Less is More: How manipulative features affect children's learning from picture books

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Abstract

Picture books are ubiquitous in young children's lives and are assumed to support children's acquisition of information about the world. Given their importance, relatively little research has directly examined children's learning from picture books. We report two studies examining children's acquisition of labels and facts from picture books that vary on two dimensions: iconicity of the pictures and presence of manipulative features (or "pop-ups"). In Study 1, 20-month-old children generalized novel labels less well when taught from a book with manipulative features than from standard picture books without such elements. In Study 2, 30- and 36-month-old children learned fewer facts when taught from a manipulative picture book with drawings than from a standard picture book with realistic images and no manipulative features. The results of the two studies indicate that children's learning from picture books is facilitated by realistic illustrations, but impeded by manipulative features.

Keywords

picture books; iconicity; symbols; manipulatives; label learning; pop-ups

Picture books play an important role in young children's everyday lives and are considered by most parents (96%) to support the intellectual development of their children (Rideout, Vandewater & Wartella, 2003). There is a long history of research examining how parents and children interact with and converse about picture books (DeLoache & DeMendoza, 1987; Ninio, 1983; Ninio & Bruner, 1978; Sénéchal, Cornell, & Broda, 1995). Recently, researchers have begun to look at how children learn information from books and what book-specific features support learning. In this paper, we examine how two variables affect children's

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learning from picture books: the iconicity of the images and the presence of manipulative features, such as "pop-ups."

Learning from Picture Books

Learning in the young age group of 2-3 year olds often occurs through social interaction with an adult who is reading or reacting to some form of media, such as a picture book. Picture books are often intended as a source of entertainment, but many studies have shown that parents ask questions and provide labels for pictures in the books such that these interactions can be very productive for children's learning (Ninio, 1983; Whitehurst, et al., 1988). Recently, researchers have found that children can learn and generalize novel labels from picture books to objects in the real world. One factor that affects this learning is the iconicity – realism – of the pictures presented in the book, with greater iconicity leading to better learning (Ganea, Pickard, & DeLoache, 2008). In this research, 15- and 18- month-old children participated in three different picture book conditions: photographs, realistic drawings, and cartoons. In each condition, the children were taught a novel label for a novel object depicted in the book. Following the training phase, children were given three tests to see if they could (1) recognize a picture of the novel target, (2) extend the label to the novel object, and (3) generalize the label to another exemplar of the target object. Children of both age groups could recognize the target picture that they had learned from. However, the iconicity of the picture affected how well 15-month-old children extended the label to the real object; they could do so above chance in the photographs and drawings conditions, but not in the cartoons (least iconic) condition. Further, neither age group of children who participated in the cartoons condition performed above chance when asked to generalize the label to a new target exemplar. These findings show that the iconicity of the image affected how well children transferred knowledge from the picture book to reality.

Simcock and DeLoache (2006) reported a similar finding, in that 18- to 30-month-old children showed better imitation of novel actions when taught from a book with more iconic images (photographs) than less iconic images (line drawings). These studies show that very young children's learning is in part dependent upon the physical similarity between the symbols presented in picture books and their real-world referents; as these become more disparate, children have difficulty appreciating the relationship between the two.

The Present Studies

Picture books differ not only in their pictorial realism, but also in a variety of other elements. In particular, books for young children commonly include pop-ups, pull tabs, textures or other features designed to increase children's physical interaction with the book. They are intended to be fun and interesting for the child, to enhance their engagement with the book. However, the very elements which are intended to attract children's attention to the book may also detract from their learning. If a parent is reading a pop-up book, the child might be distracted by manipulatives on the page, which divert the child's attention toward the sensory stimuli and away from the content of the book and the relevant information to be learned. These manipulative features may hinder learning due to the difficulty that young children have with *dual representation* – the ability to represent both the concrete characteristics of a symbol as well as the abstract category of what it stands for in the world (DeLoache, 1995; DeLoache, 2002). Children who are 2-3 years old have difficulty using objects symbolically, particularly when they have been encouraged to manipulate and play with them beforehand, because this increases the salience of the object itself rather than its symbolic function (DeLoache, 2000). Thus, a pop-up animal on a page might tax young children's ability to represent both the 3-D picture book page as well as the category of animal that their parents are trying to teach them about.

When the goal of the picture book interaction is learning, which is often the case for younger children, manipulative features may be detrimental by disrupting children's ability to recognize the real-world referents symbolized in the books. Thus, we examined the effects of picture book manipulative features on toddlers, for whom pop-up books are very common (a quick search reveals hundreds of titles). We hypothesized that picture books with no manipulative features and high iconicity will support learning over books with manipulative features and less realistic pictures.

Study 1

In the studies reported here, we examine young children's learning of new information from picture books. Study 1 reports 20-month-old children's ability to learn labels when taught from three different books that vary on the dimensions of iconicity and manipulative features.

Method

Participants—The participants were 54 18- to- 22-month-olds ($M = 20.55$ mos., 28 boys). Equal numbers of children were randomly assigned to three book conditions. Eight additional children (5 boys) were excluded due to fussiness. For both studies, participants were recruited through local birth announcements and were predominantly White and middle-class.

Materials—The stimuli for the study included three books: *Manipulative, Drawings*, and *Realistic* (See Figure 1). The *Manipulative* book was a commercial book with colored illustrations of nine different types of animals (starfish, parrot, chick, butterflies, snake, tiger, monkey, flamingo, and penguin), with one animal shown on each page. Each illustration involved some manipulative feature, such as a flap that could be lifted or a tab that could be pulled to cause the animals to pop up or move. The *Drawings* book was created by scanning the images in the Manipulative book, and binding them into a book. It was nearly identical to the Manipulative book, except for the absence of manipulative features. The *Realistic* book was created using color photographs of the same kinds of animals. Therefore, it varied from the Manipulative book in that it had more iconic images and no manipulative features. The images in the Drawings and Realistic books were printed, laminated and bound into books that were the same size ($15\,\text{cm} \times 15\,\text{cm}$) and contained pictures in the same order as the Manipulative book.

Pilot testing for Study 1 established that very few toddlers of the same age group and socioeconomic status as the ones included in the study could identify the parrot or flamingo, but they could identify the other animals in the books. Based on these data, children in our study were taught either the label "parrot" or the label "flamingo." If the parrot was the child's target animal, the flamingo was the distracter and vice versa.

The test stimuli were images of the two target animals, parrot and flamingo, from each of the three books and two miniature replica objects—a pink flamingo and a blue-and-yellow parrot. These objects matched the colors of the flamingo and parrot depicted in the three books.

Procedure

Book Reading: When the family arrived at the lab, the experimenter spent a few minutes playing with the child as a warm-up before the experimental session began. In the reading interaction, each child looked at one of the books while sitting on a couch with the experimenter (about 3-5 minutes). As they went through the book, the experimenter pointed to the pictures. In the *Manipulative* book condition, the experimenter encouraged the child to interact with the manipulative features (e.g., to lift flaps to cause the animals to move). Although the experimenter showed the child the entire book, spending a few seconds on each page, she

pointed to and *labeled* only the child's target animal (either parrot or flamingo), saying, "Look, this is a parrot. Yeah, a parrot. See, the parrot." The experimenter talked about the distracter animal the same amount, but did not label it, saying, "Oh, look at that. Do you see that? Yeah, look at that." The experimenter and child then went through the book a second time, following the same procedure. Thus, the child heard the target animal labeled a total of six times. Throughout the interaction, the experimenter was enthusiastic about showing the book, but aimed to limit conversation to the script. After the reading, the experimenter rated on a 5-point scale how attentive and engaged the child had been during the reading based, respectively, on the extent to which the child had looked at the picture book pages and was interested in what the experimenter was saying.

Testing: The five test trials were conducted immediately after the two book readings and assessed two levels of children's learning: *Recognition* and *Generalization*. For the *Recognition* trials, we assessed whether children had learned the label for the target animal ("parrot"/"flamingo") in Trial 1 and whether they remembered it throughout the test trials in Trial 5. The pairs of pictures presented to the children were identical to those in the book that they had looked at (e.g., children in the Realistic condition saw the realistic parrot and flamingo images). For the critical *Generalization* trials 2, 3, and 4, we assessed how well the children extended the label that they had learned to other types of pictures, as well as to an object. The children were presented with three different pairs of stimuli. On 2 of these 3 trials, the children were presented with the pairs of parrot and flamingo images taken from the two stimulus books that they had not seen before (e.g., children in the Realistic condition saw Manipulative images for one of the generalization trials and Drawing images for the other). For the third generalization trial, they were presented with replica objects (miniature parrot and flamingo toys). The order of presentation of these three trials was counterbalanced across participants.

For each of five test trials, the experimenter drew the child's attention to both the target and distracter stimuli, and asked the child to identify the target animal: "Show me the [parrot/ flamingo]." The side on which the target was presented was counterbalanced over trials. After the child chose either the target or the distracter, the experimenter said, "Thank you," giving neither positive nor negative feedback. If the child did not make a clear choice, reached for both stimuli, or did not respond, the trial was repeated one more time. If the child again failed to choose the target, he or she was coded as incorrect on that trial.

Results and Discussion

For the following analyses, all statistically significant effects and interactions are reported. The children in the three conditions were judged to be equally attentive and engaged during the book reading. The 3 (book) X 2 (sex) analyses of variance (ANOVAs) revealed no significant differences in the ratings (1-5) of their attentiveness ($M = 4.06$, $SD = .80$) or engagement ($M = 4.12$, $SD = .81$).

Recognition Trials—The two recognition trials (1 and 5) assessed whether children had learned and remembered the label for the target animal. Only the children in the Realistic book condition chose the correct target above chance ($M = 1.56$, $SD = .70$, t (17) = 3.34, $p < .01$). To further examine the effect of condition on the children's responses to the recognition trials, we conducted a 3 (book) X 2 (sex) ANOVA. There were no significant differences among the means for children's responses on the recognition trials, see Figure 2. With respect to individual performance, 12 of the 18 children in the Realistic condition got both trials correct as compared to 8 in the Manipulative condition and 6 in the Drawings condition. The difference between the Realistic and Drawings conditions was significant, $\chi^2 = 4.00$, $p < .05$.

Generalization Trials—Of primary interest were children's responses on the three generalization trials (2, 3, and 4), which assessed how well they extended the label that they had learned to new exemplars. The children in the Realistic ($M = 2.33$, $SD = 1.03$, $t(17) = 3.44$, $p < .01$) and Drawings ($M = 2.17$, $SD = .62$, $t(17) = 4.57$, $p < .01$) conditions chose the correct target stimuli above chance, whereas those in the Manipulative ($M = 1.50$, $SD = 1.04$) condition did not. In a 3 (book) X 2 (sex) ANOVA, there was a main effect of condition, $F(2, 51) = 4.15$, $p < .05$, partial $\eta^2 = .15$. Post-hoc analyses on which book conditions differed showed that the children in the Realistic condition were correct more often on the generalization trials than those in the Manipulative condition, $p < .05$. Further, analyses of children's individual performance showed that 11 of the 18 children in the Realistic condition chose the correct target on all three generalization trials as compared to 5 in the Drawings condition and only 3 in the Manipulative book condition. The difference between the Realistic and Drawings conditions was significant, $\chi^2 = 4.05$, $p < .05$, as was the difference between the Realistic and Manipulative book conditions, $\chi^2 = 7.48$, $p < .01$.

These results provide evidence that the type of book the children interacted with affected their learning of labels. Primarily, they generalized the new label better when they were taught from a book with realistic pictures than from a manipulative book. These two books differed on two dimensions, the iconicity of the pictures, a factor known to affect learning (Ganea, Pickard, & DeLoache, 2008), and the presence of manipulative features. However, the children also performed better in the Drawings than the Manipulative book condition: children in the Drawings condition chose the correct target above chance in the generalization trials whereas they were at chance in the Manipulative condition. This finding shows that, contrary to the expectations of publishers and parents, the books with the manipulative features were less supportive of learning than books without these features.

Study 2

Study 1 showed that low iconicity and the presence of manipulative features in picture books negatively affected children's label learning when the object that was being labeled was clearly depicted in the book. However, parents often elaborate on pictures and provide abstract information about the categories that are represented in picture books (Danis, Bernard, & Leproux, 2000; Gelman, Coley, Rosengren, Hartman & Pappas, 1998). For example, a parent may point to a picture of a cow and say, "Look at the cow! Cows say, 'Moo' and they like to eat grass." Thus, in this conversational situation, the parent could provide factual information that the picture book does not depict. It is possible that iconicity and the presence of manipulative features affect learning not only for entities that are directly illustrated but also for additional verbally presented information about those entities. Study 2 examines the extent of the effect of these book-specific factors which may affect learning even when the to-be-learned information is not represented in the book. As this is a more difficult task than label-learning, we examined how the three picture books affected older children's learning of facts.

Method

Participants—Forty-eight 27- to 32-month-olds (*M* age = 29.7 mos., 24 boys) and forty-eight 33-to 39-month-olds (*M* age = 35.8 mos., 24 boys) were tested. Five additional participants (4 boys) were excluded due to fussiness. Equal numbers of children were randomly assigned to three book conditions.

Materials and Procedures

Book Reading: The books from Study 1 were used. The book reading for the three conditions was similar to Study 1 and took about 5 minutes. The experimenter told the child four facts: 1) Chicks like to eat worms; 2) Snakes like to eat bugs; 3) Monkeys like to eat bananas; and

4) Penguins like to eat fish. For each target, the experimenter stated the fact three times, "Chicks like to eat worms. Worms are chicks' favorite food, so chicks like to eat worms." The book was then shown a second time, using the same procedure. Thus, each fact was stated a total of six times.

Testing: After the book reading was complete, the experimenter presented the child with two tasks, with four trials in each task. In the first task, *Fact Recall*, the child was shown pictures of each of the four animals from their book, one at a time and in one of two orders. For each picture, the child was asked, "What does he like to eat?" and the child was expected to repeat the appropriate fact heard during the book reading. In the second task, *Fact Identification*, all four pictures were placed in front of the child. Then the experimenter asked, for example, "Which one likes to eat worms?" and the child was expected to point to the correct animal for each fact. For each trial, the four cards were rearranged so that each target picture appeared in counterbalanced positions.

Results and Discussion

For both tasks, the children in both age groups learned more facts when they had interacted with the Realistic book than with the Manipulative book. This result was not due to motivational factors: the children in the three conditions were judged to be equally attentive and engaged during the book reading. The 3 (book) X 2 (age) X 2 (sex) ANOVAs revealed no significant differences among the conditions in ratings (1-5) of children's attentiveness ($M = 4.27$, $SD = .86$) or engagement ($M = 4.28$, $SD = .96$). There was a significant main effect of age group on children's engagement, with older children ($M = 4.56$, $SD = .74$) rated as being more engaged than younger children ($M = 4.00$, $SD = 1.07$), $F(1,83)= 9.01$, $p < .01$, partial $\eta^2 = .10$.

Using a repeated measures 2 (task) X 3 (book) X 2 (age) X 2 (sex) ANOVA, we examined differences in children's performance on the two tasks (see Figure 3). Overall, the children performed better on Fact Identification ($M = 3.31$, $SD = .89$), in which they had to choose the target from an array than on Fact Recall ($M = 2.78$, $SD = 1.06$) where they had to repeat the facts themselves, $F(1,84)= 34.68$, $p < .01$, partial $\eta^2 = .29$.

Fact Recall—*"What does he like to eat?"* A 3 (book) X 2 (age) X 2 (sex) ANOVA revealed a main effect of condition, $F(2,84)= 3.42$, $p < .05$, partial $\eta^2 = .08$, on children's ability to name the facts they had learned. Post-hoc analyses on which conditions differed showed that the children in the Realistic condition ($M = 3.13$, $SD = .91$) stated more correct facts (out of 4) than those in the Manipulative book condition ($M = 2.47$, $SD = 1.16$), $p < .05$. There was also a main effect of age for this task, with older children ($M = 3.00$, $SD = .90$) stating more facts than younger children ($M = 2.56$, $SD = 1.17$), $F(1,84)= 4.53$, $p < .05$, partial $\eta^2 = .05$.

With respect to individual performance, 25 of the 32 children in the Realistic book condition were correct on at least three of the four trials compared to 20 in the Drawings book condition and only 17 in the Manipulative book condition. The difference between the Realistic and Manipulative book conditions was significant, $\chi^2 = 4.43$, $p < .05$.

Fact Identification—*"Which one likes to eat [X]?"* As shown in Figure 3, the children in all three conditions performed well on this task, choosing the correct animals' pictures significantly above the chance level, p's $< .01$. A 3 (book) X 2 (age) X 2 (sex) ANOVA revealed a main effect of condition, $F(2,84)= 3.61$, $p < .05$, partial $\eta^2 = .08$. Post-hoc analyses on which conditions differed showed that the children in the Realistic condition ($M = 3.63$, $SD = .75$) matched more facts (out of 4) than those in the Manipulative condition ($M = 3.13$, $SD = .91$), $p < .05$. There was also a main effect of age, $F(1, 84) = 6.34$, $p < .05$, partial $\eta^2 = .07$. The older children ($M = 3.52$, $SD = .74$) chose the correct picture more often than the younger children

($M = 3.10$, $SD = .97$). A significant main effect of sex, $F(1, 84) = 12.42$, $p < .01$, partial $\eta^2 = .13$, reflected the fact that boys ($M = 3.60$, $SD = .61$) chose the correct picture more often than girls ($M = 3.02$, $SD = 1.02$).

With respect to individual performance, 24 of the 32 children in the Realistic book condition were correct on all four trials compared to 15 in the Drawings condition and only 13 in the Manipulative book condition. The difference between the Realistic and Drawings conditions was significant, $\chi^2 = 5.32$, $p < .05$, as was the difference between the Realistic and Manipulative book conditions, $\chi^2 = 7.75$, $p < .01$.

The results of Study 2 show that young children can learn novel facts from picture book interactions. With respect to the three conditions, the results parallel those of Study 1, with the children in the Manipulative book condition learning less and the children in the Realistic condition learning the most, with means for the Drawing condition falling in between. The Realistic book had two features that were predicted to increase learning: more iconic images and no distraction arising from manipulative features. In Study 2, we show that the type of picture book with which children interact affects not only label learning, but also the learning of verbally presented factual information up to 36 months of age.

General Discussion

Together, these studies support our hypothesis that the type of picture book that young children interact with affects how well they learn labels and facts. We found that 20-month-old children learned new labels less well when taught from a book with manipulative features, such as "pop-ups," than from books without manipulatives. The type of book also affected how many facts 30-and 36-month-old children learned from picture books, with children again learning the least from a *Manipulative* book and the most from a *Realistic* book with no manipulative features. It is unclear whether the two factors, low iconicity and presence of manipulatives, contributed equally to children's decreased learning in the Manipulative condition. As expected, children's performance in the *Drawings* condition, which had one "positive" factor (no manipulatives) and one "negative" factor (low iconicity), often fell between performance in the Realistic and Manipulative conditions. We did not find differences among the conditions in children's attentiveness and engagement during the book reading for either study; however, this analysis is limited in that the experimenter who rated the children was not blind to the studies' hypotheses.

The difference between the Realistic and Drawings conditions in individual performance on the fact identification task in Study 2 shows that iconicity continues to play a role in children's learning from picture books into their 4th year, beyond what had been previously shown (Ganea, Pickard, & DeLoache, 2008). This study also shows that iconicity affects how well children learn information that is only verbally presented. Thus, the negative effects of low iconicity on children's learning go beyond affecting how well children learn labels for pictured items.

Further, we found that manipulative features, which are intended to increase young children's engagement with picture books, led to less learning. In particular, handling the 3-D pop-up elements on the page may have made it difficult for children to learn about the animals featured in the book, due to the conflict of *dual representation*. This theoretical construct posits that the more salient and concrete a symbol is itself, the more difficult it is to represent its abstract referent (DeLoache, 1995). Difficulty achieving *dual representation* is well-documented in young children (see DeLoache, 2000) and may have negatively affected how well children in the Manipulative condition could learn from the animals represented on the very conspicuous 3-D pages.

In addition to the difficulty with dual representation, the children's manipulation of the flaps and pull-tabs on the page might have increased their cognitive load such that they could not additionally process what the adult was saying about the content of the book. Thus, because it did not have such distracting elements and had more detailed images, learning labels and facts from the Realistic book may have been an easier task. It may be that children at this age would be successful at learning from the pop-up books if given more time, if they had more background knowledge of the topic, or if the nature of the pop-up/manipulation was related to the verbal stimuli (e.g., showing the snake eating bugs). Further, in a more naturalistic setting, adults would likely engage children through conversational scaffolding by elaborating about each animal and giving children time to explore the manipulative on each page as well as learn factual information. Additional research is necessary to determine if these types of conditions would support greater learning from books with manipulatives. Nonetheless, the present studies show that the type of book does affect learning when adult input is held constant.

This research also has practical implications regarding which picture books to choose for young children when the intention is to teach. Manipulative books may have their place as entertainment in a young child's world, and are possibly even helpful for older children with language impairments (Kaderavek & Justice, 2005); however, our studies show that they do not support learning about the symbols that are depicted as effectively as books without manipulative aspects. Research on electronic book formats also corroborates these findings; children were found to pay less attention to the text on the pages and reproduce less story content when hearing a story from an electronic book rather than a traditional paper book (de Jong & Bus, 2002). Even parents treat electronic books differently, producing more talk about the interactive features than the content of the book than when reading traditional text-based books (Collins, Parish, Hirsh-Pasek, & Golinkoff, 2006). These results and ours are consistent with findings from educational research on "seductive details", which show that trying to increase interest in material by adding irrelevant "bells and whistles" actually results in less learning (Mayer, Heiser, & Lonn, 2001). The implication of these research findings for publishers and consumers of educational books is that "less is more" when attempting to convey information to young children.

Acknowledgments

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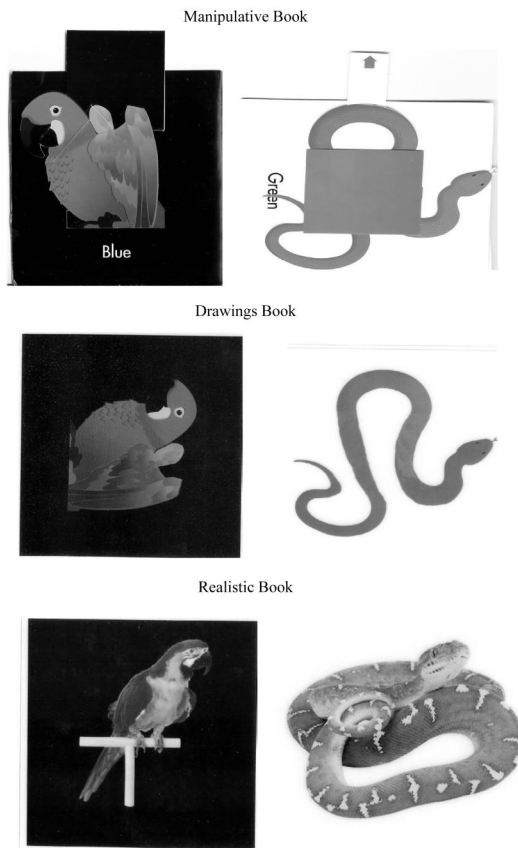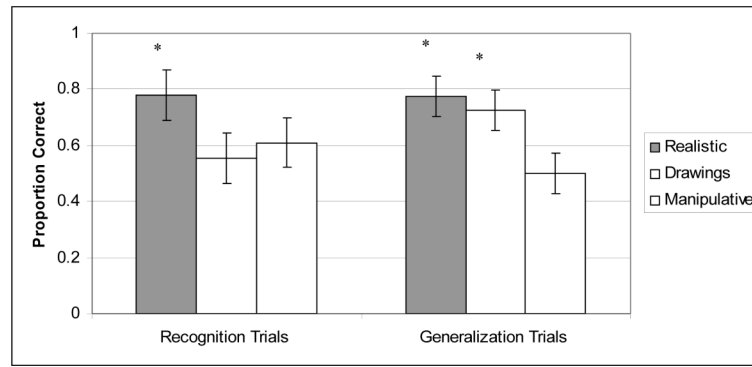
Manipulative Book

Drawings Book

Realistic Book

Figure 1.
Sample pages from the Manipulative, Drawings, and Realistic books. The Manipulative pages show pop-up and pull-tab manipulative features.

Note: * indicates performance above chance at $p < .01$

Figure 2.
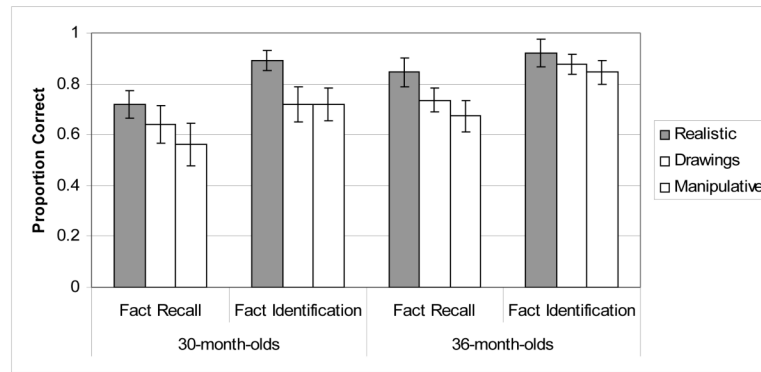Proportion of correct labeling in Study 1 by condition

Figure 3.
Proportion of correct facts in Study 2 by age, task, and condition