Lift-the-Flap Features in 'First Words' Picture Books Impede Word Learning in 2-Year-Olds

Jeanne L. Shinskey

Royal Holloway, University of London

Author Note

This research was supported by a Royal Holloway, University of London Research Strategy Fund awarded to the author.

Thank you to all the children and parents who volunteered to participate in the research, and to Emily Crosby, Ketevan Alania, Michaela Rea, Hannah Mason, Jessica March, Olivia Schaaf, and Amber Milton for research assistance.

Correspondence concerning this article should be addressed to Jeanne L. Shinskey, Department of Psychology, Royal Holloway, University of London, Egham, Surrey TW20 0EX, United Kingdom. E-mail: jeanne.shinskey@ rhul.ac.uk

Abstract

Toddlers learn more about the world from picture books with photographs instead of drawings, but commercial books often have tactile features such as flaps that may counterintuitively hinder learning. This study tested how lift-the-flap features in a commercial picture book of first words affected 2-year-olds' (*N* = 32) learning of a new word for an unfamiliar food. Sixteen children saw the original lift-the-flap book, which depicted photos, and 16 saw the same book except that it was modified to have no flaps. The researcher went through the book with the child, labelling each fruit and vegetable six times. All children were unfamiliar with starfruit and were taught that it was called "carambola". After they saw the book, children's learning was tested by asking them to choose the target (i.e., "Show me carambola.") from an array of three photos and then from an array of three fake food objects. Children who saw the lift-the-flap book chose the carambola target significantly less often than those who saw the modified no-flap book, and only those who saw the no-flap book performed above chance. However, the two groups did not differ in recognizing six higher frequency food words that were also presented in the book. Thus, 2-year-olds' word learning was hindered when taught using a book with tactile features versus one without. This finding supports dual representation accounts arguing that a symbol's concreteness interferes with representation of its abstract referent, and cognitive load accounts suggesting that tactile features distract attention from the book's content.

Educational Impact and Implications Statement

This study showed that 2-year-olds were less likely to learn a new word from a ‘first words’ picture book that had flaps to lift than from the same book when it was modified to have no flaps. These findings are important because they confirm that it is not easy for children this young to attach words to objects they have seen only in books, and that adding manipulative features to picture books makes this task harder, not easier. These findings are also important because they help clarify which picture-book features promote early learning, with implications for those who design educational picture books for very young children (e.g., publishers), and those who choose them (e.g., parents, practitioners, librarians).

Psychologists have been interested in the educational potential of picture books for infants for a century (Terman, 1918). However, most picture-book research addresses the general benefits of shared reading for language and literacy in children aged 3 and older (Flack, Field, & Horst, 2018; Fletcher & Reese, 2005; Wasik, Hindman & Snell, 2016). Even though many children in literate societies are read to regularly during the first 3 years (Rideout, 2017; Venn, 2014), little is known of what they learn about the book content that they see and hear (DeLoache, 2011). Parents believe that reading to infants and toddlers helps them attach words to objects, increases vocabulary, lays the foundations for future learning, and introduces children to concepts outside their current sphere (Venn, 2014). Correspondingly, educational picture books for children aged 0 to 3 typically focus on first words (e.g., the names of objects), early concepts that prepare them for school (e.g., letters, numbers, colors, shapes), and subjects outside their daily experience (e.g., exotic animals). Yet, rapid developments in children's understanding of the symbolic nature of pictures during the first few years of life (for reviews, see DeLoache, 2004, 2011; Jolley, 2008) suggest that parents and publishers may overestimate how easily very young children can learn from picture books.

Learning about a real object or animal from a picture book requires *dual representation* – the understanding that a symbolic object such as a picture is both a concrete thing itself and a symbol of something else in the real world (DeLoache, 1987). Two characteristics of a symbol are hypothesized to affect how easily young children appreciate its dual nature, according to DeLoache's (1995, 2011) model of the development of symbol use. One is *iconicity*. The more a symbol physically resembles its real-world referent, the easier it should be for young children to see the relation between them. For example, it should be easier for a toddler to recognize a real elephant at the zoo after having seen a color photo of an elephant versus a black-and-white line drawing of one, because a color photo is more iconic. Another characteristic is *salience*. The less interesting a symbol is as an object in its own right, the easier it should be for young children to appreciate its symbolic nature, not just its concrete one. For example, a real-world elephant can also be symbolized by a scale model object – a realistic miniature replica elephant. However, a picture is an intrinsically less interesting object to children than a tangible model object is, which helps children achieve dual representation earlier in development with pictures than with model objects (DeLoache, 1987). However, children misunderstand the dual nature of pictures until as late as age 4, such as believing that wetting a photo of an object would cause the object itself to become wet (Donnelly, Gjersoe & Hood, 2013). Such misunderstanding may hinder them from using a picture book as a source of information about the world. Picture books often vary in aspects of iconicity and salience that may make this endeavor easier or harder. This paper addresses how the salience of tactile book features affects 2-year-olds' learning of picture book content when iconicity is high, after briefly reviewing what is known about iconicity.

Iconicity of Pictures

Of the little research investigating how picture-book features affect very young children's learning, picture iconicity appears to have been researched the most (for reviews, see Ganea & Canfield, 2015; Strouse, Nyhout & Ganea, 2018). As predicted by DeLoache's (1995, 2011) model, the more realistically a picture portrays its referent, the more likely very young children are to learn and transfer information from a picture book to reality. For example, American 18-month-olds who were taught the name of a novel object from a picture book were more likely to extend this name to the real object if the book had realistic drawings rather than cartoons (Ganea, Pickard & DeLoache, 2008). Likewise, American 18-month-olds who were taught a novel action from a picture book were more likely to imitate the action with real objects if the book had photos rather than color drawings (Simcock & DeLoache, 2006). Children did not succeed with color drawings until age 24 months or black-and-white line drawings until 30 months (Simcock & DeLoache, 2006). A related pictorial feature is fantastical or anthropomorphic imagery (Ganea & Canfield, 2015; Strouse et al., 2018). For example, American 3- to 5-year-olds who were taught facts about unfamiliar animals from a picture book learned less if the drawings were anthropomorphic (e.g., animals wearing clothes and using furniture) rather than realistic (Ganea, Canfield, Simons-Ghafari, & Chou, 2014). Thus, more iconic pictures facilitate young children's transfer of information from picture books to real-world referents, evidently by making the symbol-referent relation more obvious (DeLoache, 2011).

Salience of Tactile Features

Picture books often have tactile features (e.g., pop-ups, flaps) that are designed to increase children's engagement with the book. However, such features might make the book more salient as an object in its own right rather than as a symbolic source of information about the world, according to DeLoache's (1995, 2011) model. Only two published papers appear to have investigated how tactile book features affect children's learning. The first reported two studies showing that realistic pictures aided learning but manipulative features did not (Tare, Chiong & DeLoache, 2010). Specifically, one study showed that American 18- to 22-month-olds who were taught the name of an unfamiliar bird from a commercial book of drawings with manipulatives such as flaps, pop-ups, and pull-tabs performed at chance in generalizing the name to new pictures of the bird as well as to a scale model of the bird. However, children who saw a scanned copy of the same book of drawings without manipulatives or a book of photos of the same animals performed above chance. The other study showed that 27- to 39-month-olds who were taught animal facts using the manipulative book learned fewer facts than children who saw the book of photos. In both studies, children's performance after seeing the scanned book of drawings without manipulatives fell between that of the other two groups. Children thus learned the most from a book with realistic pictures and the least from a book with manipulatives. The authors argued that manipulatives may interfere with children's dual representation by emphasizing the book's concrete nature at the expense of its symbolic one. Children's poor inhibitory control at this age may make it hard for them not to respond to the concrete properties of salient symbolic objects (DeLoache, 2011). Tare et al. also suggested that manipulatives might increase cognitive load by distracting children's attention away from the adult's description of the book's content, although children were judged to be equally attentive across book conditions.

Tactile features fail to enhance learning from picture books that teach about not only real-world referents but also early concepts that prepare them for school. The only other published paper on tactile features reported two studies showing that children learned more from plain alphabet books than tactile ones (Chiong & DeLoache, 2013). Specifically, one study showed that American 30- to 36-month-olds who were taught the names of four unfamiliar letters from a commercial book of photos with tactile features such as flaps, tabs, and shiny material performed at chance in recognizing those letters afterwards. However, children who saw either a scanned copy of the same book without its tactile features or a plain old-fashioned commercial book with no tactile features performed better than chance. The other study tested whether a tactile feature might help if it was more relevant to the information to be learned, by presenting letters made from sandpaper that were designed so their shape could be traced with a finger. It showed that 30- to 36-month-olds who were taught the names of letters while tracing them in a sandpaper alphabet book performed above chance at letter recognition, whereas those who traced them from a scanned copy of the same book without the tactile feature performed at chance. The two groups did not differ from each other, however. The authors thus concluded that there was no compelling evidence that tactile features benefit children's learning from alphabet books. They argued that the findings were consistent with the concept of dual representation, suggesting that the concrete features of manipulative books interfere with children's learning of abstract symbolic information. They also suggested that the greater complexity of the tactile books may have increased visual cognitive load and distracted children's attention from the content to be learned.

There are at least two important reasons why more research is needed on the role of tactile features in children's learning from picture books. The first is that there is simply insufficient evidence on it, despite how common these features are in picture books. Publishers may assume that any feature that attracts children's attention to a book will help them learn from it (Tare et al., 2010), and parents may assume that picture books marketed as educational have been shown to improve children's skills. Moreover, the books that are designed for the youngest children, who have the most fragile dual representation of pictures and the weakest attentional control, are the most likely to have tactile features. Yet, only two studies have investigated the effects of such tactile features, on such different topics as real-world animals and abstract alphabetic letters, and they find little to no evidence of a benefit for children in either domain (Chiong & DeLoache, 2013; Tare et al., 2010). Many contemporary first-words picture books may also increase cognitive load by presenting multiple words and tactile features on a single page (e.g., Priddy, 2013), which may differ from older or simpler books that present just one item and tactile feature per page. More evidence is needed as to how tactile features affect children's learning from commercial books, especially as children gain more experience with tactile features in other symbolic media such as touchscreens (Takacs, Swart, & Bus, 2015). Research in this domain is becoming more urgent as the features available in new forms of educational media for infants and preschoolers continue multiplying (Hirsh-Pasek, Zosh, Golinkoff, Gray, Robb, & Kaufman, 2015; Strouse et al., 2018).

The second reason to investigate tactile features further is that the previous papers leave key questions unanswered. Chiong and DeLoache (2013) tested learning about 2D letters rather than real-world referents. Tare et al. (2010) are thus the only authors to test how tactile features affect children's transfer from books to reality. Yet, although the books used by Tare et al. symbolized real birds, children's generalization of the bird's name was tested not with real birds but with scale models, which are another kind of symbol. It is clearly impractical to test learning about some categories, like animals, with real referents. However, this issue is important because dual representation is best tested with transfer from a symbol to its intended referent (DeLoache, 1987, 2011), not from one symbol to another more salient symbol. Tare et al. also combined children's generalization to pictures together with their generalization to objects. So, it is possible that children did not actually succeed in generalizing their learning from the picture in the book to the model object, but only from the picture in the book to another picture. Four-year-olds have since been shown to generalize from picture books to real animals only some of the time (Ganea, Ma, & DeLoache, 2011), but dual representation is easier at age 4 than ages 1 to 3 (i.e., Tare et al.), and the work did not address tactile features. Tare et al. also partially confounded pictorial and tactile features. Children saw drawings with manipulatives, drawings without manipulatives, or photos without manipulatives. They learned more from photos without manipulatives than from drawings with manipulatives, but it is uncertain how much of this effect was due to the presence of iconicity versus the absence of manipulatives. Perhaps manipulatives would not hinder learning as long as pictures are highly realistic. With an iconic symbol like a photo to maximize the similarity between the symbol and its referent, children may be able to attend to the page's tactile features and still represent its dual nature as symbolizing a real-world referent. Finally, the book used by Tare et al. had more than one kind of manipulative (i.e., flap, pop-up, pull-tab). It is possible that having only one kind of manipulative from page to page might be less detrimental to learning.

The Current Study

The current study was designed to both specifically address the issues above and generally provide more evidence on the role of tactile features in children's learning from picture books, using a sample of British children. It builds on previous research by focusing on real-world referents rather than alphabet letters, by using a commercial 'first words' picture book that teaches the names of things, and by manipulating whether the book has tactile features or not (Chiong & DeLoache, 2013; Tare et al., 2010). It differs from previous research by using a contemporary commercial book that depicts highly iconic images, with multiple images on a page (Priddy, 2013). It addresses a novel subject by focusing on food as the referent, specifically fruits and vegetables, rather than animals or letters. This category permits the use of more realistic referents. Fruits and vegetables (e.g., bananas, carrots) tend to vary little enough in features such as shape, size, and color that the symbol-referent similarity can be quite high, which should aid children's transfer. For health and safety reasons, children were presented with highly realistic fake food replicas rather than real food. Deceptive objects like fake food replicas are deliberately designed to trick even adults that the object is real, unlike scale models such as those used by Tare et al. (2010), which are substitutes for their larger real-world counterparts and are highly salient to children in the form of toys. Fake food replicas were considered suitable because children younger than 4 do not reliably distinguish between the appearance and reality of such deceptive objects (Flavell, Green, & Flavell, 1986), especially when they appear edible (Krause & Saarnio, 1993). In addition, the current study unconfounds tactile and pictorial features. It keeps iconicity consistently high across conditions by presenting color photographs, while manipulating the presence or absence of tactile features. Finally, the current study controls for the variability in the kinds of tactile features used by Tare et al. with a book that presents only simple flaps to lift.

The current study thus systematically tested the role of tactile features in very young children's transfer of food names from a commercial 'first words' picture book to concrete food objects. British 2-year-olds' pre-existing knowledge of the names of fruits and vegetables introduced in the book was assessed by parental report and by children's accuracy at identifying a picture of the food when asked "Show me *X*" from an array of three pictures. The researcher then engaged in a naturalistic picture-book interaction with each child, labelling all the fruits and vegetables in the book. One of these, starfruit, was unfamiliar to all children and was introduced as "carambola", whereas the others were higher frequency words that were familiar to at least some children. This study focused on the one unfamiliar target to be learned, given how slowly children's word learning progresses until at least 30 months (Bion, Borovsky, & Fernald, 2013). It also followed the examples of other word-learning studies with children in this age range by embedding one novel word among familiar words (Ganea et al., 2008, Ganea, Allen, Butler, Carey & DeLoache, 2009; Geraghty, Waxman & Gelman, 2014; Preissler & Carey, 2004; Strouse & Ganea, 2017a; Tare et al., 2010; Vandewater, Barr, Park, & Lee, 2010; Walker, Walker, & Ganea, 2013). Half the children saw the original lift-the-flap version of the book, which depicted all the referents with iconic color photos and had several flaps to lift. The other half saw the same book except that the flaps were either sealed shut or removed so that there was nothing to manipulate. Children's knowledge of the food names was then assessed with photo recognition trials (i.e., "Show me *X*") and object extension trials using fake food replicas. If manipulatives in picture books hinder learning, even when pictures are iconic, then children who saw the flap book should be less likely than those who saw the no-flap book to recognize the novel carambola picture and object. However, the two groups should not differ in their recognition of the pictures and objects for the more familiar fruits and vegetables.

Method

Participants

The final sample included 32 typically developing British 2-year-olds (*M* = 2.10 years, *SD* = .11, range = 1.93 – 2.31), with 16 girls and 16 boys. There were 16 children in the Flap book group (*M* = 2.14 years, *SD* = .11, range = 1.95 – 2.31; 8 girls and 8 boys) and 16 in the No-Flap group (*M* = 2.07 years, *SD* = .11, range = 1.93 – 2.22; 8 girls and 8 boys). This age and sample size were chosen to allow comparison with similar studies that yielded positive results on word learning from picture books in children aged 15 months to 3 years with sample sizes of 12 to 20 (e.g., Ganea et al., 2008, 2009; Geraghty et al., 2014; Strouse & Ganea, 2017a; Tare et al., 2010; Walker et al., 2013). A sample size of 32 yields 85% power to detect a small-to-medium effect size of .40 in a 2 x 2 repeated-measures design, according to G*Power (version 3.1.9.2; Faul, Erdfelder, Lang, & Buchner, 2007). Another 8 children were excluded due to unwillingness to complete the session (4 in the Flap group, 1 in the No-Flap group), experimenter error (1 in the Flap group), familiarity with the book (1 in the No-Flap group), or knowledge of all of the target words, including starfruit (1 in the Flap group). Children were recruited from a database of families in the southeastern UK who had registered their interest in research participation. Their race was 88% White, 6% Asian, and 6% more than one race. All children heard English at home at least 50% of the time. Most children came from homes with above-average education and income. Sixty-eight percent had at least one parent with a university degree and 66% of their households had an income above the median for the southeast of the UK (United Kingdom Office for National Statistics, 2016). The study received ethical approval from the Department of Psychology Ethics Committee at Royal Holloway, University of London, and conformed to the ethical standards of the Declaration of Helsinki. Data were collected from August 2014 through May 2016.

Design

A mixed design was used. Book Condition (Flap or No-flap) occurred between participants. Two Pre-tests (Parent Report and Picture Identification) assessed word knowledge within participants before children saw the book, and two Post-tests (Photo Recognition and Object Extension) assessed word knowledge within participants after children saw the book. The Picture Identification Pre-test and the Photo Recognition and Object Extension Post-tests presented children in both book conditions with the same stimuli in the same sequence. Each of these trials presented one target and two distractors. The dependent measure was whether or not the child chose the target when asked for it by name (i.e., “Show me *X*.”).

Materials and Procedure

Parent Report Pre-test. The first pre-test measure of children’s knowledge of the target words was parental report (e.g., Preissler & Carey, 2004; Robb, Richert & Wartella, 2009; Vandewater et al., 2010). All of the food and drink words that appeared in the book, including the nine fruits and vegetables, as well as words for the fruits and vegetables used as distractor stimuli (see Picture Identification Pre-test), were embedded into a list of 78 words for food and drink that 2-years-olds in the UK might be exposed to (Appendix 1). These were styled after the

MacArthur-Bates Communicative Development Inventories (CDIs; Fenson, Marchman, Thal, Dale, Reznick & Bates, 2007) and their UK adaptations (Alcock, Meints, & Rowland, 2017; Hamilton, Plunkett & Schafer, 2000). Parents were asked to indicate whether their child could say or understand each word. The nine fruits and vegetables in the book were grapes, orange, strawberry, tomato, broccoli, pear, lemon, watermelon, and starfruit. Starfruit was the only one that no children in the final sample could say or understand. Lists for three other common word categories (animals, small household items, and clothing) were added to the checklist to provide pilot data for a separate project, which also helped to discourage response bias by masking the study's focus on food. Parents completed the word checklist upon arrival in a waiting room and were blind to the study hypotheses.

Picture Identification Pre-test. The second pre-test measure of children's knowledge of the target words was their identification of a picture of the food when asked "Show me *X*" from an array of three pictures (Preissler & Carey, 2004). Picture stimuli were constructed using a color photo of each of the nine fruits and vegetables from the book (but dissimilar to the book's image) on an A4 page (21.0 x 29.7 cm) alongside photos of two distractor foods that were not in the book (Figure 1). These were roughly matched for familiarity (e.g., starfruit versus kiwi and apricot). To provide a liberal test of children's knowledge, photos were not matched for size, shape, or color, so that multiple cues differentiated them. The relative positions (left, center, right) of the target and the two distractors were counterbalanced across pages, and the nine pages appeared in an A4 binder in descending order of word acquisition, as in the word checklist, starting with grapes and ending with starfruit.

Picture Identification trials and the rest of the procedure were administered in a testing room where children sat at a table (80 x 123 cm) with their parent and the researcher. The researcher asked the parent not to interact with the child during the procedure. One videocamera on the ceiling recorded children's behavior from directly above the table and the other captured their visual attention by focusing on the face. A sound conditioning machine masked sounds from outside the room.

On each trial, the researcher held the binder out of the child's reach from the opposite side of the table, pointed to each of the three pictures in turn from left to right while saying, "See this and this and this?", and ensured that the child looked at each picture. Then she asked for the target by name ("Show me *X*."), moved the binder within the child's reach, and waited for the child to respond. To ensure that children understood they were expected to point to one picture, the researcher gave specific feedback only on the first two trials, which presented the most familiar targets of grapes and orange. If the child chose the target, the researcher clapped and cheered and confirmed that the child's choice was correct. If the child chose a distractor, the research gave contrastive feedback (e.g., "No, it's not that one. That's apple. Show me grapes.") and repeated the trial. On the remaining seven trials, the researcher gave neutral feedback (i.e., "Okay, thank you."). She repeated a trial only if the child failed to respond or the choice was unclear (e.g., pointing to two pictures), and then only once. Although parents confirmed that children did not know "starfruit", pilot testing suggested they may be more likely than expected by chance to choose the correct picture based on their knowledge of a star's shape. Thus, for the rest of the procedure after the Picture Identification phase, the researcher referred to starfruit only by its Latin name, carambola, to ensure that children's responses were based on their knowledge of the fruit's name rather than its shape.

Book Reading. No children in the final sample had seen the book, as confirmed by their parents upon arrival. The book was a commercially-available lift-the-flap board book on children's first 100 words marketed for children aged 1 year and up (Priddy, 2013). Each page presented several items organized thematically (e.g., bedtime, mealtime, colors, shapes). Each item appeared once, accompanied by its name in print. Children saw only the first two page spreads (four pages) of the book, on which foods were depicted. On both page spreads, there were flaps on the righthand page and not on the lefthand page. Children in the Flap condition received the book in its original form. Children in the No-flap condition received the same book except that it was altered so that the flaps on the righthand pages were not manipulable (Figure 2). That is, flaps were sealed by lamination if they had a target on top of them or removed if they had a target underneath.

Book Reading trials began after Picture Identification trials ended. The researcher moved her chair alongside the child's and then went through the book's first four pages (where foods were depicted) with the child in a naturalistic way, encouraging the child to hold the book, turn the pages, and lift the flaps (in the Flap condition). She followed the child's gaze and then pointed at, labelled and talked about the picture the child was looking at. When the child looked at one of the targets, the researcher labelled it three times and described it (e.g., "This is carambola. You might not have tasted carambola before. Carambola doesn't grow around here. It's yellowish green inside and very yummy and sweet."). In the case of the starfruit, the researcher never used the word "star" to describe it. If the child did not spontaneously look at a target, then the researcher drew the child's attention to it by pointing. Once all nine targets had been labelled, the researcher then read through the book a second time in the same way so that children heard each target labelled six times in total, following Tare et al. (2010) and Chiong and DeLoache (2013). The book reading lasted about 5 minutes (M = 5:04, SD = 1:09) and targets were labelled an average of 5.99 times (SD = .30).

Photo Recognition Post-test. The first post-test measure of children's understanding of the target words was their recognition of photos that were similar to the book's images (Chiong & DeLoache, 2013; Flack & Horst, 2017; Ganea, et al., 2008; Kaefer, Pinkham & Neuman, 2016; Strouse & Ganea, 2017a; Tare et al., 2010; Vandewater et al., 2010; Walker et al., 2013). Photo stimuli were constructed using a color photo of each of the nine fruits and vegetables from the book on an A4 page alongside photos of two distractor fruits or vegetables that were not in the book (Figure 3, top). To provide a conservative test of children's word-learning from the book, these were matched as closely as possible for not only familiarity but also size, color, picture angle, or shape so that fewer cues differentiated them. For example, the photo of the starfruit slice was paired with photos of a lime slice and a kiwi slice that were the same size and highly similar in color. The relative positions of the target and the distractors were counterbalanced across pages, and the nine pages appeared in randomised order in an A4 binder. Post-test trials began as soon as the book reading phase ended. The procedure was identical to that for Picture Identification trials, with two exceptions. First, the researcher gave children neutral feedback on all nine trials instead of just the last seven trials. Second, the starfruit was labelled "carambola" instead of "starfruit".

Object Extension Post-test. The second post-test measure of children's understanding of each target word's meaning was their extension of the word to its referent object (DeLoache et al., 2010; Ganea et al., 2008, 2009; Krcmar, Grela, & Lin, 2007; Preissler & Carey, 2004; Strouse & Ganea, 2017a; Tare et al., 2010; Walker et al., 2013). Objects were highly-realistic fake food replicas of each of seven target fruits and vegetables. Two fruits (grapes and orange) were not included because it was too difficult to find well-matched replicas to act as distractors for all nine fruits and vegetables and 2-years-olds were most likely to already know these two

(Alcock et al., 2017; Fenson et al., 2007). The target replica and two distractor replicas were each placed in one section of a three-section wooden tray (Figure 3, bottom). The distractors were the same foods as those presented on the preceding Photo Recognition trials. The relative positions of the target and distractor objects in the tray were counterbalanced across trials, and the seven targets appeared in randomised order across trials. Analyses focused on these seven targets that featured in all phases of the procedure. The procedure was the same as that for Photo Recognition trials, with three exceptions. First, before the researcher presented the three objects out of the child's reach from the opposite side of the table, she positioned them in in the tray while it was on her lap under the table and out of the child's sight. The objects were pre-arranged in a box with labelled slots to guide the researcher as to the order of target presentation across trials and the positions of the three objects within each trial. Second, the moment the child touched one object, the researcher removed the other two objects, to reinforce children's understanding that they were to choose only one. Finally, the child was allowed to play with the chosen object for about 20 s while the researcher prepared for the next trial.

Measures

Each word on the Parent Report pre-test was scored for whether the child was reported to understand it or not (1 or 0). This receptive vocabulary measure of words that the child understood (but could not yet say) was chosen rather than the expressive vocabulary measure of words the child could say as a more liberal benchmark of 2-year-olds' word knowledge. Each trial in the Picture Identification pre-test, Photo Recognition post-test, and Object Extension post-test was scored afterwards from video for whether the child chose the target or not (1 or 0). The child had to clearly choose *only* the target to receive a score of 1. If the child chose one of the distractors, more than one stimulus (including the target), or nothing, then the trial was scored with 0. Two observers who were blind to the study hypotheses independently coded all trials for all participants on video without audio. Inter-observer agreement was established with Cohen's kappas of .98 for Picture Identification, 1.00 for Photo Recognition, and 1.00 for Object Extension (all *p*s $< .001$).

Analyses

Analyses focused on the seven targets that featured in all pre- and post-test trials (i.e., not grapes or orange). Children's knowledge of all seven target words before they saw the book was tested with Parent Report and Picture Identification pre-test scores, each of which was the sum of the number of words understood (range 0-7). The two sums were each square-root transformed to meet assumptions of normality and homogeneity of variance. Scores were analyzed with a 2 Book (Flap or No-Flap) x 2 Pre-test (Parent Report and Picture Identification) ANOVA. Children's knowledge of the seven target words after they saw the book was tested with Photo Recognition and Object Extension post-test scores. Knowledge of the six familiar words was analyzed separately from that of the one unfamiliar word, carambola (e.g., Vandewater et al., 2010). Scores for the six familiar words (square-root transformed) were analyzed with a 2 Book (Flap or No-Flap) x 2 Post-test (Photo Recognition and Object Extension) ANOVA, and two – tailed *t* tests for difference from chance (1/3 of six words = two). Finally, children's knowledge of the one unfamiliar target word (carambola) after they saw the book was tested with a 2 Book x 2 Post-test logistic regression for repeated binary measures (Generalized Estimating Equation, or GEE) and a binomial test for difference from chance (.33).

Subsequent analyses also explored the effects of three covariates. Children's pre-test knowledge might predict their responses on the post-test trials. Thus, children's knowledge of the six familiar words from the Parent Report as well as from their own Picture Identification were included as covariates in both the 2 Book x 2 Post-test ANCOVA and the 2 Book x 2 Post-test GEE. In addition, preliminary analyses showed that the Book Reading phase lasted about 1 minute longer for the Flap book group (*M* = 5:37, *SD* = 1:13) than the No-flap book group (*M* = 4:31, *SD* = 0:46), $t(30) = 3.04$, $p = .005$, $d = 1.08$. More time with the Flap book might either help children's learning by allowing more encoding of new information, or hinder it by increasing boredom or distractibility. Thus, book reading time was included as a covariate in both the 2 Book x 2 Post-test ANCOVA and the 2 Book x 2 Post-test GEE. These three covariates (Parent Report, Picture Identification, Book Reading duration) were tested one at a time rather than all together because of the small sample size and the correlation between the pre-test measures of Parent Report and Picture Identification, $r\ (32) = .60$, one-tailed $p < .01$.

Results

Before they saw the book, children in the Flap and No-flap groups had equivalent knowledge of the seven target words, as measured by Parent Report and Picture Identification pre-test scores (Figure 4). There was no main effect of Book condition, $F(1, 30) = .11$, $p = .738$, $\eta_p^2 < .01$, no main effect of Pre-test type, $F(1, 30) = .82$, $p = .372$, $\eta_p^2 = .03$, and no Book x Pre-test interaction, $F(1, 30) = 1.58$, $p = .219$, $\eta_p^2 = .05$. Above-chance performance on the Picture Identification trial with the starfruit in both the Flap group (11 of 16 children), $p = .004$, and No-flap group (13 of 16), $p < .0001$, supported the conjecture that children who chose correctly did so using their knowledge of a star's shape, given that none were reported to understand "starfruit" in the Parent Report. Thus, children in the two groups did not differ in their target word knowledge before they saw the book.

After they saw the book, children in the Flap and No-flap groups showed equivalent knowledge of the six familiar target words, as measured by Photo Recognition and Object

Extension post-test scores (Figure 5). There was no main effect of Book condition, $F(1, 30) = 1.96$, $p = .172$, $\eta_p^2 = .06$. There was a main effect of Post-test type, $F(1, 30) = 9.85$, $p = .004$, $\eta_p^2 = .012$, showing that children identified fewer targets on the six Photo Recognition trials ($M = 3.50$ trials, $SD = 1.33$) than the six Object Extension trials ($M = 4.26$, $SD = 1.33$). There was no Book x Post-test interaction, $F(1, 30) = .61$, $p = .441$, $\eta_p^2 = .\ 02$. Subsequent analyses showed that two of the three covariates had an effect (Table 1). Post-test scores were affected by children's pre-existing knowledge of the six familiar words as measured by both the Parent Report, $F(1, 29) = 6.86$, $p = .014$, $\eta_p^2 = .19$, and Picture Identification, $F(1, 29) = 13.42$, $p = .001$, $\eta_p^2 = .32$. However, the covariate effect of book reading duration was not significant, $F(1, 29) = .01$, $p = .934$, $\eta_p^2 = .000$. Finally, both the Flap group and No-flap group scored above chance at Photo Recognition, $t(15) = 2.20$, $p = .044$, and $t(15) = 5.14$, $p < .0001$, respectively, and Object Extension, $t(15) = 6.03$, $p < .0001$, and $t(15) = 8.16$, $p < .0001$, respectively. Thus, children in the two groups did not differ in their knowledge of the familiar words after they saw the book, and their pre-test knowledge of these words predicted their post-test knowledge of the same words.

However, after they saw the book, children in the No-Flap group outperformed those in the Flap group at identifying the one unfamiliar target word, carambola, as measured by Photo Recognition and Object Extension (Figure 6). Children in the No-flap group were more than twice as likely to choose the target as those in the Flap group, as revealed by a significant main effect of Book condition, $\chi^2 = 4.44$, $p = .035$. There was no main effect of Post-test type, $\chi^2 = .00$, $p = 1.000$, and no interaction effect of Book x Post-test, $\chi^2 = .59$, $p =.443$. Subsequent analyses showed that scores were not affected by children's pre-existing knowledge of the six familiar words as measured by the covariates of Parent Report, $\chi^2 = 1.60$, *p* =.207, and Picture Identification, $\chi^2 = .30$, *p* =.584 (Table 2). Nor were they affected by Book Reading duration, $\chi^2 = .58$, *p* =.441. The No-flap group also exceeded chance performance on post-tests for Photo Recognition, binomial *p* = .001, and Object Extension, *p* = .047. By contrast, the Flap group performed at chance for Photo Recognition, *p* = .173, and Object Extension, *p* = .173. Thus, children who saw the No-Flap book were more likely than those who saw the Flap book to recognize both the target picture and the target object.

Although no children knew the name of the carambola target before they saw the book, some children also did not know the names of some of the other six targets beforehand (e.g., 19 of 32 children did not know “watermelon”). Children’s learning of these other six words from pre-test to post-test was thus compared for differences between book conditions. For each of these six targets, children were considered not to know the word beforehand if either the Parent Report pre-test score was 0 or the child’s Picture Identification pre-test score was 0. These children’s scores on the post-test trials for Photo Recognition and Object Extension were then compared between book conditions, using non-parametric tests because of the smaller sample sizes. The effect of Book condition was not significant for any of these, Mann Whitney *U*s = 5.0-39.0, *p*s = .150-1.000 (Table 3). Thus, children in the Flap and No-flap groups showed equivalent knowledge of each of these six familiar words at post-test, even though they differed in their learning of the one novel word. This non-significant effect could be attributed to lack of power, given the smaller sample sizes. It could also be attributed to confounds that exist between words and flaps in commercial books. For example, tomato is a higher frequency word that appeared on a Control page that had no flaps in either condition, whereas watermelon is a lower frequency word that appeared on an Experimental page on which flaps were manipulated between conditions.

Finally, to address the possibility that children's attention during the book reading may have differed depending on book condition (e.g., Tare et al., 2010), videos were later re-coded for visual attention to each page. In the interim, videos were unfortunately lost from five participants in the final sample (four from the Flap condition and one from the No-Flap condition). Two new observers who were blind to the study hypotheses independently coded all trials for all 27 remaining participants. They scored the cumulative number of seconds that the child looked at the page that the researcher was talking about for each of the four pages presented in each of the two book reading episodes. Inter-observer agreement was established with Pearson $r = .974$, $p < .001$. Looking times were collapsed across the two book reading episodes and across the two pages within each page type to yield two scores, one for the right-hand side of each page spread where flaps were manipulated between conditions (Experimental Pages) and one for the lefthand side of each page spread which had no flaps in either condition (Control Pages).

Looking time was analyzed with a 2 Book (Flap or No-Flap) x 2 Page Type (Experimental or Control) ANCOVA. After controlling for the significant covariate of book reading duration, $F(1, 24) = 5.55$, $p = .027$, $\eta_p^2 = .188$, a significant main effect of Book condition showed that children in the Flap group looked longer at the pages overall than children in the No-Flap group, $F(1, 24) = 7.76$, $p = .010$, $\eta_p^2 = .244$ (Figure 7). There was no main effect of Page Type, $F(1, 24) = .14$, $p = .713$, $\eta_p^2 = .006$. However, there was an interaction of Book condition and Page Type, $F(1, 24) = 8.22$, $p = .008$, $\eta_p^2 = .255$. Post-hoc pairwise comparisons showed that children in the Flap group looked longer at the Experimental than Control pages,

$F(1, 24) = 28.33$, $p < .001$, $\eta_p^2 = .541$. However, children in the No-Flap group did not differ in their looking at the Experimental and Control pages, $F(1, 24) = 1.99$, $p = .171$, $\eta_p^2 = .077$. Post-hoc comparisons also showed that children in the Flap group looked longer at the Experimental pages than children in the No-flap condition did, $F(1, 24) = 13.59$, $p = .001$, $\eta_p^2 = .362$, but there was no difference between the two conditions in looking at the Control pages , $F(1, 24) = .62$, $p = .440$, $\eta_p^2 = .025$. Moreover, non-parametric analysis of individual children's behavior showed that 11 children in the Flap group looked longer at the Experimental than Control pages whereas only 1 child did the reverse, Wilcoxon $Z = -2.90$, $p = .004$. By contrast, 9 children in the No-Flap group looked longer at the Experimental than Control pages and 6 children did the reverse, Wilcoxon $Z = -1.36$, $p = .173$. Children thus spent more time visually attending to pages with manipulable flaps than those without them.

Discussion

In sum, this study addressed how tactile features in picture books affect very young children's learning of the book's content when pictorial features are optimal. It asked whether flaps in a commercial 'first words' picture book affected British 2-year-olds' learning of a novel word for an unfamiliar fruit introduced during shared reading of a book with highly realistic color photos. The results showed that children who saw the original lift-the-flap version of the book were less likely than those who saw the modified no-flap version to recognize a picture of the fruit and extend its name to a highly realistic fake piece of the fruit. Children who saw the no-flap book scored above chance on these two trials, whereas those who saw the lift-the-flap book did not. The two groups did not differ, however, at recognizing target pictures or target objects for more familiar fruits and vegetables that were presented in the book. Finally, children who saw the lift-the-flap book spent more time looking at the pages that had flaps on them than pages that did not. Thus, manipulative flaps in a commercial picture book designed to teach new words to infants disrupted 2-year-olds' word learning.

These findings extend what little was known about the effect of tactile features on very young children's learning about the world from picture books. They corroborate findings from the sole study showing that American toddlers who were taught the name of an unfamiliar animal from a commercial picture book of drawings with manipulatives failed to transfer the name to new pictures of the animal and a scale model of it, whereas those who saw a lab-made book of photos without manipulatives succeeded (Tare et al., 2010). The current study correspondingly showed that British 2-year-olds who were taught the name of an unfamiliar fruit from a commercial book of photos with manipulative flaps failed to transfer the name to either another picture of the fruit or a highly realistic piece of fake fruit, whereas those who saw the same book without flaps succeeded in both cases. The current study improves upon the previous one in several ways. First, it unconfounded pictorial and tactile features to show that even when book publishers maximize the similarity between a picture and its referent by using color photos instead of drawings, manipulatives still disrupt children's recognition of the symbol-referent relation. Second, the current study used realistic life-size replica objects as referents rather than miniature replica objects to show that children's transfer to the book's intended real-world referents is affected, not merely their matching of the picture to another symbolic object. Third, it analyzed picture recognition separately from object extension to show that children's transfer from the picture book to the referent object was affected, not merely their transfer from the picture book to another picture. Fourth, it had blind coders measure how long children spent looking at each page during the reading rather than having the experimenter subjectively evaluate their attentiveness. Finally, the current findings generalize what is known by testing a different word category (food) than that tested before in a different sample of participants (British) than that tested before.

Theoretical and Practical Implications

These findings have important theoretical implications for understanding children's symbolic thinking. The findings from the no-flap condition corroborate claims that very young children can transfer information from a picture to its referent when the picture has high iconicity (Ganea et al., 2008). The findings from the flap condition support arguments that children this age struggle to represent the dual nature of a picture as being both a concrete thing itself and a symbol of something else, and that the salience of the symbol's concrete features makes it even harder for them to represent its abstract relation to its referent (DeLoache, 1995, 2011). Compared to other kinds of symbolic artifacts such as scale models, dual representation should be easier with pictures because they are less salient (DeLoache, 1987). Two-dimensional symbols such as pictures and video are less tangible than three-dimensional (3D) ones. They can be looked at and talked about, but apart from the action of pointing, they invite little manual exploration. Evidence that children begin to understand the referential function of iconic pictures as early as 15 to 18 months supports the interpretation that dual representation is easier with pictures (Ganea et al., 2009; Geraghty et al., 2014; Preissler & Carey, 2004). Nonetheless, children continue to expect that pictures share tangible features of their referents as late as age 4 (e.g., that a picture of ice cream would feel cold; Beilin & Pearlman, 1991). Endowing pictures with salient tactile features such as flaps may make it harder for children to represent the picture's symbolic relation to its referent rather than its concrete nature, even when the picture's iconicity makes this symbolic relation more transparent.

Tactile features may hinder young children's learning from picture books by more than one route. Representing a symbolic artifact's dual nature requires inhibiting the tendency to respond to it as a concrete object rather than a symbol (DeLoache, 2011). Children's inhibitory control improves significantly across the first years of life, as does their cognitive flexibility at switching between different mental representations of the same thing (e.g., Blakey, Visser, & Carroll, 2016). Developmental improvements in these aspects of cognitive control may thus underlie developmental improvements in achieving dual representation. Tactile features might also increase cognitive load during shared reading by dividing children's attention among looking, touching, and listening, perhaps distracting them from what the reader is saying about the pictures' referents (Tare et al., 2010). Children's attentional control is poorer earlier in development (e.g., Isbell, Calkins, Swingler, & Leerkes, 2018), which may limit how many sources of input they can process at once. In the current study, children who saw the flap book looked significantly longer at the page when it had flaps on it. The target to be learned was on a flap. However, they were significantly less likely than children who saw the no-flap book to learn the target's name. That is, they learned less despite looking more. This finding suggests that their processing of the relevant information was less efficient, perhaps because the tactile features diverted their attention from the verbal input. Recent findings with touchscreen books support this interpretation. Children up to age 5 learn less from touchscreen books than print books even when the touchscreen book's only interactive feature is its page turn, suggesting that the addition of one simple tactile feature distracts children (Krcmar & Cingel, 2014; Strouse & Ganea, 2017a). Even without tactile features, merely having more pictures on a page spread hinders 3-year-olds from learning the intended information (Flack & Horst, 2017). Pages that present too much information may thus simply distract children from learning.

The current study has important practical implications for designing and choosing educational picture books for very young children. Tactile features are extremely commonplace in picture books for infants and preschoolers, but there is scant research on them. Parents and book publishers may assume that the symbol-referent relation is as transparent to young children as it is to adults (DeLoache, 1995), and that tactile features will promote children's attention to book content rather than detract from it (Tare et al., 2010). However, if children struggle to represent the abstract relation between a symbol and its real-world referent, then they will struggle to use a picture book as a symbolic source of information about the world, which makes the book's educational value questionable. Some features of picture books, such as iconic pictures, can facilitate this dual representation, whereas others, such as tactile features, appear to hinder it (Tare et al., 2010). One implication is that tactile features might be more suitable for narrative storybooks that are designed to entertain children than for educational books that are designed to teach them new information. Another is that tactile features in an educational book might be more effective if they are conceptually related to the real-world referent, such as a flap that reveals a duckling inside of an egg or an engine inside of a car. Now more than ever, as very young children are exposed to an increasing variety of symbolic media that engage multiple sensory systems (e.g., touchscreens), it is important to understand how each symbolic medium's features affect how children learn from it, especially when the content is marketed as educational (Hirsh-Pasek et al., 2015; Robb et al., 2009). One potential benefit of early exposure to different kinds of symbolic media is that it may enhance children's general symbolic sensitivity. The more experience children have with symbolic artifacts, the more primed they are to expect artifacts to have symbolic importance (DeLoache, 1995). Perhaps early touchscreen experience would counterintuitively help very young children to regard picture books more symbolically.

Future Directions and Conclusions

Future studies can expand upon the current one by using true referents and other word categories. Although the fake food objects in the current study are more similar to true referents than scale models are, it is even better to test children's understanding of the symbol-referent relation with true referents. This is not always practical to do in the lab, given the nature of the content to be learned. For example, animal names are one of the first word categories that infants learn and the most common subject in 'first words' picture books, but testing children with real animals is impractical. Anecdotally, the fake food objects in the current study were realistic enough to fool some adults as well as some 2-year-olds, who tried to eat them. Empirically, even 3-year-olds fail to distinguish appearance versus reality with such deceptive objects (Flavell et al., 1986) and most 4-year-olds believe that fake food is appropriate to eat (Krause & Saarnio, 1993). It is expected that children who saw the no-flap book would transfer food names to real food, because recent work shows that repeatedly exposing toddlers to a picture book of photos (without manipulatives) about unfamiliar fruit increases their willingness to taste the real fruit (Houston-Price, Butler, & Shiba, 2009). However, it is possible that tactile feedback with the fake food objects on earlier trials affected children's perception of how real the objects on later trials were (Krause, 2009). Future studies could address this issue by testing some of the first word categories that infants learn with referents that are more practical to use in the lab, such as small household items or clothing.

Future studies could also address questions unanswered by the current one. First, would texture (i.e., touch-and-feel books) hinder learning less? Texture is less 3D than flaps and pop-ups. Perhaps the less 3D a feature is, the less it hinders dual representation (DeLoache, 1987). Texture in picture books also appears more often conceptually related to the referent (e.g., furry kitten, leathery shoes) than 3D features. Texture might help children learn about the real referent's texture, if not other properties of the referent, such as its name. Second, when one picture has a tactile feature, does it affect learning about other things on the same page? The current study and that by Tare et al. (2010) show that having a manipulative feature on a specific picture affects learning that word. However, neither study can account for whether that manipulative feature hinders learning the names of other things in the book, even if those other things do not have their own manipulative feature. In the current study, the absence of a difference between the two conditions in learning any of the familiar words that they did not already know suggests that the flap on the starfruit affected learning about the starfruit only. However, this null effect was based on small subsets of participants. More data is needed to support such a conclusion. Third, would tactile features become less distracting with more repetitions of the book reading? The current study employed naturalistic shared reading, but children had only two repetitions of the book with an unfamiliar researcher. Repetition can improve children's learning from picture books (Horst, Parsons, & Bryan, 2011; Simcock & DeLoache, 2008). Tactile features might therefore become less distracting after repeatedly sharing the book at home with a parent. Fourth, do tactile features affect parents' interaction style? E-book studies yield mixed evidence as to whether tactile features such as hotspots decrease parent-child interaction quality by distracting parents from focusing on relevant content (Krcmar & Cingel, 2014; Strouse & Ganea, 2017b). There appears to be no published work on how picture book features affect parent-child interactions with traditional print books, although recent work suggests that parents' education level is negatively correlated with their preference for choosing tactile rather than non-tactile books for their preschool child (Gaylord, O'Rear, Hornburg, & McNeil, 2018). Finally, which book formats do children prefer? Non-tactile books may be better for learning, but if children find them less interesting than tactile books, it may make little practical difference to the adults who choose their books. Anecdotally, parents report that they find educational first-words books more boring than narrative storybooks. Thus, book formats that interest not only children but also the adults who read to them could be examined empirically in future studies.

In conclusion, despite a century of interest in the educational potential of picture books (Terman, 1918) that has demonstrated the general benefits of shared reading for preschoolers' vocabulary and later literacy (e.g., Fletcher & Reese, 2005) and generated an increasing variety of symbolic media marketed for infants (Rideout, 2017), we still know very little about what children younger than 3 learn from picture books that are designed to teach them about the world (DeLoache, 2011). The current study showed that even when a commercial 'first words' book portrays iconic pictures of real-world referents that maximize the similarity between symbol and referent, tactile features such as flaps disrupted 2-year-olds from learning a new word and transferring it to the referent. This finding contributes theoretical insight by supporting the argument that emphasizing a symbol's concrete features makes it harder for very young children to represent the duality of a symbol as having not only a concrete nature but also an abstract relation to its referent (DeLoache, 1987). It is also consistent with claims that tactile features add cognitive load to picture book reading by distracting children from listening to book content (Tare et al., 2010). The current study also yields practical implications for parents and publishers who may overestimate how easily very young children can learn about the world from picture books (DeLoache, 2011). Designing and choosing picture books with features that make it easier for children to represent a picture's dual nature and that do not distract them from the book's educational content will help them effectively use picture books as sources of information about the world. As a result, publishers can fulfill parents' expectations that sharing picture books with infants and toddlers helps them learn new words, introduces them to concepts outside their realm of knowledge, and constructs the building blocks for future learning (Venn, 2014).

References

Alcock, K. J., Meints, K., & Rowland, C. F. (2017). UK-CDI Words and Gestures - Preliminary norms and manual. Retrieved from http://lucid.ac.uk/ukcdi

Beilin, H., & Pearlman, E. G. (1991). Children's iconic realism: Object versus property realism. In H. W. Reese (Ed.), *Advances in child development and behavior, Vol. 23* (pp. 73-111). San Diego, CA: Academic Press. doi:10.1016/S0065-2407(08)60023-3

Bion, R.A.H., Borovsky, A., & Fernald, A. (2013). Fast mapping, slow learning: Disambiguation of novel word-object mappings in relation to vocabulary learning at 18, 24, and 30 months. *Cognition, 126*, 39-53. doi:10.1016/j.cognition.2012.08.008

Blakey, E., Visser, I., & Carroll, D. J. (2016). Different executive functions support different kinds of cognitive flexibility: Evidence from 2-, 3-, and 4-year-olds. *Child Development, 87*(2), 513–526. doi:10.1111/cdev.12468

Chiong, C., & DeLoache, J. S. (2013). Learning the ABCs: What kinds of picture books facilitate young children's learning? *Journal of Early Childhood Literacy, 13*(2), 225-241. doi:10.1177/1468798411430091

DeLoache, J. S. (1987). Rapid change in the symbolic functioning of very young children. *Science*, *238*(4833), 1556-1557. doi:10.1126/science.2446392

DeLoache, J. S. (1995). Early understanding and use of symbols: The model model. *Current Directions in Psychological Science, 4*(4), 109-113. doi:10.1111/1467-8721.ep10772408

DeLoache, J. S. (2004). Becoming symbol-minded. *Trends in Cognitive Sciences, 8*(2), 66-70. doi:10.1016/j.tics.2003.12.004

DeLoache, J. S. (2011). Early development of the understanding and use of symbolic artifacts. In U. Goswami (Ed.), *The Wiley-Blackwell handbook of childhood cognitive development* (pp. 312-336). Wiley-Blackwell.

DeLoache, J. S., Chiong, C., Sherman, K., Islam, N., Vanderborght, M., Troseth, G. L., Strouse, G. A. & O'Doherty, K. (2010). Do babies learn from baby media? *Psychological Science*, *21*(11), 1570-1574. doi:10.1177/0956797610384145

Donnelly, K. E., Gjersoe, N. L., & Hood, B. (2013). When pictures lie: Children's misunderstanding of photographs. *Cognition*, *129*(1), 51-62. doi:10.1016/j.cognition.2013.06.002

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*(2), 175–191. doi:10.3758/BF03193146

Fenson, L., Marchman, V.A., Thal, D., Dale, P., Reznick, S., & Bates, E. (2007). *MacArthur-Bates Communicative Development Inventories: User's guide and technical manual*. Baltimore: Paul Brookes.

Flack, Z. M., Field, A. P., & Horst, J. S. (2018). The effects of shared storybook reading on word learning: A meta-analysis. *Developmental Psychology*, *54*(7), 1334-1346. doi:10.1037/dev0000512

Flack, Z. M. & Horst, J. S. (2017). Two side to every story: Children learn words better from one storybook page at a time. *Infant and Child Development, 27:*e2047. doi:10.1002/icd.2047

Flavell, J. H., Green, F. L., & Flavell, E. R. (1986). Development of knowledge about the appearance–reality distinction. *Monographs of the Society for Research in Child Development*, *51*(1), 1-68. doi:10.2307/1165866

Fletcher, K. L., & Reese, E. (2005). Picture book reading with young children: A conceptual framework. *Developmental Review*, *25*(1), 64-103. doi:10.1016/j.dr.2004.08.009

Ganea, P. A., Allen, M. L., Butler, L., Carey, S., & DeLoache, J. S. (2009). Toddlers' referential understanding of pictures. *Journal of Experimental Child Psychology*, *104*(3), 283-295. doi:10.1016/j.jecp.2009.05.008

Ganea, P. A., & Canfield, C. F. (2015). An examination of factors that affect young children's learning and transfer from picturebooks. In B. Kümmerling-Meibauer, J. Meibauer, K. Nachtigäller, & K. J. Rohlfing (Eds.), *Learning from picturebooks: Perspectives from child development and literacy studies* (pp. 33-50). New York, NY, US: Routledge/Taylor & Francis Group.

Ganea, P. A., Canfield, C. F., Simons-Ghafari, K., & Chou, T. (2014). Do cavies talk? The effect of anthropomorphic picture books on children's knowledge about animals. *Frontiers in Psychology*, *5*

Ganea, P. A., Ma, L., & DeLoache, J. S. (2011). Young children's learning and transfer of biological information from picture books to real animals. *Child Development*, *82*(5), 1421-1433. doi:10.1111/j.1467-8624.2011.01612.x

Ganea, P. A., Pickard, M. B., & DeLoache, J. S. (2008). Transfer between picture books and the real world by very young children. *Journal of Cognition and Development*, *9*(1), 46-66. doi:10.1080/15248370701836592

Gaylord, S. M., O'Rear, C. D., Hornburg, C. B., & McNeil, N. M. (2018). Preferences for tactile and narrative counting books across parents with different education levels. *Early Childhood Research Quarterly*. doi:10.1016/j.ecresq.2018.07.010

Geraghty, K., Waxman, S. R., & Gelman, S. A. (2014). Learning words from pictures: 15- and 17-month-old infants appreciate the referential and symbolic links among words, pictures, and objects. *Cognitive Development*, *32*1-11. doi:10.1016/j.cogdev.2014.04.003

Hamilton, A., Plunkett, K., & Schafer, G. (2000). Infant vocabulary development assessed with a British communicative development inventory. *Journal of Child Language*, *27*(3), 689-705. doi:10.1017/S0305000900004414

Hirsh-Pasek, K., Zosh, J. M., Golinkoff, R. M., Gray, J. H., Robb, M. B., & Kaufman, J. (2015). Putting education in 'educational' apps: Lessons from the science of learning. *Psychological Science in the Public Interest, 16*(1), 3-34. doi:10.1177/1529100615569721

Horst, J. S., Parsons, K. L., & Bryan, N. M. (2011). Get the story straight: Contextual repetition promotes word learning from storybooks. *Frontiers in Psychology*, 2doi:10.3389/fpsyg.2011.00017

Houston-Price, C., Butler, L., & Shiba, P. (2009). Visual exposure impacts on toddlers' willingness to taste fruits and vegetables. *Appetite, 53,* 450-453. doi:10.1016/j.appet.2009.08.012

Isbell, E., Calkins, S. D., Swingler, M. M., & Leerkes, E. M. (2018). Attentional fluctuations in preschoolers: Direct and indirect relations with task accuracy, academic readiness, and school performance. *Journal of Experimental Child Psychology*, *167*, 388–403. doi:10.1016/j.jecp.2017.11.013

Jolley, R. (2008). Children's understanding of the dual nature of pictures. In C. Lange-Küttner, & A. Vintner, (Eds.), *Drawing and the non-verbal mind: A life-span perspective* (pp. 86-103). New York, NY, US: Cambridge University Press. doi:10.1017/CBO9780511489730.005

Kaefer, T., Pinkham, A.M., Neuman, S.B. (2016). Seeing and knowing: Attention to illustrations during storybook reading and narrative comprehension in 2-year-olds. *Infant and Child Development, 26*:e2018. doi:10.1002/icd.2018

Krause, C. M. (2009). How tactile and function information affect young children's ability to understand the nature of food-appearing, deceptive objects. *Journal of Applied Developmental Psychology, 30*(4), 486-493. doi:10.1016/j.appdev.2008.12.028

Krause, C. M., & Saarnio, D. A. (1993). Deciding what is safe to eat: Young children's understanding of appearance, reality, and edibleness. *Journal of Applied Developmental Psychology*, *14*(2), 231-244. doi:10.1016/0193-3973(93)90034-S

Krcmar, M., & Cingel, D. P. (2014). Parent–child joint reading in traditional and electronic formats. *Media Psychology*, *17*(3), 262-281. doi:10.1080/15213269.2013.840243

Krcmar, M., Grela, B., & Lin, K. (2007). Can toddlers learn vocabulary from television? An experimental approach. *Media Psychology*, *10*(1), 41-63.

Preissler, M. A., & Carey, S. (2004). Do both pictures and words function as symbols for 18- and 24-month-old children? *Journal of Cognition and Development*, *5*(2), 185-212. doi:10.1207/s15327647jcd0502_2

Priddy, R. (2013). *Lift-the-Flap First 100 Words.* Priddy Books: London.

Robb, M. B., Richert, R. A., & Wartella, E. A. (2009). Just a talking book? Word learning from watching baby videos. *British Journal of Developmental Psychology*, *27*(1), 27-45. doi:10.1348/026151008X320156

Rideout, V. (2017). The Common Sense census: Media use by kids age zero to eight. *Common Sense Media Inc.* San Francisco, CA, USA.

Simcock, G., & DeLoache, J. (2006). Get the picture? The effects of iconicity on toddlers' reenactment from picture books. *Developmental Psychology*, *42*(6), 1352-1357. doi:10.1037/0012-1649.42.6.1352

Simcock, G., & DeLoache, J. S. (2008). The effect of repetition on infants' imitation from picture books varying in iconicity. *Infancy*, *13*(6), 687-697. doi:10.1080/15250000802459102

Strouse, G. A., & Ganea, P. A. (2017a). Toddlers' word learning and transfer from electronic and print books. *Journal of Experimental Child Psychology*, *156*129-142. doi:10.1016/j.jecp.2016.12.001

Strouse, G. A., & Ganea, P. A. (2017b). Parent–toddler behavior and language differ when reading electronic and print picture books. *Frontiers in Psychology*, *8.*

Strouse, G. A., Nyhout, A., & Ganea, P. A. (2018). The role of book features in young children's transfer of information from picture books to real-world contexts. *Frontiers in Psychology, 9:50. doi: 10.3389/fpsyg.2018.00050*

Takacs, Z. K., Swart, E. K., & Bus, A. G. (2015). Benefits and pitfalls of multimedia and interactive features in technology-enhanced storybooks: A meta-analysis. *Review of Educational Research*, *85*(4), 698-739. doi:10.3102/0034654314566989

Tare, M., Chiong, C., Ganea, P., & DeLoache, J. (2010). Less is more: How manipulative features affect children's learning from picture books. *Journal of Applied Developmental Psychology*, *31*(5), 395-400. doi:10.1016/j.appdev.2010.06.005

Terman, L. M. (1918). An experiment in infant education. *Journal of Applied Psychology*, *2*(3), 219-228. doi:10.1037/h0071908

United Kingdom Office for National Statistics (2016). *Annual Survey of Hours and Earnings (ASHE) - Gross Annual Earnings for the 90 to 99 percentiles of employee jobs by sector in the UK and Regions, 2015 to 2016 provisional.* Retrieved from https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkingh ours/adhocs/005278annualsurveyofhoursandearningsashe2015grossannualearningsforthe90to99percentilesofemployeejobsbysectorintheukandregions2015

Vandewater, E. A., Barr, R. F., Park, S. E. & Lee, S-J. (2010). A US study of transfer of learning from video to books in toddlers. *Journal of Children and Media, 4(*4), 451-467. doi:10.1080/17482798.2010.510013

Venn, L. (2014). Family reading habits and the impact of Bookstart: Executive summary of findings. *Free Thought Research.* Retrieved from http://www.booktrust.org.uk/about-us/how-booktrust-makes-a-difference/research-reports/early-years/bookstart/

Walker, C. M., Walker, L. B., & Ganea, P. A. (2013). The role of symbol-based experience in early learning and transfer from pictures: Evidence from Tanzania. *Developmental Psychology, 49*(7), 1315-1324. doi:10.1037/a0029483

Wasik, B. A., Hindman, A. H., & Snell, E. K. (2016). Book reading and vocabulary development: A systematic review. *Early Childhood Research Quarterly*, *37*39-57. doi:10.1016/j.ecresq.2016.04.003

Tables

Table 1. Analyses of variance for children's post-test knowledge of the six familiar words between the two book conditions, conducted without covariates in the first model and with each of the three covariates (Parent Report pre-test, Picture Identification pre-test, Book Reading duration) in subsequent models. (Italics denote significant *p* values.)

Model	**Source**	**df**	**MS**	***F***	***p***	η_p^2
1	Book condition	1,30	.52	1.96	.172	.06
	Post-test type	1,30	.79	9.85	*.004*	.25
	Book x Post-test	1,30	.05	.61	.441	.02
2	Parent Report	1,29	1.50	6.86	*.014*	.19
	Book condition	1,29	.65	2.98	.095	.09
	Post-test type	1,29	.01	.11	.743	.00
	Book x Post-test	1,29	.04	.48	.493	.02
3	Picture Identification	1,29	2.49	13.42	*.001*	.32
	Book condition	1,29	.17	.90	.350	.32
	Post-test type	1,29	.30	3.78	.062	.12
	Book x Post-test	1,29	.03	.31	.582	.01
4	Book reading duration	1,29	.00	.01	.934	.00
	Book condition	1,29	.42	1.55	.224	.05
	Post-test type	1,29	.03	.36	.555	.12
	Book x Post-test	1,29	.04	.45	.506	.02

Table 2. Logistic regressions for children's post-test knowledge of the one novel word between the two book conditions, conducted without covariates in the first model and with each of the three covariates (Parent Report pre-test, Picture Identification pre-test, Book Reading duration) in subsequent models. (Italics denote significant *p* values.)

Model	**Source**	β	SE β	Wald χ^2	**Df**	***p***
1	Book condition	1.72	.82	4.44	1	*.035*
	Post-test type	.00	.82	.00	1	1.000
	Book x Post-test	.85	1.10	.59	1	.443
2	Parent Report	.51	.40	1.60	1	.207
	Book condition	1.78	.82	4.79	1	*.029*
	Post-test type	.00	.82	.00	1	1.000
	Book x Post-test	.87	1.12	.59	1	.441
3	Picture Identification	.40	.73	.30	1	.584
	Book condition	1.66	.82	4.18	1	*.041*
	Post-test type	.00	.83	.00	1	1.000
	Book x Post-test	.85	1.11	.60	1	.440
4	Book reading duration	.00	.01	.58		.441
	Book condition	2.04	.81	6.48	1	*.011*
	Post-test type	.00	.84	.00	1	1.000
	Book x Post-test	.85	1.12	.58	1	.446

Table 3. The number of children out of 16 in each book condition who did not know the more familiar target words before they saw the book (defined as a score of 0 on either the Parent Report or the Photo Identification pre-test measures) but then correctly identified the target on either the Photo Recognition post-test trial or the Object Extension post-test trial. Four of the familiar target words were on Experimental Pages in which flaps were manipulated between the Flap and No-flap book conditions, and two were on Control Pages that had no flaps in either book condition. There were no significant differences between the Flap and No-flap book conditions, as shown by Mann-Whitney *U* tests.

Experimental Pages (flaps manipulated between book conditions)										
Target	**Pre-test N Unknown**		**Photo Recognition Post-test Trial N Correct**				**Object Extension Post-test Trial N Correct**			
	Flap	No-flap	Flap	No-flap	*U*	*p*	Flap	No-flap	*U*	*p*
Watermelon	10	9	4	6	33.0	.258	5	6	39.0	.661
Lemon	10	6	3	0	21.0	.150	7	6	21.0	.150
Pear	9	6	4	5	16.5	.224	6	2	18.0	.328
Strawberry	4	3	1	1	5.5	.823	2	2	5.0	.683
Control Pages (no flaps in either book condition)										
Target	**Pre-test N Unknown**		**Photo Recognition Post-test Trial N Correct**				**Object Extension Post-test Trial N Correct**			
	Flap	No-flap	Flap	No-flap	*U*	*p*	Flap	No-flap	*U*	*p*
Tomato	8	8	2	1	28.0	.535	3	3	32.0	1.000
Broccoli	8	6	5	5	19.0	.573	6	4	22.0	.852

Figures

	Tomato Trial	Starfruit Trial
Picture Identification Pre-test		

Figure 1. Children's understanding of each target's name was measured before they saw the book by asking them to "Show me *X*" (e.g., tomato, starfruit) from an array of three pictures.

Figure 2. The Flap book (left) and No-flap book (right), which was identical except that no flaps were manipulable (i.e., they were laminated shut on this page).

	Tomato Trial	Carambola Trial
Photo Recognition Post-test		
Object Extension Post-test		

Figure 3. Children's understanding of each target's name was measured after they saw the book by asking them to "Show me *X*" (e.g., tomato, carambola) from an array of three photos (top) and an array of three fake food replicas (bottom).

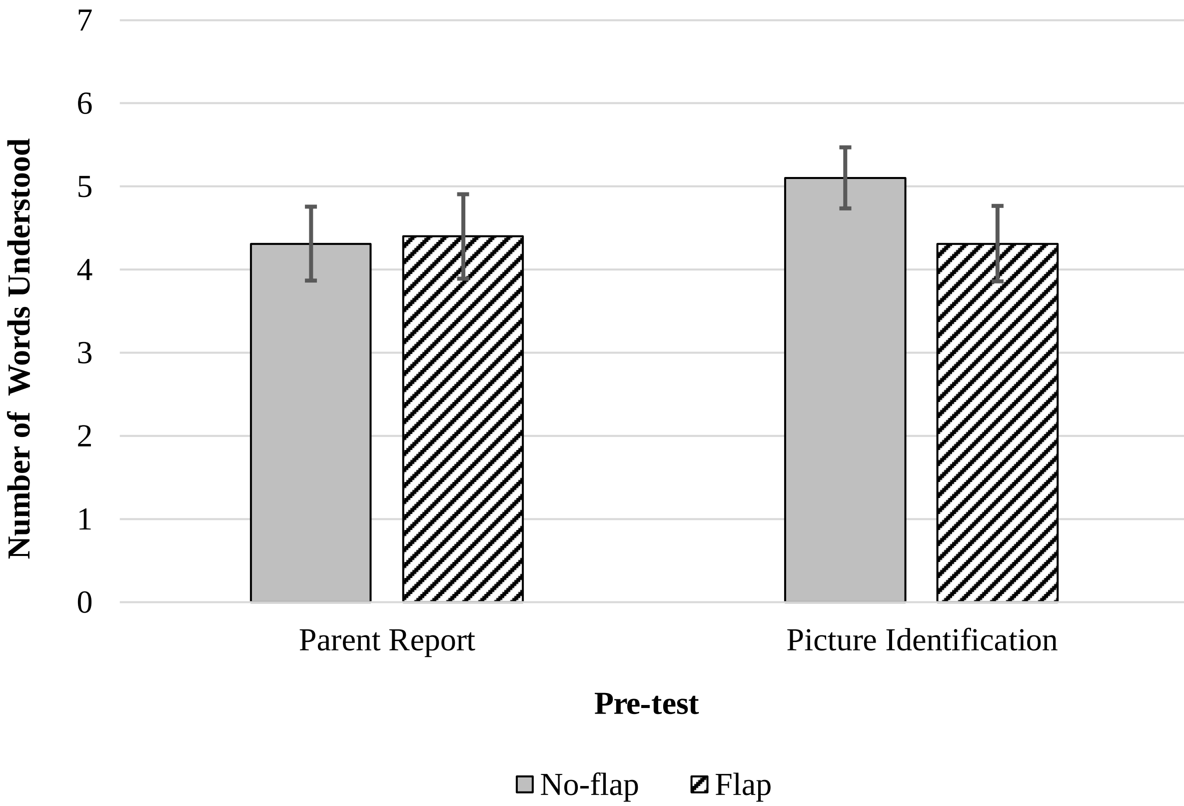

Figure 4. Children assigned to the Flap and No-flap book conditions did not differ in their knowledge of the seven target words before they saw the book, as reported by parents (left) and identified by children when asked to "Show me *X*" from an array of three pictures (right). Error bars in all figures reflect the standard error of the mean.

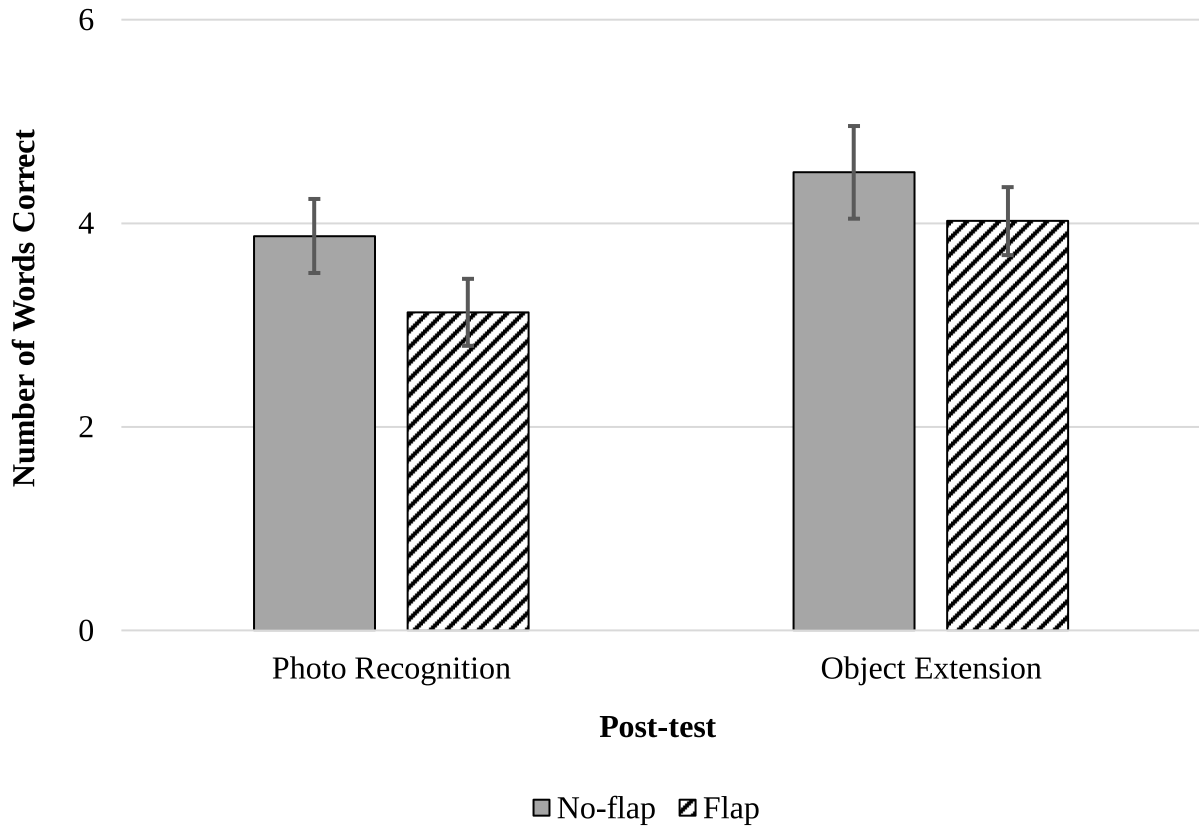

Figure 5. Children in the Flap and No-flap book conditions did not differ in their identification of the six familiar target words after they saw the book, when asked to “Show me *X*” from arrays of three photos (left) and arrays of three objects (right). Both groups exceeded the chance value of two.

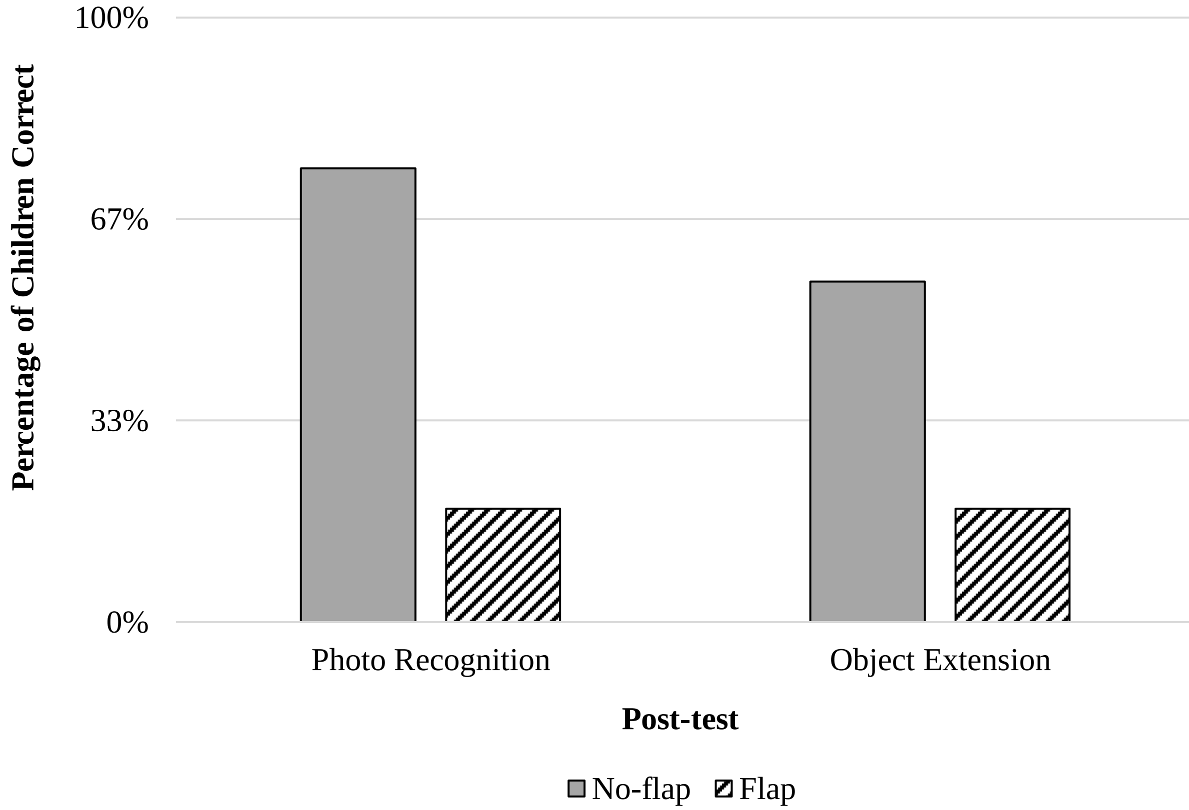

Figure 6. Children in the No-flap condition exceeded the chance value of 33% and also outperformed children in the Flap condition, whose performance did not differ from chance, when asked to identify the one unfamiliar target after they saw the book ("Show me carambola") from an array of three photos (left) and an array of three objects (right).

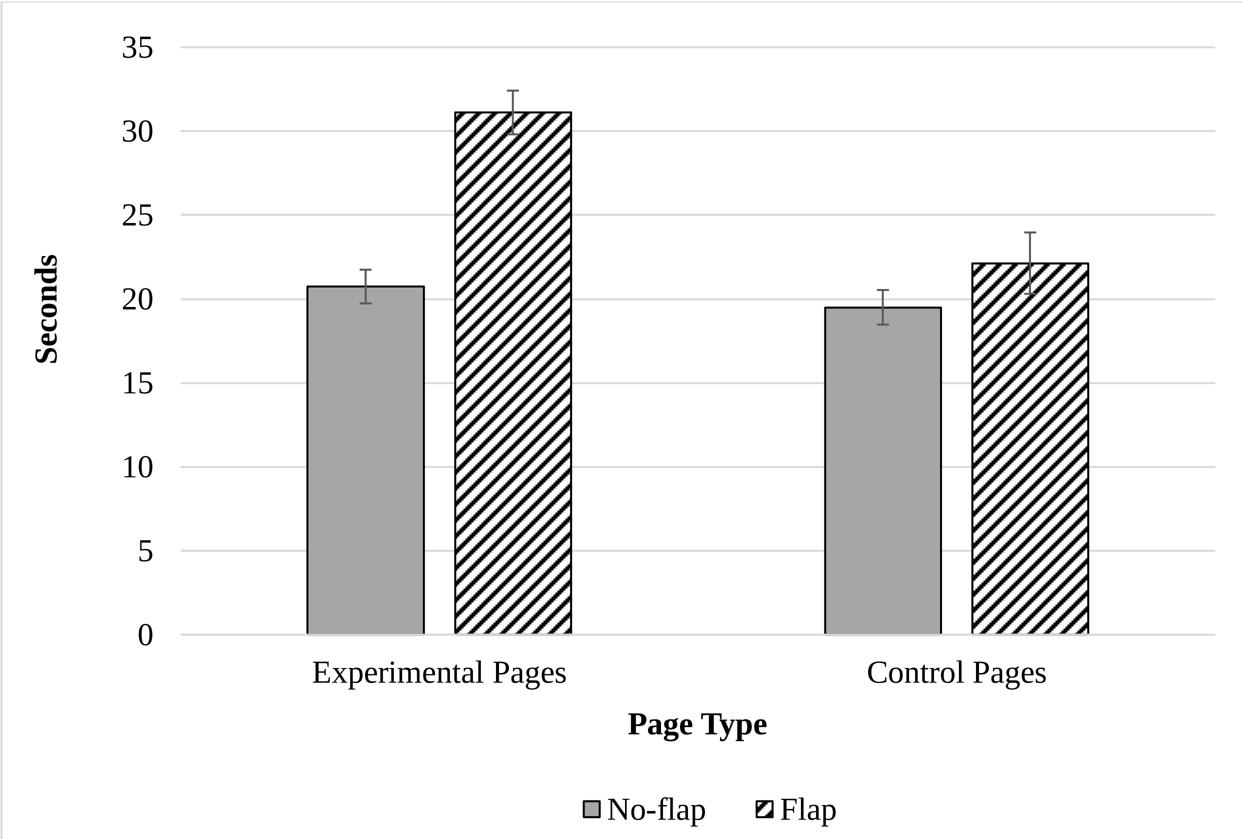

Figure 7. Children who saw the Flap book looked longer at the Experimental pages with flaps on them than at Control pages with no flaps, whereas those who saw the No-Flap book did not differ in their looking at the Experimental and Control pages, neither of which had operable flaps on them.

Appendix 1

Word List

Child's Birthdate: ____________ Sex: Girl / Boy Today's date: ____________

For each of the following words, please indicate just **ONE** of the following.

- Tick **U** if your child cannot say the word but **UNDERSTANDS** what it means.
- Tick **S** if your child **SAYS** the word on his or her own (not just when you ask, "say shoe"). Give your child credit for saying a different word or partial word with the same meaning, such as "raffe" for "giraffe".
- Leave blank if your child neither says nor understands the word yet.

Food and Drink (78)

U	S		U	S		U	S	
☐	☐	banana	☐	☐	corn	☐	☐	nut
☐	☐	apple	☐	☐	bean	☐	☐	drink
☐	☐	orange	☐	☐	green bean	☐	☐	juice
☐	☐	grape	☐	☐	pickle	☐	☐	water
☐	☐	raisin	☐	☐	tomato	☐	☐	tea
☐	☐	pear	☐	☐	broccoli	☐	☐	coffee
☐	☐	peach	☐	☐	lettuce/salad	☐	☐	food
☐	☐	apricot	☐	☐	onion	☐	☐	soup
☐	☐	plum	☐	☐	pepper	☐	☐	sandwich
☐	☐	strawberry	☐	☐	courgette	☐	☐	pizza
☐	☐	cherry	☐	☐	avocado	☐	☐	crisp
☐	☐	raspberry	☐	☐	beet	☐	☐	biscuit
☐	☐	blackberry	☐	☐	cheese	☐	☐	sweet/treat
☐	☐	blueberry	☐	☐	milk	☐	☐	ice cream
☐	☐	melon	☐	☐	yoghurt	☐	☐	cake
☐	☐	watermelon	☐	☐	bread	☐	☐	muffin
☐	☐	lemon	☐	☐	toast	☐	☐	chocolate
☐	☐	lime	☐	☐	cereal	☐	☐	gum
☐	☐	pineapple	☐	☐	pasta	☐	☐	jelly
☐	☐	kiwi	☐	☐	egg	☐	☐	jam
☐	☐	mango	☐	☐	fish	☐	☐	pudding
☐	☐	starfruit	☐	☐	meat	☐	☐	butter
☐	☐	peas	☐	☐	chicken	☐	☐	sauce/dip
☐	☐	carrot	☐	☐	sausage	☐	☐	salt
☐	☐	chip	☐	☐	burger	☐	☐	vanilla
☐	☐	potato	☐	☐	tuna			

Animals (53)

U	S		U	S		U	S	
☐	☐	animal	☐	☐	cockerel/rooster	☐	☐	hedgehog
☐	☐	dog/doggy/puppy	☐	☐	goose	☐	☐	bear
☐	☐	cat/kitty/kitten	☐	☐	swan	☐	☐	panda
☐	☐	bird	☐	☐	horse/pony	☐	☐	koala
☐	☐	fish	☐	☐	donkey	☐	☐	monkey
☐	☐	bunny/rabbit	☐	☐	cow	☐	☐	elephant
☐	☐	guinea pig	☐	☐	pig	☐	☐	lion
☐	☐	budgie/parakeet	☐	☐	sheep/lamb	☐	☐	tiger
☐	☐	insect/bug	☐	☐	goat	☐	☐	giraffe
☐	☐	bee	☐	☐	mouse	☐	☐	zebra
☐	☐	ant	☐	☐	squirrel	☐	☐	camel
☐	☐	fly	☐	☐	owl	☐	☐	rhino
☐	☐	spider	☐	☐	turtle	☐	☐	kangaroo
☐	☐	ladybird	☐	☐	frog	☐	☐	parrot
☐	☐	butterfly	☐	☐	snake	☐	☐	penguin
☐	☐	snail	☐	☐	deer	☐	☐	whale
☐	☐	duck	☐	☐	fox	☐	☐	seal
☐	☐	chicken/hen	☐	☐	badger			

Clothing (33)

U	S		U	S		U	S	
☐	☐	shoe	☐	☐	mitten	☐	☐	vest
☐	☐	welly/boot	☐	☐	glove	☐	☐	tights
☐	☐	slipper	☐	☐	scarf	☐	☐	pyjamas
☐	☐	trainer	☐	☐	trousers	☐	☐	sleepsuit
☐	☐	sandal	☐	☐	shorts	☐	☐	button
☐	☐	sock	☐	☐	jeans	☐	☐	belt
☐	☐	nappy	☐	☐	top/shirt	☐	☐	zip
☐	☐	bib	☐	☐	jumper	☐	☐	glasses/specs
☐	☐	hat	☐	☐	cardigan	☐	☐	watch
☐	☐	coat	☐	☐	dress	☐	☐	necklace
☐	☐	jacket	☐	☐	knickers/pants	☐	☐	umbrella/brolly

Small Household Items (53)

U	**S**		**U**	**S**		**U**	**S**	
☐	☐	bottle	☐	☐	brush	☐	☐	purse
☐	☐	cup	☐	☐	comb	☐	☐	money
☐	☐	glass	☐	☐	soap	☐	☐	penny
☐	☐	mug	☐	☐	towel	☐	☐	box
☐	☐	spoon	☐	☐	sponge	☐	☐	bag
☐	☐	fork	☐	☐	flannel	☐	☐	basket
☐	☐	knife	☐	☐	tissue	☐	☐	paper
☐	☐	bowl	☐	☐	dummy/soother	☐	☐	scissors
☐	☐	plate/dish	☐	☐	medicine	☐	☐	tape
☐	☐	tin/can	☐	☐	blanket	☐	☐	camera
☐	☐	jar	☐	☐	pillow/cushion	☐	☐	radio
☐	☐	jug	☐	☐	light/lamp	☐	☐	hoover
☐	☐	napkin	☐	☐	clock	☐	☐	broom
☐	☐	tray	☐	☐	picture	☐	☐	bucket
☐	☐	bin	☐	☐	plant	☐	☐	mop
☐	☐	rubbish	☐	☐	keys	☐	☐	hammer
☐	☐	toothbrush	☐	☐	(tele)phone/mobile	☐	☐	nail
☐	☐	toothpaste	☐	☐	computer/laptop			