The Early Growth of Symbolic Understanding and Use: A Tribute to Ann Brown

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INTRODUCTION: IN HONOR OF ANN BROWN

A note from the first author: I am delighted to be authoring a chapter in a book in honor of the illustrious career and accomplishments of Ann Brown, and I want to begin the chapter by acknowledging both my admiration for Ann and my enduring gratitude for her influence on my career and life.

Ann was the "compleat scientist." Her focus was squarely on the really important questions and issues, both theoretical and practical. Her research was extremely creative and typically involved a variety of methods, skillfully employed. Ann's remarkable knowledge of the literature in a wide variety of areas provided a firm grounding for everything she did. Her prolific reports of that research were invariably written beautifully; reading an article by Ann Brown was both an educational and an aesthetic experience.

Particularly admirable was her ever-deepening commitment to doing research that made contact with the real world. Her laboratory research was typically designed with an eye to learning about how real children behave in the everyday world, and she and Joe conducted some of the most ambitious and influential applied educational research I know of. The countless children who have benefited from their participation in a "community of scholars" constitute one of her lasting legacies.

To honor Ann, this chapter summarizes the research I have conducted from the time I was a post-doctoral fellow with her until the present. Only the early studies were direct collaborations with Ann, but the research I have done throughout my entire career bears the stamp of her influence in myriad ways. It thus seemed natural to write the first part of this chapter autobiographically, emphasizing the many continuing benefits I enjoyed through my association with Ann. The final section of the chapter, written by Patricia Ganea, focuses on our current joint research. As a post-doctoral fellow with me, just as I was a post-doc with Ann, Patricia also benefits from Ann's intellectual legacy.

MEMORY FOR LOCATION

The earliest research I conducted in collaboration with Ann was initiated by her suggestion of how we might study memory in very young children. We were both interested in memory; I had done some studies with infants, and Ann had done extensive work with older children. At the time, toddlers occupied a no-child's land; there was hardly any cognitive research on this particular age group, notorious for being less than fully compliant research subjects. Ann had recently read a paper on early language development by Janellen Huttenlocher (1974), in which very young children were asked to go find familiar objects in their home as a test of word comprehension. Obviously, the children had to remember where the objects were in order to retrieve them, so Ann suggested that we could use this simple task to study memory in toddlers.

Part of the motivation for our initial studies was the assumption that studies conducted in unfamiliar labs might underestimate young children's memory abilities. This assumption was based in part on Ann's observation of a very young child who had visited her home and received a treat from a candy dish. Several weeks later, the child visited again and made a beeline for the candy dish. Clearly, the child had remembered both the existence and location of the candy in this natural setting. I include this anecdote to emphasize one of Ann's strengths, which was to generate research questions based on everyday observations of children in their natural habitats. This was a valuable lesson — one that I have tried to implement in my own research and that I explicitly try to convey to my own students.

Our initial studies were designed to be as naturalistic as possible, both in terms of the task itself and the environment in which it was situated. Toddlers (18- to 30-month-olds) watched as a desirable toy was hidden in a natural location (under a chair, behind the couch) in their own homes. After a delay period, which ranged from 30 seconds to several minutes (and sometimes overnight), they were encouraged to find the toy. Their retrieval rate was taken as a measure of their memory for location. Our new task that toddlers could understand and were motivated to perform paid off: The success rate of our very young participants was over 80%, a rate far above anything reported in standard lab studies (DeLoache & Brown, 1979).

Testing the young children in their own homes was, however, time consuming and labor intensive. Further, we had some specific questions that couldn't really be addressed in children's homes, where there was so much variability from one to another. So, we moved into the lab with a testing room furnished like a regular living room (albeit a rather shabby one). We immediately discovered that the retrieval performance of 18- to 30-month olds was equal to that of children tested in their own homes, thereby invalidating our assumption that a highly familiar environment was a vital support for young children's memory. Rather, it pointed to the fact that even very young children have excellent memory for distinctive locations.

This simple memory-for-location game turned out to tell us a number of interesting and important things about early memory development. One was a powerful demonstration of a cognitive limitation in very young children's representational capacity (DeLoache & Brown, 1983). When a toy was hidden directly behind an armchair — a distinctive landmark — 18- to 30-month-olds were extremely successful at retrieving it. However, if the toy was hidden instead in one of four identical boxes, only the children between 24 and 30 months were successful. The 18- to 24-month-olds rarely found the toy, even though the box was sitting right on top of the distinctive landmark.

Apparently, the younger children failed to link the actual hiding place of the object (the box) with the landmark (the piece of furniture) that distinguished it from the other boxes. The children remembered and used one relation; they knew the toy was in one of the boxes, and they always searched there. However, they did not use the second relation (between the box and the landmark) to identify which box was relevant. This and subsequent studies made it clear that there is a sharp limit on the number of relations that young toddlers can represent in the service of memory; they can remember the relation between an object and a distinctive hiding place, but not the relation between the object and a non-distinctive hiding place and a distinctive landmark (DeLoache, 1989).

Another result to emerge from this early research was evidence of very early, primitive memory strategies. Ann had, of course, been studying memory strategies in older children and adults for some time. Our discovery of simple strategies in children as young as 18 months came about through serendipity (DeLoache, Cassidy, & Brown, 1985). Graduate student Deb Cassidy was testing young children's memory performance at home and in the lab. She alertly noticed that, although, their memory performance was the same in the two settings, there were interesting differences in the children's behavior in the two settings. In the lab, but not at home, the children did things that suggested they were trying to keep track of where the toy was hidden during the 5-minute delay period. As they waited before retrieving the hidden toy, they would repeatedly interrupt their play with the experimenter to look toward the hiding place, talk about the invisible toy, and sometimes even go over and hover near its hiding place. We interpreted these behaviors as primitive memory strategies — behaviors designed to keep in mind the to-be-remembered information (the hiding place of the toy). Apparently, when very young children are in an unfamiliar setting in which they are a bit uncertain about the "lay of the land," they do things to help them remember where the desirable toy is hidden; when they're in their familiar home environment, they don't feel the need for that extra insurance. There are similar reports of more advanced cognitive strategies being employed in unfamiliar settings, both for younger infants (Acredolo, 1979) and for older children (Ceci & Bronfenbrenner, 1985).

A counterintuitive prediction emerged from this interpretation: children should orient *less* often to the target toy during the delay interval if it remains in plain sight than if it is concealed. If children look toward, talk about, hover around the hidden toy as a means of keeping its hiding place in mind, then if the toy stays in view, they should look at it less often, not bother to talk about it, and not hover around it while they wait to retrieve it. This counterintuitive prediction was confirmed, lending particularly strong support to our argument that very young children can engage in simple strategic behaviors.

YOUNG CHILDREN'S UNDERSTANDING OF SCALE MODELS

My next line of research, which continues to this day, is a long series of studies on very young children's understanding and use of scale models as a source of information. This research got its start from another case of serendipity.

In an extension of the memory research done with Ann, I wanted to examine the nature of young children's memory representation of object location. To address this topic, I had a scale model constructed of my laboratory playroom. Young children watched as the experimenter hid a miniature toy somewhere in the model (e.g., behind the tiny chair), and then they were asked to search for a larger version of the toy that they were told was hidden in the same place in the room. Thus, the children had to use their memory for where they had seen the miniature toy being hidden in the model to figure out where to search for the larger toy in the room.

To my immense surprise (and that of all my colleagues), 2-1/2-year-old children performed abysmally in this task. It was also surprising to the parents of the children; the task appeared so straightforward and easy that they were stunned to see their children fail. The unexpected result was so intriguing that I started trying to figure out why it occurred.

The first thing I discovered was that it was *not* difficult for children only a few months older; in contrast to the 2-1/2-year-olds, 3-year-olds knew exactly where to find the toy in the room. The difference was dramatic – approximately 15% correct for the younger children and over 85% correct for the older ones. The younger children's problem did not have to do with memory: when asked to retrieve the miniature toy they had observed being hidden in the model, both ages succeeded over 80% of the time.

I delayed writing up the original studies for quite some time, because I had no idea why this task was so hard for very young children. I slowly came to realize, however, that what this research was really about was young children's understanding of symbolic relations. The model is a symbolic artifact; it stands for or represents the room. Thus, the model task tests children's appreciation of the symbolic relation between model and room.

An important insight came from a study based purely on an intuition I had; there was no theoretical basis for the idea at all, but it just seemed to me that the task would somehow be easier if a photograph, instead of a model, was used. The intuition was correct: When 2-1/2-year-olds were informed of the location

First, we demonstrated the powers of our incredible shrinking machine to turn the to-be-hidden toy into a miniature version of itself and to shrink the tent into a small model. Then the children watched as a toy was hidden in the full-sized tent. The shrinking machine was aimed at the tent, and the child and experimenter waited in the room next-door for about a minute while the machine did its work. When they returned to the lab, the small model was where the large tent had been. (One of the most remarkable things about this study is that the children did not find the transformation at all remarkable.)

Next, the children were asked to search for the toy. Believing the model to *actually be* the tent itself after it had been shrunk, they successfully retrieved it. This result provides very strong support for the role of dual representation in young children's understanding and use of symbolic objects.

SCALE ERRORS — SYMBOL-REFERENT CONFUSION

The shrinking room study made it clear that very young children can be induced to conflate a symbol and its referent. Some very recent research in my lab has established that young children do the same spontaneously, that the line between a symbolic object and its referent can momentarily become blurred.

The inspiration for this research came from observations of surprising and fascinating behaviors that my colleagues (David Uttal and Karl Rosengren) and I made in our own homes and labs. What we noticed — and found remarkable — was that very young children occasionally treat a miniature object as if it were its larger counterpart. In my lab, every once in a while a young child would try to sit in the miniature chair in the scale model, in spite of the fact that the chair was only about five inches tall. My colleagues observed their own children trying to lie down in a doll's bed about 12 inches in length and attempting to get into a small toy car. Intrigued that even very young children could attempt such obviously impossible actions, we decided to study the phenomenon in the lab (DeLoache, Uttal, & Rosengren, 2004).

The primary goal with which we started was simply to document the occurrence of what we call scale errors, defined as a *serious* attempt to perform an action on an object that is impossible because of large differences in the size of the two entities involved. It is important to emphasize that we are not interested in pretense; to count as a scale error, a behavior has to be judged to be a serious effort to carry out a physically impossible action.

Because scale errors are presumably relatively rare, we set up a situation designed to increase the likelihood that we could observe and record their occurrence. In a large laboratory playroom, young children (18- to 36-months of age) were encouraged to interact with three large objects — a child-sized chair they could sit in, an indoor slide they could climb up and go down, and a car they could get in and propel around the room. (A few other toys were also present, including a doll and doll-sized stroller.) After the children had interacted with of the toy in the room by the experimenter pointing to a picture of the target location, they were able to find it (DeLoache, 1987; DeLoache, 1991).

This result led to the formulation of the concept of *dual representation* (DeLoache, 1987, 1995, 2002). Every symbolic object is both an object in and of itself and, at the same time, a representation of something other than itself. To use a symbolic artifact like a model, map, or picture as a source of information about reality, one has to represent both the symbolic object itself and its relation to what it stands for. Thus, in the scale model task, children have to mentally represent the model itself and also the relation between the model and room. When they observe the miniature toy being hidden in the model, they have to appreciate that this tells them about the unseen hiding event in the room.

The dual representation concept also entails that the more salient a symbolic object is in and of itself, the more difficult it will be to appreciate its symbolic role. Very young children can be so attracted to the object itself that they fail to appreciate its relation to what it represents. Pictures are easier than a scale model in the retrieval task precisely because they are not physically salient; the child's attention is not drawn to the picture itself at the expense of its relation to what it depicts.

The concept of dual representation led to several highly counterintuitive predictions, all of which have been supported (DeLoache, 2000). One was that decreasing the physical salience of the model should make it *easier* for very young children to appreciate the model-room relation. To test this idea, we placed the model behind glass in a puppet theater and 2-1/2-year-olds simply watched as the experimenter pointed to the correct location behind the glass. When asked to retrieve the larger toy from the room based on the hiding event they had observed in the model, they were successful.

A second test was based on the opposite prediction: Making the model even more physically salient to young children should make it *more difficult* for them to use it symbolically; that is, it should be more difficult to achieve dual representation. This time, 3-year-old children were invited to play with the model for a few minutes before beginning the standard model task. Having previously played with the model as a set of objects, these children now had difficulty interpreting the model symbolically. Their retrieval performance was quite poor.

Finally, one of my favorite studies I have ever done provided especially strong evidence in support of the concept of dual representation (DeLoache, Miller, & Rosengren, 1997). The idea for this study was that if the need for dual representation could be removed altogether, the task should be much easier. Accordingly, we endeavored to convince 2-1/2-year-olds that we could shrink a room, that is, that we had a machine that could turn a large, room-sized tent into a small scale model of it. The logic was that if children believed that the scale model and larger space actually were the same thing, then there would be no need for dual representation. In the child's mind, the model and room simply *are* the same entity. The model is no longer functioning as a symbol.

all the objects, they were taken from the room for a few minutes while the three large objects were replaced with miniature versions that were highly similar to the large ones except for size. The small objects measured no more than a few inches, and none could possibly afford the actions associated with their larger counterparts.

When the children returned to the room, we simply filmed what they did with the miniature objects. The study was a success, in that we documented on film the occurrence of scale errors. The children tried to sit on the miniature chair and to go down the tiny slide, often falling off in the process. They even attempted to get into the 4-inch high car, persistently and futilely shoving their far-too-large foot against the tiny door opening. One little girl apparently diagnosed the source of her problem; she took off her shoe and tried again. Seeing is believing, and convincing (and very funny) films of some scale errors can be seen at *http://www.faculty.virginia.edu/childstudycenter/clips.html.*

A follow-up study established that scale errors are not limited to attempts to do impossible things involving the relation between one's own body and an object (Ware, Uttal, & DeLoache, 2006). Young children also commit them with dolls and miniature objects, trying, for example, to put a doll into a bed that is far too small for it to fit.

In committing a scale error, a child momentary makes a symbol-referent confusion, treating the symbolic object — the small toy — as its referent — the corresponding larger object. Scale errors thus involve a failure of dual representation, a failure to keep in mind the difference between a symbol and what it stands for.

Why do young children make scale errors? How could anyone of any age commit size confusions of such magnitude? A clue comes from the specific behaviors involved in scale errors. Although the children ignore the miniature size of the replica objects when deciding to interact with them (i.e., when deciding to sit in the chair or get into the car), they do take the actual size of the objects into account when trying to use them. Before sitting down on the miniature chair, some children actually bent over and looked between their legs to locate its exact position. Similarly, when the children tried to get into the tiny car, they precisely opened its tiny door before trying to force their foot through the opening.

Scale errors thus reflect a dissociation in the use of visual information for planning versus controlling the execution of an action. When children see a miniature replica of a familiar object, visual information (the object's shape, color, texture, and so on) activates their mental representation of the familiar larger object or class of objects. Associated with that memory representation is the motor program for interacting with the referent object(s).

A scale error originates when children form an action plan based on the size of the large object, rather than the size of the replica. They then fail to inhibit the motor behaviors associated with the larger object that are activated by the sight of the replica. In other words, the real size of the object in front of them is ignored in the formation of their action plan. However, once the plan is initiated, the actual size of the replica object is used to calibrate the movements directed toward it. Thus, scale errors involve the execution of finely-tuned actions in the service of an impossible plan.

The occurrence of scale errors may reflect immaturities in the cortical functioning of typically developing young children. The dissociation between planning and action that is the hallmark of scale errors is consistent with theories of visual processing that posit the existence of neurally and functionally distinct visual systems underlying perception and action (Milner and Goodale, 1995; Glover, 2002, 2004). Research with both brain-damaged and intact adults have provided evidence for the existence of separate streams of visual information from primary visual cortex to other cortical areas. Separate systems are involved in identifying objects and generating action plans versus controlling the specific movements performed in the execution of those plans. Scale errors may represent occasional breakdowns in the integration of visual information about the identity of an object processed by one area with information about its size processed by another. With development, the integration of the two systems becomes stronger and more reliable, leading to the decline of scale errors.

DOLLS AS SELF-REPRESENTATIONS

The dual representation concept is applicable to a variety of other domains in which young children are asked to reason based on symbolic representations. This fact led me to follow (to some extent) in Ann's footsteps in extending research insights and findings to topics of practical importance. One relevant domain of application has to do with legal investigations and proceedings. In an effort to improve the identification of sexual abuse of very young children, many professionals (police officers, social workers, mental health professionals, physicians, etc.) have employed anatomically explicit dolls to question suspected victims. The rationale for the use of dolls is the assumption that they should help young children to provide more complete and more accurate accounts of their experience, and the fact that young children routinely play in meaningful ways with dolls is assumed to lend credence to this notion. However, this rationale also rests on the assumption that very young children can readily appreciate a doll as a representation of themselves and can accurately map between their own body and the doll.

Our research on young children's understanding of symbolic artifacts casts suspicion on this assumption. Catherine Smith and I conducted a series of studies designed to examine very young children's ability to map between themselves and a doll (DeLoache & Smith, 1999). The task was extremely simple: The experimenter placed a sticker somewhere on the child (e.g., on the child's shoulder, knee, foot) and asked the child to place a smaller version of the sticker in the same place on a doll. All that was necessary for success was that the child

(1) interpret the doll as representing him- or herself and (2) map the sticker location from his or her own body to the corresponding place on the doll.

In the initial study, we found that 4-year-old children were quite successful (97%) and 3-year-olds were reasonably successful (approximately 80%) at this task, but that 2-1/2-year-olds were not (less than 50%). Thus, the youngest children mapped correctly less than half the time in spite of the simplicity of the task and a very generous scoring system (if the sticker had been placed on the child's left wrist, putting the smaller sticker on the doll's right arm would be counted as correct).

In an effort to understand why this seemingly trivial task was so difficult, we conducted several further studies. Starting with the idea that increased similarity between child and doll might improve performance, we used a large doll that was close to the same size as the children in the study. Performance barely improved.

Three studies were conducted based on the idea that it might be easier for children to use a picture as a self-symbol (based on the difficulty of dual representation). In each case, a large sticker was placed on the child, and then the child was asked to place the miniature sticker on the appropriate place in the picture. In the first study, using a simple colored line drawing of a doll, there was no improvement in performance. In the second, in an effort to help children understand the picture-self relation, we took a Polaroid photograph of the child when he or she arrived at the lab and got it enlarged immediately to use for the placement task. The result was no better than with the drawing of the doll.

In a further effort to emphasize the self-picture relation, the child lay down on a large piece of paper while the outline of his or her body was drawn. Hair and eye color and clothing details were then added to the picture. In spite of these efforts, the children still failed to map the sticker location from their own body to the drawing.

Thinking that perhaps the children had difficulty mapping from their own body to anything else, we next assessed whether they could map from a *different* child to the doll used in the original studies. Each participant watched as the experimenter placed a sticker on a 6-year-old confederate, and then the child was asked to put the miniature sticker in the corresponding place on the doll. Again, performance hovered below 50%, indicating that the children's problem was not reasoning from themselves to a representation.

The final two studies clarified matters. We now asked children to perform a simple mapping between two people or between two dolls. All the previous tasks had involved the child mapping between themselves or another child and a doll or picture. When asked to map from one doll to a second doll (either the same or different size), 2-1/2-year-olds were very successful (ca 90%). They were similarly successful (ca 70% when asked to map between themselves and their mother.

This series of studies makes two important points, one theoretical and one practical. On the theoretical side, these results reveal that young children have much more difficulty reasoning from one entity to another when a symbolic relation is involved. Performance was poor in every case in which the child had to perform a symbol-referent mapping — person to doll or picture. Performance was excellent when virtually the same mapping had to be done within a category — doll to doll or person to person. Virtually all symbol-referent relations involve qualitatively different kinds of entities; hence, part of the difficulty young children have doing symbolic mappings may have to do with reasoning across ontological categories.

On the practical side, these results raise suspicion that the memory reports of very young children could ever be improved by the use of dolls. If young children cannot even map between themselves and a doll in an extremely unchallenging situation, how could introducing a doll into the questioning that goes on in a real forensic setting possibly assist them?

MANIPULATIVES AS EDUCATIONAL AIDS

The concept of dual representation has a variety of implications for teachers and parents. For example, teachers in elementary school classrooms around the world use "manipulatives" — blocks, rods, and other objects that have been designed to represent numerical quantity. The assumption is that these concrete objects should help children come to appreciate mathematical operations and principles. However, if children fail to appreciate the relation between the objects and what they represent, the use of manipulatives could actually be counterproductive. Some research suggests that children do often have trouble understanding and using manipulatives, particularly if their teacher does not fully explain how they are to be used (e.g., Hughes, 1986; Resnick & Omanson, 1987). David Uttal and I are currently examining the use of various sorts of manipulatives with the goal of identifying under what conditions they are helpful and when they are harmful. In this work, we follow Ann and Joe's example of extending our basic research to asking questions of direct relevance to the classroom.

YOUNG CHILDREN'S LEARNING FROM PICTURE BOOKS

Collaborative research currently underway by both authors also can be seen to be following in the footsteps of Ann Brown in the sense that we are investigating learning and transfer in the context of common everyday activities. Our specific focus is picture-book interactions between very young children and their parents, and some of Ann's own research will be explicitly incorporated into the project.

Every day millions of American parents sit down with their infants and young children to engage in a common family ritual — joint picture book reading. Parents read to young children for many reasons - to foster their language and cognitive development, to encourage a love of books and reading, to help them take their first steps toward literacy, to provide a calm time in the child's busy day, to share an intimate experience, and so on. In addition, parents and preschool teachers assume that young children learn useful information from the books to which they are exposed and that they generalize that information beyond the pages of the book.

But, do they? To what extent do young children extend what they learn from books to the real world? We simply do not know, for example, how likely it is that a young child who has learned to identify a picture of a kangaroo in a book and has also learned that mother kangaroos carry their babies in a pouch would generalize that knowledge upon first encountering a real kangaroo in a zoo.

In our lab, we are examining the processes involved in young children's learning from picture book interactions, and, of most importance, we are assessing the extent to which they apply what they have learned beyond the pages of the book. The primary focus of this line of research is thus young children's extension and generalization of new knowledge from picture book experiences to the real world, with the goal of identifying factors that facilitate or impede that process.

In our initial study, we taught 15- and 18-month-old children a novel name for a novel object in a picture-book interaction and then assessed how well they extended that name to the real depicted object and generalized it to new objects (Ganea & DeLoache, 2006). We also asked whether the nature of the pictures in the books affected what the children learned and generalized. Illustrations in picture books for young children vary widely in how realistic they are. Even in books that are designed to provide information about the world, the pictures can vary from highly realistic color photographs and accurate drawings of real entities to less realistic cartoons that distort and exaggerate the features of those entities. Would pictures with different degrees of realism make a difference in how well young toddlers can learn and generalize from a book to the real world?

The three kinds of books used in our study contained highly realistic color photographs, realistic colored drawings, or colored cartoons of the objects. Each book showed pictures of two novel and six familiar objects. The experimenter talked about each picture as the child looked at the book, and she labeled one of the novel objects with a novel name (e.g., "blicket"). The other novel object was talked about but never named.

The children in both age groups learned the novel name for the novel object during the brief interaction. When they were presented with pictures of the two novel objects that they had seen depicted in the book and asked to show the "blicket," most of them identified the correct picture.

We then assessed whether the children would extend the novel label they had learned from the book to real objects. When we presented them with the two novel objects that they had seen depicted in the book and asked for the blicket, they chose the appropriate object. Finally, when we showed them new exemplars of the novel objects, most of the 18-month-olds and about half of the 15-month-olds correctly generalized the novel word. These results show that children in the second year of life can apply new information learned from a book to the real world, although the results also indicate that their extension from book to world may be fairly limited.

The results provided a clear answer to our question regarding the influence of pictorial realism on children's generalization from the book. The children generalized less well from the cartoons than from the photographs or the realistic drawings. Thus, very young children's application of new information from a picture book to the real world is quite fragile and is sensitive to how realistic the pictures are. These results have important practical implications for the design and use of educational books with young children. When the purpose of a picture book interaction is to get children to learn new information about the world, books with more realistic pictures will be better.

In other research, we are examining a second aspect of books aimed for young children that we think might affect learning — *physical complexity*. Many children's books have a variety of manipulative features built into them, including elements that pop up when the page is turned, flaps that can be lifted to reveal added material, tabs that can be pulled to animate aspects of the pictures, textured surfaces to be rubbed, and so on. These elements encourage children to interact physically with the book. Publishers presumably assume that such features are appealing to children (and their parents).

There are good reasons to suspect that manipulative features in books might actually impede children's learning of the content presented. According to the dual representation hypothesis discussed earlier (DeLoache, 1987, 1995, 2002), symbolic objects that are highly salient and interesting as objects are more difficult for young children to understand as representations of something else. The more a child's attention is drawn to the concrete aspects of a symbolic artifact, the less likely the child is to appreciate its symbolic import.

A recent set of studies conducted in our lab (Chiong & DeLoache, 2006) explored the effect of three different types of books on 30- to 36-month-old children's ability to learn alphabet letters: (1) a plain alphabet book, containing simple pictures and letters, (2) a book containing "manipulative" features - pop-up pictures and letters, and (3) a book in which the letters were embedded within pictures (for example, a snake in the shape of the letter "S").

In line with predictions from dual representation theory, children learned best with the simplest book: The children who had been taught with the plain book identified more letters than did children who had been taught with the more complex books. One possible reason for the poorer performance with the complex books is that their appealing features may have distracted the children's attention from the relevant, symbolic material. This study suggests that, even if they are appealing to young children, complex features with no communicative function can have a negative impact on children's ability to acquire information from a book. Thus, the "less is more" maxim should be considered by parents when choosing picture books to teach their children new information.

Another common feature of commercial picture books for children that we think might affect what children learn and apply to the real world is the use of fantasy characters and themes. Human consciousness, knowledge, abilities, intentions, and emotions are often attributed to animal characters (e.g., seals solve mysteries, cats build houses) and even to inanimate objects (e.g., lamps have faces and dance the tango, trains strive to achieve impossible goals). Fantasy elements are often employed even in children's books designed to convey serious information about the real world, including ones with a focus on scientific knowledge. Fantasy content can, of course, be entertaining, exciting, and pleasurable for children (and their parents). The question is whether fantasy elements affect children's learning from books and have an impact on their beliefs about reality.

To examine this issue, we exposed 2-, 3-, and 4-year-olds to either fantasy books (e.g., showing a cat cooking or a train with a smiley face talking) or realistic books (e.g., showing a cat feeding baby kittens or a train carrying passengers). On a different day, we asked the children a series of fantasy and reality questions about real animals and vehicles (e.g., Do cats paint houses? Do trains have engines?). Although the 4-year-olds did not seem to be affected by the fantasy content of the books, the younger children did seem to be. The 2- and some of the 3-year-olds who had listened to the fantasy books were more likely to say that animals and vehicles in the real world can have human-like characteristics than were the 2- and the 3-year-olds who had been exposed to the realistic books. These results indicate that the books that very young children are exposed to on a daily basis may have an impact on what information they incorporate into their conceptions about reality.

In the studies done to date, we have focused primarily on teaching young children new words and letters. In upcoming research, we will focus on children's learning of factual information from books. Joint book reading has the potential to serve as an excellent source of early knowledge. Under what conditions do young children generalize the factual information they learn through picture-book interactions to the real world?

In a new project just beginning, we examine young children's learning about scientific concepts from picture books. In particular, we ask whether children can learn about simple biological mechanisms, such as natural camouflage, from books. Again our primary interest concerns the extent to which they will generalize what they learn to the real world. The inspiration for the choice of biological mechanism is Ann's work. She used the topic of biological defense mechanisms (including camouflage) extensively in her research on analogical reasoning (e.g., Brown, 1989). We are planning to adapt her stories for inclusion in our picture books.

Another aspect of Ann's work that will be incorporated into this project is analogical structure, a feature that could readily be included into commercial books for young children. Ann's work on the early development of analogical reasoning showed that analogical structure facilitates learning, reasoning, and generalization (e.g., Brown, 1989; Brown, Kane & Long, 1989; Crisafi & Brown, 1986). For instance, in some of her studies, preschool children were read stories about animals that use various survival mechanisms, including camouflage. Children who had heard analogous stories about the benefits conveyed to different animals by protective coloration, for example, were better able to identify a superficially dissimilar example of the same mechanism in a new story. We expect that incorporating analogies into our picture books will facilitate children's understanding and generalization of the basic scientific principles presented.

Our long-term goal is to expose young children to new information in a picture-book interaction at home with their parents and then test them for generalization of that information to a real setting, such as the zoo or a museum exhibit. We plan, for example, to have parents read to their children from a specially constructed book. Then, after some interval, the children's generalization of information from the book will be assessed at the zoo or museum.

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