtually identical to the corresponding trials from Experiments 1 through 3.

Picture choice control. These results were grouped together across children and across all trials. Children selected both the picture and object on 50% of the trials, the object alone one 46.7% of the trials, and the picture alone on only 3.3% of

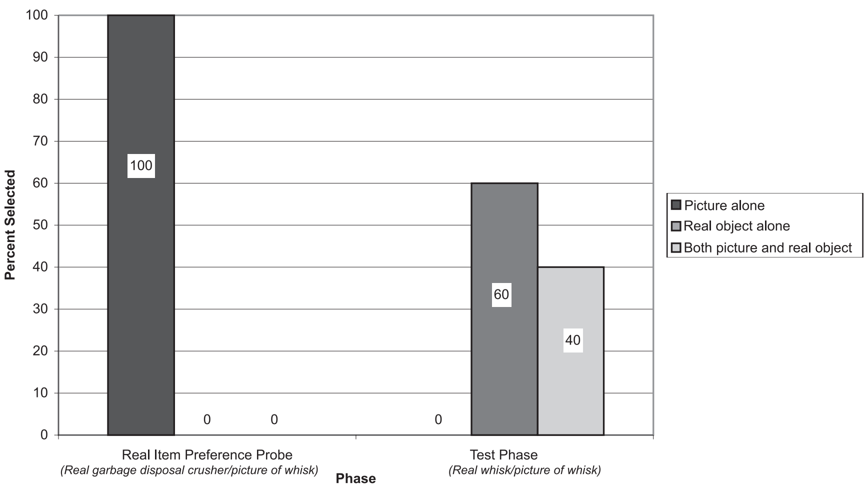


FIGURE 5 Results from Experiment 4, 18-month-old children: real-item preference probe and test phase after word/picture (whisk) training.

the trials. These results are virtually identical to those of Experiments 1 through 3 (Figure 3). There was no significant difference between responses for real items and toy models (as in Experiments 1–3).

Conclusions

The 18-month-old children of Experiment 4 performed similarly to the 24-month-old populations of Experiments 1 and 2. The younger children required more pairings of word and picture during training. They also made more nonintentional responses, merely playing with the objects and pictures on about one third of the trials. Still, just like the older children, those 18-month-olds who complied with the request to show the experimenter the whisk indicated the real whisk alone or indicated both objects, despite the associative pairing between the word *whisk* and the pictured whisk during training. Apparently, as soon as children unequivocally appreciate the 2D nature of pictures, they also appreciate the symbolic function of pictures. By 18 months of age, the pairings between words and real objects and between pictures and real objects is referential, not associative.

GENERAL DISCUSSION

When parents name pictures for their toddlers and provide information about the named entities, they assume that the children often take the pictures as symbols for objects in the real world. These experiments demonstrate that this assumption is correct, at least for 18- and 24-month-old children. When taught the label of a pictured object, the toddlers assumed that the label referred to the object, not the picture. It is no coincidence that at this age children begin to point at rather than manually grasp pictures (DeLoache et al., 1998) and that children are using referential cues for word learning (Baldwin, 1993a, 1993b; Tomasello, 1998). By 24 months, children begin to assert their understanding of pictures as symbols verbally, as noted in our task (e.g., a child points to the real object and exclaims, “That’s a whisk,” then points to the depicted picture and states, “And that’s a picture of a whisk!”).

These experiments partially fill a gap in the literature between DeLoache’s (1987, 1989, 1991; DeLoache & Burns, 1994) studies of the differentiation of the 2D nature of pictures from the 3D nature of real objects at 18 to 19 months of age and her studies of toddler’s understanding that a picture can represent a current situation at 30 months of age. They also raise the question of why 24-month-old children failed in the task of DeLoache and Burns (1994) given the present evidence that children understand the referential relations between pictures and objects in the real world by 18 months. DeLoache and Burns’ task placed greater demands on picture understanding than did ours. In their experiments, children were told a fact about a pictured room (e.g., that a target object was hidden under “here,” with the experimenter indicating the couch on the picture). They were then taken into the real room and instructed to find the object. The children under 2.5 years of age who failed this task passed versions that pose equivalent working memory demands, so the problem is not that they simply could not encode or remember the information. Rather, it is clear that they did not know what to do with the information in the photographs. In these tasks, children had to invoke a representation of a specific individual in a room at a particular time and moment. Perhaps representations of generic kinds (words like *whisk* and pictures taken to represent kinds) are easier to understand. To coordinate information gained from a particular picture and a unique referent, the children must consider a picture as an object in its own right and as a symbol at the same time (DeLoache & Burns, 1994). Our task required that children understand that the line drawing represented a real object, but did not require that the children use any information in the picture, other than the appearance of the pictured object, to solve any problem.

The DeLoache and Burns tasks showed there is more to mature pictorial competence than that tapped in the present studies (see Bloom & Markson, 1997, and Zaitchik, 1990, for still later developing understanding of pictures). Nonetheless, it is clear that children as young as 18 months of age understand the basic nature of pictures: Pictures are representations of real-world objects.

Our conclusions are based on what might seem to be scant data—a single test trial per participant, the crucial pictured whisk/real whisk test trial. We designed the study this way on purpose, for we did not want children to develop response strategies over repeated trials of the same sort (see also Feigenson, Carey, & Hauser, 2002, for an extended series of studies with one response per child). We are confident in our results for two reasons. First, the basic finding was replicated in three separate experiments (Experiments 1, 2, and 4). Only one child of 50, across all three studies, selected the pictured whisk alone on the crucial test trials. Also, the proportion choices of the real object alone was remarkably consistent across the three studies (Experiment 1, 55%; Experiment 2, 40%; Experiment 4, 60%). Second, within each experiment, the pattern of responses on the crucial test trial contrasted with that on other types of trials, and the patterns on all other phases of the experiment were also replicated across the experiments. Thus, despite a design in which only one data point was obtained from each child, we are confident in the pattern of results we present here.

The results of these experiments also provide convergent evidence for the conclusion from the studies of Baldwin (1991, 1993a, 1993b) that the mapping between words and objects is a symbolic relation and not an associative one. Baldwin approached this question very differently from the approach taken here, but like this study, she showed that the conditions that ensure associative mappings between stimuli (in her case, temporal contiguity between a word and an associated object) are not sufficient to guarantee a successful mapping. Rather, in Baldwin's study, children needed evidence that a speaker intended the word to refer to that object. Our method differed: We provided the association between a word and some stimulus, not the referent (a picture in this case), and yet we showed that the word–stimulus mapping we provided via the associative mechanism was not the primary mapping the child made. Specifically, children indicated that they knew the word referred to what the picture depicted.

Our participants were quickly able to learn a mapping between the novel word and novel picture in the training phase, which is not surprising, considering the abundance of evidence for fast mapping (Carey & Bartlett, 1978; Markson & Bloom, 1997). Our procedure included explicit labeling, combined with repeated pairings, creating the optimal conditions for associative mapping. Of course children did form an association between the word and the picture, but this is not all they did. They also inferred a referent for the word, an unseen object that the picture represented.

Clearly children are not merely forming an association between a word and stimulus paired with it. But perhaps a more complex associative story could account for these data. Words are usually paired with objects; children could represent this statistical regularity. Attributions in this experiment may reflect the overall associative structure of pairings of words with objects. We certainly acknowledge this possibility, but Baldwin's (1993b) results mitigate against it.

One other line of research could bear on this issue. Many nonverbal individuals with autism use a symbolic system of communication such as Picture Exchange Communication System (PECS; Bondy & Frost, 1998). In this system, icons represent words and can be exchanged for items or strung together to build sentences. The paradigm of Experiment 1 was administered to 15 children with autism (*M* age = 8.6 years; Allen, 2001). The preliminary data included 7 children with autism with PECS experience (*M* age = 9.6 years) and 8 children with autism without PECS experience (*M* age = 7.6 years). In the test trial, 40% of participants selected the whisk picture alone, 13.3% selected the real item alone, and 46.7% selected both picture and real item. These results (selecting the picture alone rather than the object alone) supports the associative explanation for how children with autism learn the mapping between symbols and referents, which is strikingly different from results obtained with typically developing toddlers.[3] In addition, children with autism with PECS experience were much more likely to select only the picture (57.1% vs. 25% for

[3]By hypothesis, children with autism are "mindblind" (Baron-Cohen, 1995) and are impaired at interpreting others' intentional states. This, in turn, may affect their capacity to represent words and pictures as symbols, which by definition are entities people intend to represent something else. At any rate, that children with autism show the pattern of results predicted by the associative mapping story makes it all the more significant that typically developing 18- and 24-month-olds did not.

Notice that the choice of both pictured and real whisk is predicted on both hypotheses, although for different reasons. On the associative hypothesis, the response to the pictured whisk is generalized to the real whisk because of stimulus generalization based on perceptual similarity. On the referential hypothesis, the word is applied to the pictured whisk because language is used that way, elliptically. Although a picture of a whisk is not a whisk, we refer to pictures using the bare noun. Thus, the significant finding from these autistic pilot data is the large percentage of picture-alone choices, almost 60% from the PECS population, in the face of virtually 0% picture-alone choices from typically developing toddlers.

non-PECS-trained individuals with autism), suggesting that overall experience with word–picture mapping influences subsequent learning.

These autism data bear replication and extension, which is currently underway, but if results maintain consistent, this will provide strong support for the conclusions we tentatively draw from this study: Typically developing 18- and 24-month-old toddlers display knowledge that both words and pictures are symbols. The mapping between words and pictures, on the one hand, and the objects they refer to, on the other, is a meaning-determining relation, infused with intentionality.

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