MINDFUL OF symbols

On the way to learning that one thing can represent another, young children often conflate the real item and its symbol. These errors show how difficult it is to start thinking symbolically.

By Judy S. DeLoache
Photographs by Randy Harris

About 20 years ago I had one of those wonderful moments when research takes an unexpected but fruitful turn. I had been studying toddler memory and was beginning a new experiment with two-and-a-half- and three-year-olds. For the project, I had built a model of a room that was part of my lab. The real space was furnished like a standard living room, albeit a rather shabby one, with an upholstered couch, an armchair, a cabinet and so on. The miniature items were as similar as possible to their larger counterparts: they were the same shape and material, covered with the same fabric and arranged in the same positions. For the study, a child watched as we hid a miniature toy—a plastic dog we dubbed “Little Snoopy”—in the model, which we referred to as “Little Snoopy’s room.” We then encouraged the child to find “Big Snoopy,” a large version of the toy “hiding in the same place in his big room.” We wondered whether children could use their memory of the small room to figure out where to find the toy in the large one.

The three-year-olds were, as we had expected, very successful. After they observed the small toy being placed behind the miniature couch, they ran into the room and found the large toy behind the real couch. But the two-and-a-half-year-olds, much to my and their parents’ surprise, failed abysmally. They cheerfully ran into the room to retrieve the large toy, but most of them had no idea where to look, even though they remembered where the tiny toy was hidden in the miniature room and could readily find it there.

Their failure to use what they knew about the model to draw an inference about the room indicated that they did not appreciate the relation between the model and room. I soon realized that my memory study was instead a study of symbolic understanding and that the younger children’s failure might be telling us something interesting about how and when youngsters acquire the ability to understand that one object can stand for another.

What most distinguishes humans from other creatures is our ability to create and manipulate a wide variety of symbolic representations. This capacity enables us to transmit information from one generation to another, making culture possible, and to learn vast amounts without having direct experience—we all know about dinosaurs despite never having met one. Because of the fundamental role of symbolization in almost everything we do, perhaps no aspect of human development is more important than becoming symbol-minded.
PHOTOGRAPHS PROVE TRICKY to many toddlers because they have not mastered dual representation: awareness that a symbolic object is itself [in this case, a highly realistic photograph] as well as a representation of something else [a sneaker]. Many try to interact with the objects in photographs, just as this boy is doing by attempting to put his foot in the shoe.
What could be more fascinating, I concluded, than finding out how young children begin to use and understand symbolic objects and how they come to master some of the symbolic items ubiquitous in modern life. As a result of that fortuitous model-room experiment, I shifted my focus from memory to symbolic thinking.

Pictures Come to Life

The first type of symbolic object infants and young children master are pictures. No symbols seem simpler to adults, but my colleagues and I have discovered that infants initially find pictures perplexing. The problem stems from the duality inherent in all symbolic objects: they are real in and of themselves and, at the same time, representations of something else. To understand them, the viewer must achieve dual representation: he or she must mentally represent the object as well as the relation between it and what it stands for.

A few years ago I became intrigued by anecdotes suggesting that infants do not appreciate the dual nature of pictures. Every now and then, I would hear of a baby who tried to pick up a depicted apple or to fit a foot into a photograph of a shoe. My colleagues—David H. Uttal of Northwestern University, Sophia L. Pierroutsakos of St. Louis Community College and Karl S. Rosengren of the University of Illinois at Urbana—Champaign—and I decided to investigate even though we assumed such behaviors would be rare and therefore difficult to study. Fortunately, we were wrong.

We began testing infants' understanding of pictures in a very simple way. We put a book containing highly realistic color photographs of individual objects in front of nine-month-olds. To our surprise, every child in the initial study, and most in our subsequent studies, reached out to feel, rub, pat or scratch the pictures. Sometimes the infants even grasped at the depicted objects as if trying to pick them up off the page. We had a unique opportunity to see how universal this response was when anthropologist Alma Gottlieb of the University of Illinois took some of our books and a video camera to a remote Beng village in the Ivory Coast. The testing situation there was different: Beng babies sat on the ground or in their mother's lap as chickens and goats wandered around and other children and villagers played, worked, talked and laughed nearby. Yet the Beng babies, who had almost certainly never seen a picture before, manually explored the depicted objects just as the American babies had.

The confusion seems to be conceptual, not perceptual. Infants can perfectly well perceive the difference between objects and pictures. Given a choice between the two, infants choose the real thing. But they do not yet fully understand what pictures are and how they differ from the things depicted (the "referents") and so they explore some actually lean over and put their lips on the nipple in a photograph of a bottle, for instance. They only do so, however, when the depicted object is highly similar to the object it represents, as in color photographs. The same confusion occurs for video images. Pierroutsakos and her colleague Georgene L. Troesch of Vanderbilt University found that nine-month-olds seated near a television monitor will reach out and grab at objects moving across the screen. But when depicted objects bear relatively little resemblance to the real thing—as in a line drawing—infants rarely explore them.

By 18 months, babies have come to appreciate that a picture merely represents a real thing. Instead of manipulating the paper, they point to pictures and name objects or ask someone else for the name. Melissa A. Preissler of Yale University and Susan Carey of Harvard University recently provided a good example of this development. The two researchers used a simple line drawing of a whisk to teach 18- and 24-month-olds the word for this object that they had not seen before. Most of the children assumed the word referred to the object itself, not just to the picture of it. In other words, they interpreted the picture symbolically—as standing for, not just being similar to, its referent.

One factor we think contributes to the decline of manual exploration of pictures is the development of inhibitory control. Throughout the first years of life, children become increasingly capable of curbing impulses. This general developmental change is supported by changes in the frontal cortex. Increased inhibitory control presumably helps infants restrain their impulse to interact directly with pictures, setting the stage for them to simply look, as adults do.

Experience with pictures must play a role in this development as well. In an image-rich society, most children encounter family photographs and picture books on a daily basis. Such interactions teach children how pictures differ from objects and how they are supposed to be targets of contemplation and conversation, not action.

Nevertheless, it takes several years for the nature of pictures to be completely understood. John H. Flavell of Stanford University and his colleagues have found, for example, that until the age of four, many children think that turning a picture of a bowl of popcorn upside down will result in the depicted popcorn falling out of the bowl.

Pictures are not the only source of symbol confusion for very young children. For many years, my colleagues and
Scale errors are common among 18- to 30-month-olds, who often interact with small objects as they do with larger versions. Scale errors are another example of failed dual representation. Here the boy couldn’t sit on the chair and kept falling off. In experiments, objects can be even smaller.

Students and I watched toddlers come into the lab and try to sit down on the tiny chair from the scale model—much to the astonishment of all present. At home, Urrutia and Rosengren had also observed their own daughters trying to lie down in a doll’s bed or get into a miniature toy car. Intrigued by these remarkable behaviors that were not mentioned in any of the scientific literature we examined, we decided to study them.

**Gulliver’s Errors**

We brought 18- to 30-month-old children into a room that contained, among other things, three large play objects: an indoor slide, a child-size chair and a car. Toddlers could get inside and propel around the room with their feet. After a child had played with each of the objects at least twice, he or she was escorted from the room. We then replaced the large items with identical miniature versions. When the child returned, we did not comment on the switch and let him or her play spontaneously. If the toddler ignored the miniature toys for more than three or four minutes, however, we would draw attention to them.

We then examined films of the children’s behavior for what we came to call scale errors: earnest attempts to perform actions that are clearly impossible because of extreme differences in the relative size of the child’s body and the target object. We were very conservative in what we counted as a scale error.

Almost half the children committed one or more of these mistakes. They attempted with apparent seriousness to perform the same actions with the miniature items that they had with the large ones. Some sat down on the little chair; they walked up to it, turned around, bent their knees and lowered themselves onto it. Some simply perched on top, others sat down so hard that the chair skittered out from under them. Some children sat on the miniature slide and tried to ride down it, usually falling off in the process; others attempted to climb the steps, causing the slide to tip over. (With the chair and slide made of sturdy plastic and only about five inches tall, the toddlers faced no danger of hurting themselves.) A few kids tried to get into the tiny car. Just as they had done with the large version, they opened the door and attempted—often with remarkable persistence—to force a foot inside. One little girl went so far as to take off her shoe in the apparent hope that her foot would then fit.

Interestingly, most of the children showed little or no reaction to their failed attempts with the miniatures. A couple seemed a bit angry, a few looked sheepish, but most simply went on to do something else. We think the lack of reaction probably reflects the fact that toddlers’ daily lives are full of unsuccessful attempts to do one thing or another.

Our interpretation is that scale errors originate in a dissociation between the use of visual information for planning an action and for controlling its execution. When a child sees a miniature of a familiar object, visual information—the object’s shape, color, texture and so on—activates the child’s mental representation of its referent. Associated with that memory is the motor program for interacting with the large object and other similar objects. It is more difficult to inhibit the motor program that is already set.

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and the children did not attempt to interact with the miniature in the same way as they did with the large version.

But in the other half the motor routine was not inhibited. Once the child began to carry out the typical motor sequence, visual information about the actual size of the object was used to accurately perform the actions. Some children, for instance, bent over the tiny chair and looked between their legs to precisely locate it; those trying to get into the miniature car first opened its door and then tried to shove their foot right in. In deciding to interact with the replica, the children relied on visual information linking it to the normal-size object, but in executing their plan, they used visual information about the miniature's actual size to guide their actions. This dissociation in the use of visual information is consistent with influential theories of visual processing—ones positing that different regions of the brain handle object recognition and planning versus the execution and control of actions.

Scale errors involve a failure of dual representation: children cannot maintain the distinction between a symbol and its referent. We know this because the confusion between referent and symbolic object does not happen when the demand for dual representation is eliminated—a discovery I made in 1997 when Rosengren and Kevin F. Miller of the University of Illinois and I convinced two-and-a-half-year-olds—with the full consent of their parents, of course—that we had a device that could miniaturize everyday objects.

The Magical Machine

Using our amazing shrinking machine, we hoped to see if the need to think of an object in two ways at once was at the heart of young children's inability to appreciate symbols. If a child believes that a machine has shrunk an object or a room, then in the child's mind the miniature is the thing itself. There is no symbolic relation between room and model, so children should be able to apply what they know about the big version to the little one.

We used the powers of our device to turn toys into miniature versions of themselves and to shrink a large tent. In front of the child, we placed a toy—a troll doll with vivid purple hair—in a tent and aimed the shrinking machine at the tent. The child and experimenter then decamped to another room to wait while the machine did its work. When they returned to the lab, a small tent sat where the big one had been. (One of the remarkable things about this study is the fact that the children did not find it at all surprising that a machine could miniaturize objects. Or that it might need privacy to do so.)

When we asked the children to search for the toy, they immediately looked in the small tent. Believing the miniature to actually be the original tent after shrinking, they successfully retrieved the hidden toy. Unlike in our scale model experiment, they had no dual representation to master; the small tent was the same as the large tent, and thus the toy was where it should be, according to the toddlers' view of the world.
Understanding the role of dual representation in how young children use symbols has important practical applications. One has to do with the practice of using dolls to interview young children in cases of suspected sexual abuse. The victims of abuse are often very young children, who are quite difficult to interview. Consequently, many professionals—including police officers, social workers and mental health professionals—employ anatomically detailed dolls, assuming that a young child will have an easier time describing what happened using a doll. Notice that this assumption entails the further assumption that a young child will be able to think of this object as both a doll and a representation of himself or herself.

These assumptions have been called into question by Maggie Bruen of Johns Hopkins University, Stephen J. Ceci of Cornell University, Peter A. Ornstein of the University of North Carolina at Chapel Hill and their many colleagues. In several independent studies, these investigators have asked preschool children to report what they remember about a checkup with their pediatrician, which either had or had not included a genital check. Anatomically detailed dolls were sometimes used to question the children, sometimes not. In general, the children's reports were more accurate when they were questioned without a doll, and they were more likely to falsely report genital touching when a doll was used.

Based on my research documenting young children's difficulty interpreting symbolic objects, I suspected that very young children might not be able to relate their own body to a doll. In a series of studies in my lab using an extremely simple mapping task, Catherine Smith placed a sticker somewhere on a child—on a shoulder or foot, for example—and asked the child to place a smaller version of the sticker in the same place on a doll. Children between three and three-and-a-half usually placed the sticker correctly, but children younger than three were correct less than half the time. The fact that these very young children cannot relate their own body to the dolls in this extremely simple situation with no memory demands and no emotional involvement supports the general case against the use of anatomically detailed dolls in forensic situations with young children. Because of many demonstrations akin to this one, the use of dolls with children younger than five is viewed less favorably than in the past and has been outlawed in at least one state.

Educational Ramifications

The concept of dual representation has implications for educational practices as well. Teachers in preschool and elementary school classrooms around the world use 'manipulatives'—blocks, rods and other objects designed to represent numerical quantity. The idea is that these concrete objects help children appreciate abstract mathematical principles. But if children do not understand the relation between the objects and what they represent, the use of manipulatives could be counterproductive. And some research does suggest that children often have problems understanding and using manipulatives.

Meredith Amaya of Northwestern University, Uttal and I are now testing the experience of difference with symbolic objects on young children's learning about letters and numbers. Using blocks designed to help teach math to young children, we taught six- and seven-year-olds to do subtraction problems that require borrowing (a form of problem that often gives young children difficulty). We taught a comparison group to do the same but using pencil and paper. Both groups learned to solve the problems equally well—but the group using the blocks took three times as long to do so. A girl who used the blocks offered us some advice after the study: "Have you ever thought of teaching kids to do these with paper and pencil? It's a lot easier."

Dual representation also comes into play in many books for young children. A very popular style of book contains a variety of manipulative features designed to encourage children to interact directly with the book itself—flaps that can be lifted to reveal pictures, levers that can be pulled to animate images, and so forth.

Graduate student Cynthia Chiong and I reasoned that these manipulative features might distract children from information presented in the book. Accordingly, we recently used different types of books to teach letters to 30-month-old children. One was a simple, old-fashioned alphabet book, with each letter clearly printed in simple black type accompanied by an appropriate picture—the traditional "A is for apple, B is for boy" type of book. Another book had a variety of manipulative features. The children who had been taught with the plain book subsequently recognized more letters than did those taught with the more complicated book. Presumably, the children could more readily focus their attention with the plain 2-D book, whereas with the other one their attention was drawn to the 3-D activities. Less may be more when it comes to educational books for young children.

As these various studies show, infants and young children are confused by many aspects of symbols that seem intuitively obvious to adults. They have to overcome hurdles on the way to achieving a mature conception of what symbols represent, and today many must master an ever-expanding variety of symbols. Perhaps a deeper understanding of the various stages of becoming symbol-minded will enable researchers to identify and address learning problems that might stem from difficulty grasping the meanings of symbols.