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11

Symbol-Based Learning in Infancy

JUDY S. DELOACHE, UNIVERSITY OF VIRGINIA;
AND PATRICIA A. GANEA, BOSTON UNIVERSITY

Picture a person—an infant or toddler—in the process of learning new information about the world. It seems likely that you may have generated some of the following types of images—a baby looking intently at a talking adult as if trying to figure out what the words mean, an infant working intently to fit one object inside another, a toddler wobbling uncertainly while attempting to walk from one piece of furniture to another.

Now picture another person—an adult—also in the process of learning new information about the world.

We would guess that your images this time might include an adult having a conversation with another person, reading a newspaper, watching a documentary on television, consulting a road map, interpreting a graph, and so on. Notice the stark contrast in these images of how very young versus mature humans go about the process of acquiring information about their world. Most of the infants' efforts involve *direct*, physical interaction with the world. By interacting directly with the environment and objects in it, infants gain valuable information about what they are capable of doing, the properties of objects, the meaning of words, and so on. For the adults, most routes to acquiring new information involve a variety of symbolic media that represent the environment and objects in it, in addition to ideas, beliefs, and so on. Because of their ability to acquire information indirectly, in the absence of direct experience, adults have vastly greater opportunities for learning than infants do.

This difference between the learning possibilities for adults and older children versus infants and toddlers is profound. Nothing distinguishes humans from other species more than our use of symbols for acquiring information. Our capacity for symbolization enables us to learn new information provided to us by other people,

whether in conversation or via symbolic artifacts. Indeed, without symbols, the cultural preservation and transmission of information from one generation to succeeding ones would be impossible. Becoming symbol-minded (DeLoache, 2002) is required for full participation in any society, so beginning to master some of the symbolic media that play a prominent role in one's society is a fundamental learning task of early childhood.

A crucial benefit of coming to understand the nature and use of various symbolic media is the possibility of then exploiting those media to learn about the world. A recurrent theme of this chapter is the relation between learning *about* various types of symbols and learning *from* them.

We review some of the growing literature on symbol-based learning in the first few years of life, focusing particularly on very recent research involving two of the most common and influential symbolic media in the lives of very young children. We begin with the most powerful and prevalent symbol system—language—and consider how infants and very young children come to acquire new information from what they hear people say, even when the entities to which the information applies are absent. Next, we consider early learning with respect to another nearly ubiquitous type of symbol—pictures.

LANGUAGE-BASED LEARNING

A vast literature documents the early steps of language development, including research on the processes involved in speech perception, word learning, and syntactic and pragmatic development in infancy. Less attention has been focused on *language as a tool*, as a means of acquiring information about the world. Parents and older siblings expose infants and toddlers to massive amounts of information simply by talking to them. They tell young children the names of people, animals, and objects, and they communicate a great deal of conceptual information about those entities. Often, the entity being discussed is physically present, but the potential of language as a source of new knowledge would be markedly restricted if one could learn only from information provided about the here and now. Because of language, we can learn new information about entities around the corner or on the moon.

The ability to use language to communicate about something not currently perceptible is made possible by the symbolic nature of language (Werner & Kaplan, 1956; Brown, 1958; Hockett, 1960). A word (or larger unit of speech) stands for something by virtue of a purely abstract relation between words and referents. Very early in development, however, the name of an object or person may be associated with the relevant entity without there being a *symbolic* relation between them.

Suppose, for example, a mother calls her very young child into the kitchen and says, "Do you want a cookie?" The child's mental representation of cookies might be activated because the sound "cookie" is associated with the jar in which they are normally kept, the room in which the jar and its contents are to be found, the period right after lunch when cookies are usually offered, his mother—the usual offerer, and so on. At this point, the word is simply an associate of but not a symbol for cookies. Later in development, however, the child could hear the same phrase while playing in the yard and be inspired to come into the house, go to the kitchen, and wait expectantly by the cookie jar. At this point, the word is functioning symbolically.

In a seminal paper, Huttenlocher and Higgins (1978) provided an extensive analysis of possible ways to distinguish between nonsymbolic (associative) links versus symbolic relations between words and concepts in the early phases of language development. They concluded that the strongest evidence that a word is understood or used symbolically comes from the child's performance of some behavior that could be based only on an active representation of an absent entity (as in the cookie jar example).

Early in the second year of life, infants begin to provide evidence of understanding references to absent entities. This momentous developmental step marks the advent of an enormous expansion in the extent to which an infant can share a focus of attention with another person. In particular, joint attention and communication can now occur about things that are not currently present. As a consequence, it becomes possible for children to acquire new information about entities they have never directly experienced; they become capable of learning simply from hearing new information attributed to non-present entities.

Understanding Displaced Speech

A large literature exists on the *production* of references to absent objects or events—also referred to as displaced speech—from early theoretical views (Werner & Kaplan, 1956; Brown, 1958; Hockett, 1960) to recent empirical investigations (e.g., Veneziano & Sinclair, 1995; Adamson & Bakeman, 2006). Infants first begin referring to absent entities at around 17 or 18 months of age.

Much less is known about the development of the ability to *comprehend* displaced speech. Early information on this topic came from naturalistic observations conducted in the homes of infants (Lewis, 1936; Huttenlocher, 1974; Sachs, 1983). When an infant's parent referred to a person or object that was not present, the researchers noted any response on the part of the infant indicating that hearing the name brought the entity to mind. For example, upon hearing a favorite toy mentioned, the infant's going to search for it in the toy box where it was usually kept was taken as evidence that the child understood the reference to the absent object. This research established that the ability to understand another person's reference to something not present in the environment is evident as early as 13 months of age, at least when infants are in their own homes (Lewis, 1936; Huttenlocher, 1974).

Home observation studies, often of the researcher's own child, have also revealed that when parents refer to non-present entities in conversation with their infants, they often provide assistance to help the child understand what they're talking about (e.g., Sachs, 1983). One form of assistance is talking about a unique, highly familiar referent (e.g., "Where's Daddy?" or "See the moon?"), leaving little room for ambiguity with respect to the topic of conversation. Another strategy to facilitate comprehension is to refer to an absent entity in conjunction with

some perceptually available cue, such as the container in which the object is usually found, or an object belonging to the person mentioned (Shimpi, 2005).

Recent laboratory studies of the comprehension of displaced reference have furthered our understanding of the early development of this vital ability. One factor that has emerged from this work is the importance of contextual support: Whether a very young child responds to the mention of an absent referent depends on multiple aspects of the situation.

For example, Saylor (2004) established that children as young as 12 months of age are capable of responding to the mention of an absent entity when there is something available to remind them of its existence. In this research, the infants first saw two objects from familiar categories. The objects differed in color, and each rested in front of a panel of the same color as the object itself. The objects were then removed. When the experimenter subsequently mentioned one of the now-absent objects, the matching panel that had previously been associated with the object was available to serve as a reminder of the object. Hearing the object named, the infants looked and gestured to the panel of the matching color, indicating that hearing the name of the object had brought it (and its color) to mind.

Related evidence suggests that quite young infants may respond to the mention of a non-visible entity *only* when there is some form of contextual support. In another study by Saylor and Baldwin (2004), 12- to 31-month-old infants heard an experimenter refer to an absent familiar person—the child's own father. Hearing the experimenter talk about "Daddy," the infants from 15 months on responded in some way (e.g., looking toward the door of the laboratory playroom and even searching for their absent parent). The 12-month-olds, however, showed no discernible response. Thus, there was no evidence that hearing the name of an extremely familiar and highly valued absent person caused 12-month-olds to think about him.

Ganea and Saylor (2008) asked whether a different result might occur if there was additional contextual support for very young infants' response to hearing the name of a beloved person. In their study, the child was accompanied to the lab by two people—either both parents or one parent and a sibling. The trio spent some time together in the testing room, and then one of the child's companions left the room. Shortly afterward, the experimenter referred to the absent person. The majority (88%) of the 13-month-olds and all of the 15-month-olds responded in a meaningful way to the name of their out-of-view sibling or parent.

In combination with the previous research, this study indicates that children are more likely to comprehend and react to a reference to an absent entity in a supportive context. There were two factors that may have contributed to better performance than was seen in the Saylor and Baldwin (2004) study. First, the absent individual had been in the room in which the reference to him or her occurred; thus, the person was associated with the current context in the child's mind. Second, there was a relatively short delay (only 2 min) between when the child had last seen the person and when the reference to him or her was heard.

Systematic evidence specifically delineating the importance of contextual factors in the early comprehension of absent reference has recently been provided (Ganea, 2005). In an initial study, 13- and 14-month-old infants were first taught

a proper name—Max—for a novel stuffed animal. (They were taught a name for the toy so that it could later be referred to in its absence.) The toy was then put in a basket that was placed beside a couch, and the experimenter and child sat on the floor in front of the couch to read a picture book. The toy was out of sight in the basket, but quite nearby and easily accessible. (See Fig. 11–1.)

The picture book that the experimenter read to the child had been specially designed to provide a natural way that the experimenter could repeatedly refer to "Max" without providing any other reminders of the existence of the out-of-sight toy. The toy was never depicted in the book, but the text repeatedly referred to it. ("This is the park where Max likes to play. He likes to go down the slide.") As in the other studies of comprehension of absent reference described above, the question was whether the child would do something to indicate that his or her mental representation of the toy had been activated by hearing its name.

The infants provided evidence of comprehension of absent reference. Upon hearing Max referred to, most of them (86%) did something to reestablish contact (either visual or physical) with the toy. Some simply looked to where the invisible toy was concealed in the basket beside the couch, and sometimes they also pointed

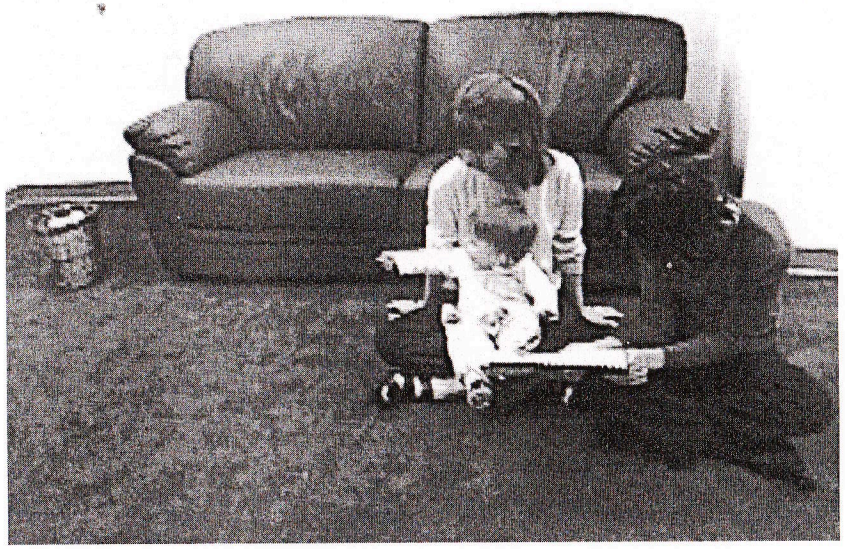

Figure 11–1. In the first study in Ganea's (2005) research on comprehension of absent reference by 13- and 14-month-old infants, a toy was out of sight but readily accessible in a basket beside the couch when the child heard it referred to. In the subsequent two studies, the toy was farther back, beside the couch, making it somewhat less readily accessible. This slight contextual change affected the children's performance. Reprinted from Ganea (2005). Contextual factors affect absent reference comprehension in 14-month-olds. *Child Development, 76,* 989–998. With permission from Blackwell.

toward it. Some children actually got up and went over to reestablish contact with the toy. Thus, by 13 months of age, hearing the newly learned name of a currently absent object in a novel environment can bring the object to mind.

Two additional studies employed the same basic approach, but contextual factors were varied. In the second study, everything was the same as in the first, but the toy was less readily accessible. It was placed farther back to the side of the couch so that it was not visible to the child unless he or she actually got up and went toward it. In the third study, the procedure was the same as in the second one, but a 15-minute delay (a walk down the hallway for a drink of water) was interposed between when the toy was placed in the basket and when it was referred to in the picture-book interaction.

The 13-month-old children less frequently reacted to the name of the absent object in these two studies than did the infants in the first one. When the toy was less readily accessible, only 50% of the children reacted to hearing it referred to by looking, pointing, or going over to reestablish contact with it. When the toy was both less accessible *and* there was a 15-minute delay from when the infant had last seen it, only 19% of the children responded to its name.

This series of studies provides direct evidence that comprehension of absent reference is context-dependent. Hearing a reference to something not immediately present may or may not prompt a very young child to respond to it, depending on various factors. When the out-of-sight toy was readily accessible (i.e., nearby and easy to get to), the infants more often responded to hearing its name than they did when it was slightly less accessible. Similarly, a delay between when the object was last seen and when the reference to it was heard led to a lower rate of responding.

Recent research by Shimpi (2005) provides evidence of a further step in the development of the comprehension of absent reference—an effect of hearing a reference to an absent object on the activation of associated information. In the crucial condition in this study, infants of 14, 18, and 22 months of age were shown pairs of video images of common objects (e.g., wheel, flower). With the two images on the screen, the infants heard a word ("car") that was not the name of either object, but that was associated with one of them. When the 18- and 22-month-olds (but not the 14-month-olds) heard the name of a familiar but absent object ("car"), they looked longer at the picture of the object commonly associated with it (the wheel). Thus, hearing the name of the familiar type of absent object not only brought it to mind but also directed the older infants' attention to something associated with that object.

To summarize, at the beginning of their second year, infants take a crucial preliminary step toward mastery of one of the core features of language—the use of words to communicate beyond the here and now. However, whether they respond overtly to hearing an absent object referred to depends on the complex interaction of multiple representational and contextual factors (Ganea, 2005).

With respect to *representational* factors, for a child to respond to hearing the name of an absent object—"doggie," for example—the child's mental representation of dogs in general or of a particular dog has to be activated. (We use "object" here, even though the absent entity could also be a person, pet, substance, etc.)

The likelihood that an object representation will be activated by mention of the object depends on the strength of the child's mental representation of both the object itself and its name. Further, activation depends on the strength of the word–object link. Thus, the more experience a child has had with an object and the more times the child has heard the name in connection with it, the more likely it is that hearing the object named when it is out of sight will activate its representation.

With respect to *contextual* factors, activation of the object representation is more likely to happen in a context with which the object has been directly associated. Similarly, activation is more likely the more recently the object was encountered. The presence of something that the child has experienced in association with the object also makes mental activation more likely.

The affective importance of the object—the child's emotional attachment to it—may also matter. We suspect that a child would be more likely to respond to hearing the name of a beloved security object (if the child could be separated from it in the first place) than to a less emotionally salient entity. Similarly, a response to the name of an absent parent or family member should occur earlier than a response to the mention of a relatively unfamiliar person that the child just met. Note that these examples of affective salience are inherently confounded with amount of experience, but these factors could be teased apart in future research.

Presumably, all these and many other representational and contextual factors interact to determine whether a young infant does anything in response to hearing an absent entity referred to. Future research on the interaction of these and other factors could markedly enhance our understanding of what brings about the beginning of the comprehension of references to absent objects. One general difficulty with this line of research is that inferences can be drawn only if the child makes an observable response to the mention of an absent object. When children fail to respond, it could be that they are incapable of understanding a reference to an absent object or that for some reason they are not at the moment motivated to do anything overt. Future research employing imaging techniques might further our understanding of this phenomenon, as it could reveal specific neural activation to the mention of an absent object when no behavioral response is observable.

Learning from Displaced Speech

The emergence early in the second year of life of the comprehension of references to absent objects sets the stage for the development of the ability to *acquire new information* about non-present entities and events. Often when someone communicates information to us about a known person (place, object, situation, etc.), the topic of the message is absent. We accommodate such information by updating our mental representation of the person with the recently received information. Thus, if we are told that our dog got into the mud hole again, we update our mental representation of the pet, regretfully incorporating his current bedraggled state.

Young children frequently hear information that provides the basis for updating: "Mommy's getting her hair cut." "The cookies are done now." When are infants capable of revising their mental representation of an object or situation based

on what someone tells them has happened? What is involved in the emergence and early development of this ability?

We are not aware of any existing research on this important topic. Accordingly, we have been examining infants' ability to incorporate new information into their mental representation of a currently absent object (Ganea, Shutts, Spelke, & DeLoache, 2007). Our specific question concerns the modification of an existing mental representation of an absent object, based solely on hearing something new about it.

To examine this topic, we first taught infants a proper name for a stuffed animal. Then—with the toy out of sight in another room—we informed the infant that the toy had undergone a change in state. What we wanted to know was whether the infants' mental representation of the toy would be modified to accommodate the change that they had been told about but had not witnessed.

In this study, 19- and 22-month-old infants were initially shown three stuffed animals—for example, two identical frogs and one pig. One of the frogs was then put away, and the children learned a proper name—"Lucy"—for the remaining one. (A proper name was taught so the specific toy could later be referred to in its absence.) The child and experimenter played for a while with Lucy and the pig (which was never given a proper name). Next, the toys were left behind as the experimenter and child went to the adjoining room to read an unrelated picture book.

As they were engaged in the reading interaction, an assistant entered, carrying a bucket of water, and announced, "I'm going to go next door and wash the table." She went into the room in which the toys were located, closing the door behind her. About two minutes later, she returned and exclaimed in an agitated voice, "I'm so sorry—I spilled water on Lucy. Lucy's all wet!" Then the experimenter and child returned to the first room to "see Lucy." The question was whether the child's mental representation of Lucy had been modified on the basis of the new information.

Upon entering, the child saw the three toys on the table. One of the two frogs was sopping wet, as was the nameless pig. The child was asked to indicate which toy was Lucy. Our reasoning was that if the infants identified the thoroughly drenched frog as Lucy, it would indicate that hearing "Lucy's all wet" had (1) activated their mental representation of Lucy (a frog) *and,* of primary importance for this study, (2) led to the incorporation into that representation of what they heard had happened to Lucy. Thus, successful identification would provide evidence that the infants had updated their mental representation of the absent entity.

The majority (80%) of the 22-month-old children selected the wet frog as Lucy. Thus, this age group showed evidence of being able to incorporate new information into an existing mental representation of an absent object. The 19-month-olds, however, did not perform above chance (45% correct). They did remember the object–name relation, as shown by the fact that they almost always ignored the pig, identifying one of the two frogs as Lucy. Nevertheless, they did not use the information they had heard about the toy in its absence to identify which particular frog was Lucy.

To see if the younger children might be able to update if the task were simplified, a new group of 19-month-olds was given the same experience, but the test involved only the two identical animals—one wet and one dry. Even with this less demanding task, selection of the correct toy was not above chance.

An additional test confirmed that the poor performance of the younger children was not due to a simple failure to understand what was said to them. Everything was the same for a new group of 19-month-olds except that the two animals were in full view when they heard about the spilling accident. When the experimenter informed them that she had spilled water on Lucy ("Look what happened! I spilled water all over Lucy."), they were standing in front of the two identical animals—one wet and one dry. The children were then asked to indicate which of the toys was Lucy. This procedure eliminated the need to update a representation of an *absent* object. All that was needed to respond correctly was to understand what the experimenter said about the toys they could see and update their representation of a *present* object.

The majority of children (70%) selected the correct toy (a rate marginally above chance). This result indicates that, in the previous studies, the 19-month-olds' failure to use the information about the out-of-view toy cannot be attributed to difficulty understanding the experimenter's description of the spilling event. Rather, their poor performance seems to be primarily due to difficulty incorporating new information into their existing representation of an absent object.

The results of this series of studies suggest that the ability for updating an existing representation of an absent object may emerge quite rapidly in the second half of the second year (that is, between 19 and 22 months). However, it is also possible that 19-month-olds are capable of updating but that the manifestation of this ability depends on a complex interaction of representational and contextual factors (as is true for the comprehension of absent reference in general—Ganea, 2005). Thus, they might be capable of updating their representation of an absent object under less challenging conditions than those examined so far.

Future research will further explore this important ability. One question concerns the extent to which prior experience might affect infants' updating. For example, we suspect that updating may occur more readily for an object for which the infant already has a rich mental representation. Thus, 19-month-olds, who failed to incorporate new information about a change to a recently encountered object might succeed with a highly familiar one. Temporal factors might also matter, with updating more likely for objects, whether familiar or new, that infants have recently interacted with than ones they have not seen for some time. The type of transformation might also make a difference. For example, our intuition is that a change in the location of an object ("I moved Lucy to the couch.") should be easier to update than a change in the object itself.

PICTURE-BASED LEARNING

Infants and young children are exposed to a variety of kinds of symbols other than language, with one of the most common being pictures. Pictorial representations have substantial potential to support learning about the world, in part because young children have so much exposure to them. Pictorial media are abundant

in most modern societies, and the majority of homes in the United States contain many pictures—family photographs, magazines, children's books, and so on. Thus, the possibility exists for learning from pictures early in life.

But when and how do young children actually begin to acquire information from pictures? What is required to do so? At a minimum, the abilities to perceive pictures, to remember pictorial information, and to relate pictorial representations to what they represent would seem to be necessary. However, it would presumably not be necessary to have achieved full-fledged *pictorial competence*—mastery of the myriad factors involved in perceiving, interpreting, understanding, and using pictures, in addition to knowledge of the conventions and techniques of pictorial representation (DeLoache, Pierroutsakos, & Troseth, 1996; DeLoache, 2002).

An abundance of research on a wide variety of topics testifies to the ability of infants to *perceive* a relation between a picture and its referent right from birth. For example, newborns recognize photographs of their mother's face (Pascalis, de Schonen, Morton, Deruelle, & Fabre-Grenet, 1995) and five-month-olds can relate pictures of people and objects to the real people and objects depicted (Dirks & Gibson, 1977; DeLoache, Strauss, & Maynard, 1979). In spite of these early abilities, there are limits to infants' pictorial competence that might interfere with picture-based learning.

Understanding Pictures

To use pictures as a source of information about the world, it would seem necessary to understand something about the difference between pictures and their referents and about the nature of the representational relation between depiction and depicted. Specifically, some appreciation of the symbolic nature of pictures may be necessary for the acquisition of new information via pictures.

Manual Exploration of Pictures

There is substantial evidence that a symbolic interpretation of pictures emerges only gradually. A lack of appreciation of the basic nature of the pictorial medium is reflected in how young infants interact with pictures. Rather than simply looking at depictions, as older individuals do, infants between four and nine months of age manually explore them (Murphy, 1978; DeLoache, Pierroutsakos, Uttal, Rosengren, & Gottlieb, 1998; Callaghan, Rochat, MacGillivray, & MacLellan, 2003; Pierroutsakos & DeLoache, 2003; Yonas, Chov, Alexander, & Jacques, 2003; Pierroutsakos, Lewis, Brewer, & Self, 2004). When presented with a highly realistic color photograph of an object, infants touch, rub, pat, and scratch at the depicted object, and sometimes even grasp at it as if trying to pluck it off the page. A few infants have even leaned over and applied their lips to the nipple of a depicted baby bottle!

The extent to which infants manually explore depicted objects is related to how much the depictions resemble real objects (Pierroutsakos & DeLoache, 2003). Color photographs elicit the most manual activity, and black-and-white line drawings the least. Thus, the more a depicted object looks like a real object, the more infants try to physically interact with it.

Manual exploration of depicted objects tends to occur only if infants are constrained in their interaction with pictures. In the original research (DeLoache et al., 1998), pictures were presented in a board book, and the experimenter did not permit the infant to pick up the book itself. In recent research (Callaghan, Rochat, MacGillivray, & MacLellan, 2003), infants in one condition were presented with pictures mounted on cardboard and were allowed to interact with them however they chose. In this case, infants up to nine months did not manually explore the depicted objects. Instead, they treated the cardboard-mounted pictures as objects in and of themselves, picking them up and manipulating them. In another condition, in which the experimenter prevented the infants from treating the pictures in this way by holding the pictures down on the table, the infants attended to and manually explored the depicted objects, just as in the earlier studies. Both types of behaviors exhibited by these infants—ignoring the depicted objects to act on the picture–object itself and manually exploring the depicted objects—are immature responses to pictures. Both indicate a lack of appreciation of the nature and use of pictures.

Our basic interpretation of infants' manual exploration of pictures is that it reveals confusion about the true nature of depicted objects (DeLoache et al., 1998; Pierroutsakos & DeLoache, 2003; Pierroutsakos et al., 2004). To some extent the highly realistic color photos typically used in this research do look like real objects, and they presumably activate infants' conceptual representations of the categories of the objects, in addition to motor schemes for interacting with them. At the same time, however, these depicted objects provide few of the visual cues for three-dimensionality that real objects offer. Infants thus manually explore pictures, not because they in any way misperceive them and not because they believe the depicted objects to be real objects, but because they find pictures somewhat puzzling. They touch, rub, and grasp at them out of interest and uncertainty.

This interpretation is supported by research examining infants' manual behavior toward pictures in which their exploration of the depicted objects was compared to their exploration of non-pictorial areas of high contrast in the same picture (Pierroutsakos & DeLoache, 2003). Each of the depicted objects used in the original set of studies (DeLoache et al., 1998) was centered in a cardboard square with a circular dark area completely surrounding it. Thus, the highest amount of contrast on the page was the edge of the dark area. If infants' manual exploration of pictures is elicited by the depicted object, they should focus most of their manual activity on the depiction, ignoring the high-contrast border. Otherwise, they should explore the edge of the surrounding dark area at least as much as, or more than, the depicted objects. In fact, the infants' manual exploration was overwhelmingly directed to the depicted objects in the center of the page. It was the depicted objects themselves that attracted their investigatory attention.

Manual exploration of depictions is strongly related to age; infants' physical interaction with depicted objects is an inverted U-shaped function of age. It increases from four to nine months of age (Pierroutsakos et al., 2004), probably due in part to improving motor control of arm and hand movements, making it increasingly possible for a baby to accurately contact and explore a small image. Manual exploration then decreases from 9 to 18 months, at which point it is quite

rare (DeLoache et al., 1998). The decline in manual behavior toward pictures presumably reflects infants' learning about the nature of pictures and how they differ from real objects.

Simultaneous with infants' decrease in manual exploration of depicted objects between 9 and 18 months of age is an increase in their pointing to and talking about pictures. This switch indicates a growing appreciation of how people interact with pictures—they look at, point to, and talk about them. Thus, by the middle of the second year of life, children growing up in a picture-rich society have come to understand and use pictures as a vehicle for communicating with other people, whether for requesting or offering information. This new orientation to pictures sets the stage for the next major step in pictorial competence—appreciation of the symbolic nature of pictures.

Understanding the Symbolic Nature of Pictures

Evidence regarding the emergence of an understanding of the referential nature of pictures has recently come from an elegant series of studies by Preissler and Carey (2004). Specifically, they established that infants as young as 18 months of age appreciate that a word that is used to refer to a depicted object refers to the real object as well. The children were taught a label ("whisk") for a small line drawing of an object (a whisk) that was unfamiliar to them. Subsequently, they were presented with a pair of stimuli—the simple drawing for which they had learned the label and a real whisk—and asked to indicate "whisk."

The results were quite dramatic: The infants *never* selected the picture alone, in spite of the fact that they had initially learned the label for it. Instead they all indicated either the object alone or the object and its picture. Both of these choices offer evidence of extending the label learned with the picture to the real object. Thus, by 18 months of age, very young children who hear a novel word applied to a depicted object assume that the word refers to the real object that is depicted.

New research indicates that very young children's symbolic interpretation of pictures may depend on the nature of the pictures (Ganea, Preissler, Butler, Carey, & DeLoache, 2008). Children in this study were taught a novel word ("blicket") for one of two novel objects depicted in a specially constructed picture book. The pictures in the book were highly realistic color photographs of the two novel objects and several familiar objects.

To assess whether the children had learned the novel label for the depicted object during the book interaction, they were shown pictures of the novel target and the novel non-target and asked to indicate the "blicket." Only after a child had answered this question correctly on two consecutive trials, indicating that the name–object link had been learned, did we proceed with the test.

The first test, the Picture–Object Test, was the same as the symbolic test used by Preissler and Carey (2004): The children were presented with the *picture* of the target object and the *real* target object and asked to show "a blicket." Selection of the picture alone would suggest little or no appreciation of the symbolic nature of pictures. In contrast, choosing the object or both the object and picture would indicate an appreciation of the nature of the picture–referent relation.

In the next test, the Real Object Bias Test, the children were shown a *picture* of the target and the *real* non-target object and asked to show the "blicket." This test was a measure of any general tendency to choose objects over pictures, and hence provided important information to evaluate performance on the Picture–Object Test. Selection of the non-target object on this test would indicate a simple preference for objects over pictures.

On the last test, the Extension Test, the children were presented with the two real objects (target and non-target) and asked to show the "blicket." This test was a measure of children's application of the newly learned word to the real object.

Based on their responses to the first two tests—the Picture–Object Test and the Real Object Bias Test—the children were categorized in one of three groups, as shown in Figure 11–2. (1) Children who indicated the picture on the Picture–Object Test and selected the picture on the Real Object Bias Test were considered to have made an *associative response*. They associated the label with the picture with which it was learned but not with the real object. (2) Children who selected either the object alone or both the picture and the object on the Picture–Object Test *and* also chose the object on the Real Object Bias Test were considered to have a general *object bias*. (3) Children who selected the object alone or both the picture and the object on the Picture–Object Test *and* selected the picture on the Real Object Bias Test were categorized as giving a *symbolic response*. They selected the real object as an appropriate referent for the label, but not on the basis of a simple object bias.

The results showed a gradual increase in the number of children who made a symbolic response when presented with both the picture of the blicket and the real blicket. Specifically, 55% of the 15-month-olds, 69% of the 18-month-olds, and 81% of the 24-month-olds indicated the object alone or both the object and the picture when asked to show a "blicket" on the Picture–Object Test (these children also responded correctly to the Real Object Bias Test, by indicating the picture

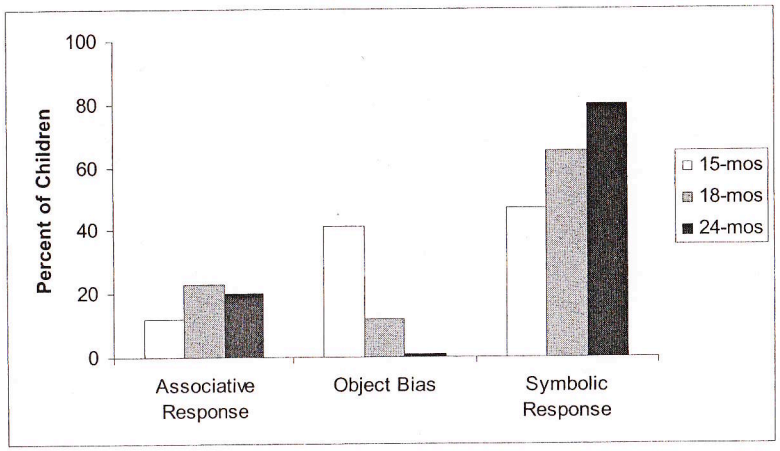

Figure 11–2. Infants' symbolic interpretation of depicted objects. (Ganea et al., 2008).

as the correct target). The number of children who responded symbolically was significantly different from chance (25%) for all age groups.

This study provides evidence that some children as young as 15 months of age interpret pictures symbolically and that children's appropriate interpretation of the referential nature of pictures increases gradually with age. However, in stark contrast to Preissler and Carey's (2004) study, in which *no* children selected the picture alone, some children at every age (2 at 15 months, 4 at 18 months, and 3 at 24 months) selected the picture alone on the Picture–Object Test. These children seem to consider the picture as a better referent for the word than the real object.

One factor that might explain why fewer children in this study gave a symbolic response (choosing the object alone or both the object and the picture) is the nature of the pictures used. In the Preissler and Carey (2004) research, the children learned the novel label in relation to quite small (5 cm × 5 cm) black-and-white line drawings. In the current study the children learned the label in relation to larger, highly realistic color photographs (13 cm × 18 cm). It is possible that the high level of realism of the photographs may have increased their physical salience, thereby making the representational relation more difficult for children to appreciate.

This speculation is consistent with the finding of Pierroutsakos and DeLoache (2003) that infants manually explore photographs more than black-and-white line drawings. The realistic nature of pictures may thus play a counterintuitive role in how easily infants interpret them symbolically, with more faithful representations actually eliciting less mature responses. Future research examining the effects of iconicity on children's grasp of the referential function of pictures will provide important information about the processes involved in the early development of a symbolic understanding of pictures.

Even after coming to appreciate the symbolic nature of pictures, very young children still evidence substantial difficulty negotiating the relation between pictures and what they depict (Callaghan, 1999; Rochat & Callaghan, 2005). For example, before the age of two years, children have problems matching a real-object display with a color photograph of that display (Harris, Kavanaugh, & Dowson, 1997), and even 2.5-year-olds sometimes incorrectly choose which of two objects matches a picture they have just seen (Callaghan, 2000). Young children also reveal a variety of confusions regarding the differing properties of pictures and depicted objects (Beilin & Pearlman, 1991), and the differing consequences of actions on pictures versus objects (Flavell, Flavell, Green, & Korfmacher, 1990; Zaitchik, 1990; Robinson, Nye, & Thomas, 1994).

Learning from Picture Books

With their increasing appreciation of the symbolic nature of pictures, it should be possible for very young children to acquire new information about the world from pictures. Almost certainly, the most common opportunity that very young children have for learning from pictures comes in the form of joint picture-book reading interactions with their parents, teachers, and older siblings. Such interactions are

very common in the homes of American children: Most children below the age of three are read to several times a week, and the majority of them participate in daily book-centered interactions (Rideout, Vandewater, & Wartella, 2003). The prevalence of picture-book reading in American homes is at least partly attributable to American parents' belief that books and reading play a positive role in the development of young children (Gelman, Coley, Rosengren, Hartman, & Pappas, 1998; Rideout et al., 2003).

This general assumption has empirical support. There is extensive documentation of positive relations between early picture-book experience and later developments, most notably with respect to vocabulary development. Vocabulary size in preschool children is correlated with the amount of time they spent in picture-book interactions with their parents (DeBaryshe, 1993; Sénéchal & Cornell, 1993; Whitehurst et al., 1994; Fletcher & Reese, 2005; Karass & Braungart-Rieker, 2005).

The relation between joint picture-book reading and literacy skills and knowledge has also been documented. Early book-reading experience is positively related to how much young children know when they enter school about the nature of books and how they are used (Mason, 1980; Sulzby, 1985; Teale & Sulzby, 1986; Adams, 1990; Bialystok, 1995; Bus, van Ijzendoorn, & Pellegrini, 1995; Whitehurst & Lonigan, 1998; Justice & Ezell, 2000; Sénéchal & LeFevre, 2001).

Experimental evidence of the benefits of picture-book reading has come from effective intervention programs with educationally at-risk young children, based on joint parent–child picture-book interactions (e.g., Whitehurst et al., 1994; Lonigan & Whitehurst, 1998; Whitehurst & Lonigan, 1998). The very successful interventions of Whitehurst and his colleagues involve a highly interactive style of reading known as "dialogic reading," which is based on three principles (Arnold, Lonigan, Whitehurst, & Epstein, 1994): (1) using evocative techniques to encourage children to participate actively in reading interactions; (2) providing children with feedback in the form of expanding their ideas and utterances, correcting misconceptions, and praising their active participation; and (3) scaffolding the interaction to maintain a level of book-related input that is near or slightly beyond the child's current level of understanding.

One reason that interventions based on these principles are so effective is that they differ from how most parents interact with their young children in picture-book interactions. For example, with infants, parents spend most of the time simply calling their child's attention to the pictures and providing labels for them: "That's a frog. Oh look, a bear." They rarely relate the pictured items to real ones, even if real objects of the same category as the depicted ones are nearby and visible (DeLoache & DeMendoza, 1987). Parents of two- and three-year-old children typically just read the text in books (Huebner & Meltzoff, 2005).

With older children, parents provide additional information, commonly drawing their children's attention to categorical relationships among depicted items (Gelman et al., 1998). Recent research by Gelman, Chesnick, and Waxman (2005) suggests that parents tend to talk more about categories when referring to pictures than when talking about real objects. Getting information about kinds and categories is especially important for acquiring general knowledge about the world, and

picture-book interactions thus provide an opportunity for parents to scaffold this development. Parents of older children also try to orient children to the general theme of a book by, for instance, providing information about the spatial relations among depicted objects and by talking about the graphic representations included in the book (Szechter & Liben, 2004).

Clearly, very young children learn a great deal in terms of vocabulary and literacy knowledge from their extensive participation in picture-book interactions. What else is it possible to learn through such interactions? We have recently inaugurated a program of research asking new questions about very young children's learning from picture books. Unlike most previous research, our focus is not on the nature of the interaction or on general learning but on the acquisition of specific information. We are interested in the extent to which very young children learn information from picture books that they then extend to the real world.

The prototype question underlying this research is this: If a toddler learns in a picture-book interaction something about horses—their name, where they live, the fact that they sometimes pull wagons—to what extent does the child extend that knowledge to the first real horse he or she encounters? In other words, what influences very young children's extension of information learned from the pages of a picture book to the real world?

Two primary goals guide this research: One involves increasing our basic understanding of the development of pictorial competence (DeLoache et al., 1996; DeLoache, 2002) by examining the processes underlying very young children's ability to extrapolate information learned about depicted objects and events to real ones. The second goal is primarily practical—discovering more about what can be done to enhance infants' and very young children's learning about the world from picture-book interactions.

Our initial study (Ganea, Bloom Pickard, & DeLoache, 2008) focused on a very common form of early picture-book reading in which the book serves primarily as a mechanism to promote word learning. We examined 15- and 18-month-olds' learning of a novel name for an object from a brief picture-book interaction with an adult. Most importantly, we asked whether they would extend the name from the book to the real object and generalize it to a new instance of it. We also wanted to find out whether the nature of the pictures in the books influenced children's learning and generalization from them. Thus, we used books that contained realistic photographs, colored drawings, or cartoons to teach 15- and 18-month-olds a novel name ("blicket") for one of two novel objects.

The results indicated that, as expected, both age groups learned the novel word for the depicted object from the brief picture-book interaction. Moreover, they extended the name to the real novel object. The older children also generalized it to a new instance (a differently colored exemplar). Thus, by 15 months of age, children apply something learned from a book beyond the pages of the book, providing evidence that early picture-book interactions can serve as a source of information about the real world. Very young children also transfer information in the opposite direction, and iconicity again plays a role. After learning a label for a real object, children more successfully transferred to a photograph than to a cartoon of the object (Ganea, Bloom Pickard, & DeLoache, 2008).

These results for iconicity show that the early application of information between books and the world is quite conservative. The very young children in this research extended and generalized what they learned from a book to the world only when there was a substantial level of physical similarity between depicted and real objects. Similar effects occurred for their identification of known objects depicted in a book.

Simcock and DeLoache (2006) also reported effects of iconicity on slightly older children's learning of sequences of actions from picture books. The 18- and 30-month-old toddlers in this study were better at imitating a sequence of actions with novel objects if it was depicted with realistic photographs than with line drawings.

The fact that the iconic nature of pictures seems to have an important role in children's ability to interact meaningfully with books has important educational implications; namely, that books with more realistic pictures are better for assisting young children's learning.

Another common aspect of books that might affect learning and generalization by young children is the physical complexity of the book in which information is presented. "Manipulative" books are very popular style of book for young children. These are books with features that invite children to interact physically with the book (e.g., pop-up elements, flaps, and tabs). Chiong and DeLoache (2007) found that very young children learn alphabet letters better from books that present information in a simple format than from manipulative books. These results suggest that manipulative books may distract children from the relevant content presented in the book and thereby hinder their learning.

Another set of studies has focused on the processes involved in young children's learning of conceptual information from picture books, with a particular focus on the learning of simple scientific information. We chose the topic of the biological defense mechanism of camouflage to examine three- and four-year-old children's learning of simple scientific information from specially constructed books (Ganea, Ma, & DeLoache, 2007).

The books contained color photographs depicting a type of insect (butterfly) or animal (frog) in camouflage and non-camouflage situations. For example, a yellow butterfly was shown sitting on a yellow flower, making it difficult to see, and then on the bark of a tree, where it was very visible. The accompanying story provided factual information about color-camouflage (without actually using the word "camouflage"). The text explained, for example, why a predatory bird could find and eat the butterfly when it was on the tree but not when it was on the flower.

Before reading the book to the children, we first assessed their prior knowledge of camouflage. The child was shown two depicted animals (a green lizard lying among green leaves, or a red lizard lying on sand) and asked to indicate which one a bird would be likely to eat and to explain why. Then the child engaged in an interaction with the experimenter, who read the story aloud in a natural way.

On the subsequent test, the children were shown two pictures of novel butterflies (same-category items) or two frogs (cross-category items) in camouflage and non-camouflage situations, together with a picture of a bird. They were told that

the bird was looking for food and were asked to show which of the two butterflies (or frogs) it was more likely to eat. In addition, on one of the trials, they were asked to *explain* why the bird would eat the particular item they chose.

The results indicated that four-year-olds learned the information about color camouflage from the book and used the concept of camouflage to explain their choices. On the pre-test, the four-year-old children chose the correct target animal at chance (62% of the trials), and justified their choices with camouflage-based explanations on only 5% of the trials (using the idea of camouflage, not the term itself). After reading the book, these children chose the target animal on 75% of the trials. More importantly, the children now justified their correct responses with the concept of color camouflage on 53% of the trials. These results reveal that by four years of age children can learn new conceptual information from picture books and that they are capable of applying that information to novel exemplars. In contrast, the performance of the three-year-olds did not change from pre-test to post-test, either in their choices or their explanations, suggesting they are relatively limited in their ability to acquire conceptual information from books.

A future goal of this research is to examine the effect of presenting scientific information in fantasy formats on young children's learning and extension of information to the real world. It is well established that young children have a tendency to reason teleologically about biological domains; that is, they often attribute purpose or design to natural phenomena (Springer & Keil, 1989; Keil, 1992; Hatano & Inagaki, 1994; Keil, 1995; Kelemen, 1999a, 1999b; 2003). Given that this tendency is already quite strong in young children, it seems likely that presenting scientific information in fantasy formats might make children less likely to interpret it appropriately. In addition to the possibility that fantasy elements might encourage even more teleological reasoning by young children, fantasy might interfere with their interpretation of the reality status of the information they encounter in the first place.

A study exploring the general issue of the effect of different types of pictures and language on children's learning of simple scientific information supports this assumption (Seiver, Greif & Keil, 2003). Kindergartners listened to either fantasy or factual stories about biological (animals and plants) and physical (natural non-living kinds and artifacts) domains. The stories presented simple scientific information, such as how a snake sheds its skin or how a magnet works. The fantasy stories had pictures of inanimate objects (e.g., magnets) that had faces, facial expressions, and limbs. In addition, the objects were described with intentional terms (e.g., as having desires and thoughts). The factual stories provided straightforward factual explanations of the scientific concepts.

Children who had listened to the fantasy stories remembered less of the story content than did children who had heard the factual stories, and they provided fewer correct answers to factual questions than did children who had listened to factual stories. Thus, the fantasy stories seemed to interfere with children's ability to reason causally about the scientific phenomena described in the pictures. This study suggests that books with fantasy context might be detrimental for learning scientific concepts. The use of anthropomorphism (e.g., attributing human

reasoning to nonhuman beings) and teleological explanations in children's books might confuse children and prevent them from thinking in a scientific manner.

We have recently found evidence of a generalized effect of exposure to fantasy books in a tendency for young children to extrapolate fantasy elements encountered in books to the real world (Ganea, Richert, Bean, & DeLoache, 2006). Two- and three-year-olds were read fantasy cartoon books in their preschool classroom on two consecutive days. The books depicted animals wearing clothes and engaged in human-like activities. The question was whether children's beliefs about real cats and pigs would be affected by the fantasy content of the books. On the third day, the children were asked a series of questions about what kinds of things cats and pigs do in the real world ("Do cats scratch?" "Do pigs bake cakes?"). The results showed that the children who had recently been exposed the fantasy cartoons were significantly more likely to attribute human powers to animals than were those in a control group who had not recently been exposed to fantasy books. These studies suggest that fantasy formats in books can affect children's interpretation of real phenomena and might ultimately impede their learning of factual information from such books.

CONCLUSIONS

One of the most important advances of the first years of life is the dawning of symbolization, which sets in motion revolutions in infants' and young children's interaction with and ability to learn from people, either directly or from cultural artifacts such as pictures. We have summarized here recent research from our laboratories on the development in the second year of life of infants' ability to comprehend references to absent objects, focusing especially on recent research on the ability to learn new information about an absent referent—a prerequisite to learning from symbols. Our second focus was the learning from another nearly ubiquitous source of information about the world—pictures. The extremely common form of parent–child interaction, joint picture-book reading, is a learning opportunity from which most young children benefit.

A host of research questions springs from our research on very young children's updating of their representation of an absent object. For example, how does the strength of children's mental representation of an object affect their updating ability? Would it be easier to incorporate new information in a relatively extensive mental representation of a highly familiar object? It seems likely that it would be, but one can also imagine that updating might actually occur more readily for less elaborate representations. Is updating more likely to occur with shorter delays between the child's initial experience with the object and the time at which new information is received? Similarly, does the delay between children's receiving the new information and being presented with the choice of altered and unaltered objects affect their performance? These and many related questions will be the focus of future research.

A particularly fruitful topic for future research might be the relation between very young children's ability to understand and update references to absent

entities and their ability to learn new information about the world from picture-book interactions. What cognitive abilities are common in acquiring new information without direct experience in these quite different ways? A related topic concerns the relative credence young children might place in verbal information and/or testimony versus pictorial evidence. Would one be privileged over the other?

In conclusion, very young children's learning about the world is based in large part on information provided to them by a variety of symbols—most notably language and pictures. Further research on the early understanding and use of various symbolic artifacts should enhance our knowledge about the role of learning in the development of the infant mind.

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