Beyond Concepts of Print: Development of Concepts of Graphics in Text, PreK to Grade 3

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Drawing on the literature on concepts of print and graphics in text, as well as informal observations of children, we identified eight concepts that we posit are fundamental to understanding how graphics work in text: Action (static graphics can be interpreted as representing dynamic action), Intentionality (graphics are chosen by authors to accomplish a communicative purpose within a larger text), Permanence (graphics in printed texts are permanent and do not change), Relevance (graphics and written text are related), Representation (illustrations and photographs represent objects, but do not share the same physical properties as those objects), Partiality (not everything in the written text must be represented in the graphics), Extension (some graphics provide additional information that is not present in the written text), and Importance (some information in a graphic may be more important than other information). We administered a series of tasks to tap understanding of these concepts among 60 children in grades preK to 3. Results revealed considerable variation within any given grade level in children’s acquisition of concepts of graphics; some children have acquired concepts of graphics that their peers have not. In general, more children demonstrated acquisition of a given concept at higher grade levels. All or nearly all children displayed full acquisition as follows: Action—by the end of preK; Intentionality, Permanence, and Relevance—by the end of grade 2; Representation and Partiality—by the end of grade 3. Less than half demonstrated full acquisition of the concepts of Extension and Importance even at the end of grade 3.

We live in an increasingly visually complex world; the ability to read graphics—defined as any illustration or photograph—is becoming as important as...
the ability to read written text (Boulter, 1999; Hibbing & Rankin-Erickson, 2003; Lancaster & Rowe, 2009; Oblinger & Oblinger, 2005). Graphics have been present in children's texts since at least 1461 (Muir, 1971); however, researchers have noted that, beginning in the 1970s, the presence of graphics has increased each decade (e.g., Carney & Levin, 2002; Concannon, 1975; Simons & Elster, 1990). Researchers have also established that these graphics play many roles, some vital, in written text—from decorating the page, to representing events described in the written text, to organizing information, to helping readers interpret or remember information (Carney & Levin, 2002; Levin, 1981; Levin, Anglin, & Carney, 1987), to providing information beyond what is included in the written text (Bishop & Hickman, 1992; Fang, 1996).

Indeed, there is considerable research indicating that graphics can improve comprehension and memory of ideas presented in written text, though much of the research currently available comes from studies utilizing narrative text. For example, Bromley (2001) found that 6- to 11-year-old children were more reliant on pictures than written text when making connections to a story and making inferences, a pattern that held across the age span and reading levels. From this, Bromley concluded that the graphical elements of the text provided children with more equitable access to the story's content than did alphabetic text alone. In their work with fourth-grade children, Gambrell and Jawitz (1993) found that reading an illustrated version of a story resulted in better recall of the plot than did reading an unillustrated version. Similarly, Peeck (1974) found that children who read an illustrated version of a storybook outperformed children who read an unillustrated version, not just on questions about the story's illustrated events, but also on questions about unillustrated story elements.

Given the ubiquity and importance of graphics in text, it is important to investigate children's understanding of them. In the following section, we discuss what little is currently known about the role graphics play in young children's early interactions with, and comprehension of, text. We then present a theoretical framework that illuminates the need to expand research on concepts of print—those initial understandings about texts and how they work—to include concepts of graphics.

The Centrality of Graphics to Children's Comprehension of Text

It is clear that young children attend closely to graphics in text. Using eye-tracking equipment, Evans, Williamson, and Pursoo (2008) found that children aged 3 to 5 years spent, on average, less than 6% of one-on-one shared reading time looking at the written text in illustrated books when the adult reader did not point to the words, and less than 25% even when the reader did point to the words. Even when preschoolers were read storybooks in which written text was manipulated to be particularly salient, only 7.1% of fixations focused on written text and less than 6% of the remaining time was spent looking at “regions of print” (Justice, Skibbe, Canning, & Lankford, 2005). As children grow older, they do pay more attention to the words on the page, both on their own and when books are read to them,
eventually attending more to print than graphics, at least with some types of text (Guttmann, Levin, & Pressley, 1977; Roy-Charland, Saint-Aubin, & Evans, 2007).

Even as they decrease in relative influence, graphics clearly continue to play an important role in shaping children’s thoughts about, and comprehension of, illustrated storybooks and information books through the early elementary-school years (e.g., Martinez, Roser, & Dooley, 2003; Norman, 2010, 2012; Sipe, 1998; Sipe & Brightman, 2005). For example, studying first and second graders, Sipe (1998) noted that 23% of the students’ comments about read-alouds revolved around the graphics or an integration of the graphics and the written text.

Notably, most of the research that has examined the role of graphics in young children’s comprehension has involved narrative texts (see Norman, 2010 and 2012, for exceptions). Yet there are reasons to suspect that graphics in informative/explanatory texts may play an even more important role. Informative/explanatory texts are intended to “communicate information about the natural or social world” (Duke, 2000, p. 205) and contain a wide range of graphics, such as diagrams, maps, and tables (Moss, 2008; Pappas, 2006; Purcell-Gates, Duke, & Martineau, 2007; Roth, Pozzer-Ardenghi, & Han, 2005). Moreover, whereas narrative texts are relatively unlikely to include many graphics after the early childhood years, photographs, diagrams, charts, and other graphics remain common in informative/explanatory texts for older readers. This makes graphical comprehension an important component of reading comprehension not only when children are young, but throughout the lifespan. Research on the early development of graphical comprehension may thus help us better understand short- and long-term comprehension development. Finally, it is important to note that beyond supporting ideas already represented in written text, graphics in informative/explanatory texts for young children often convey important information that is not available through the written text alone. Indeed, an analysis of informative/explanatory texts written for second and third graders revealed that 60% of graphics (including those that were captioned) contained information not represented in the running text (Fingeret, 2012). Interestingly, research also indicates that young children tend to focus much more on the parts of graphics that are explicitly referenced in the running text, gazing both less frequently and for shorter durations at other parts of the graphic (Verhallen & Bus, 2011). The reverse is also true, at least for older readers. In their study of college-aged students, Rittschof and Kulhavy (1998) found that readers were more likely to remember details from written text that corresponded to information they had seen on an accompanying map. These findings speak directly to the importance of the current study. As explained earlier, comprehension of graphics contributes to overall comprehension of the texts that contain them—though how exactly and to what extent are empirical questions beyond the scope of this study. That said, the fact that texts—particularly informative/explanatory texts written for young children—are very likely to contain some pieces of information accessible only through graphics points to the importance of examining the early underpinnings of graphical comprehension, a topic on which research is conspicuously lacking.
Theoretical Framework

Long before young children receive any formal, direct instruction, they develop and use concepts and categories to make sense of their environment (e.g., Carey, 1985; Piaget & Inhelder, 1972). In most knowledge domains, these initial concepts and categories are—as one might expect—incomplete, inaccurate, or naïve in some way (e.g., Caravita & Hallden, 1994; Vosniadou, 2003). Over time, such naïve understandings are revised and come to resemble more complete, accurate, adult-like understandings (e.g., Hatano & Inagaki, 1994; Venville, 2004). Nonetheless, these naïve and emergent understandings serve a vital function: they provide the cognitive tools children need to explore their environment, process experiences and acquire new knowledge, and gradually expand—and refine—their repertoire of concepts and categories for making sense of the world around them.

This developmental perspective is congruent with what we know about the early stages of children’s acquisition of written text literacy. Well before they learn to read, children form initial understandings about books, words, and letters and how they work. Collectively, these early understandings of print concepts have been referred to as “print awareness,” “concepts of print,” or “concepts about print” (Clay, 2000; Justice, Bowles, & Skibbe, 2006; Purcell-Gates, 1996). They are acknowledged as foundational to literacy development and, indeed, they are predictive of various later literacy outcomes (National Early Literacy Panel, 2008; Teale & Sulzby, 1986).

In theorizing and researching concepts of print, however, literacy scholars have largely neglected the role of graphics. In the concepts-of-print assessments developed by Clay (2005) and Justice et al. (2006), for example, the only items that mention graphics assess (1) children’s understanding that a text’s written words, not its graphics, are the elements needing to be “read”; and (2) children’s ability to orient a picture by correctly identifying its top and bottom. However, given what we know (see earlier discussion) about (1) the prominent role graphics play in young children’s sense-making activities with texts; (2) the important role graphics play in communicating essential information in many texts, especially informative/explanatory texts in the content areas; and (3) the contribution graphics can make to readers’ comprehension of written text, this inattention to graphics in the concepts-of-print literature seems potentially problematic.

Much like constructing meaning from written text, constructing meaning from a graphic—be it a black-and-white photograph, a timeline, or a cross-sectional diagram—requires knowledge of concepts, codes, and conventions (Barthes, 1977; Eco, 1976; Jewitt & Oyama, 2001; Kress & van Leeuwen, 1996). Some of these rules and concepts are isomorphic with those which readers use to construct meaning from written text. In a cartoon strip with multiple panels, for example, an experienced reader knows to start in the top-left corner and then read the page from left to right and from top to bottom. Other concepts and conventions are unique to texts with graphics. For example, when graphics are combined with text, the experienced reader understands that there may be information a reader can gain from a graphic that is not available in the written text.

While many of these concepts and conventions may seem obvious to literate
adults, children take years to develop this knowledge and the basic interpretive facility that goes with it (DeLoache, 1991; DeLoache & Burns, 1994; DeLoache & Marzolf, 1992). To date, however, no one has done for graphics what Clay (1966, 1972) and others did for written text when they developed a list of “concepts of print.” No one has proposed a list of “concepts of graphics.”

**Concepts of Graphics**

In response to this theoretical and practical need, we turned our attention to the challenge of identifying a set of concepts of graphics required for comprehending graphics in written text. These would be concepts that young children eventually need to acquire in order to extract and construct meaning, in adult-like ways, from the graphics found in written texts. In so doing, we drew ideas from the available literature on concepts of print, graphics in text (e.g., Carney & Levin, 2002), and visual literacy development in younger children (e.g., DeLoache, 1991), as well as our own observations of young children interacting with graphics in text. We also examined a multitude of graphically rich informative/explanatory texts written for children, asking ourselves: What concepts or understandings must a child have acquired in order to successfully extract and construct meaning from these graphics?

As a result, we identified a preliminary list of eight concepts of graphics that we hypothesized to be foundational to comprehension of graphics and likely to develop in early childhood (birth to 8 years). Please see Table 1 for explanations of each, bearing in mind that, as with concepts of print, there is overlap among some of these concepts. For each concept considered as a possible candidate for inclusion in our list, we asked: Could failure to grasp this concept prevent a child from extracting and constructing meaning from a text’s graphical elements in an adult-like manner? If the answer was affirmative, we included the concept in our list of concepts to be tested. Our decision to stop at eight concepts was dictated by logistical concerns and by a consensus in our research group that we could not think of any concepts more salient than these eight—not by any determination that our list is exhaustive.

To investigate children’s actual knowledge (if any) of the eight concepts of graphics we identified, we designed a study to systematically ascertain the age at which young children first demonstrate acquisition of each. Additionally, we sought to ascertain the depth of children’s grasp of each concept (based on the assumption that concepts are at first only partially and imperfectly grasped). Specifically, our research question was: What degree of acquisition of eight key concepts of graphics do children demonstrate in grades preK through 3?

**Method**

Following a long tradition of studies of young children’s literacy development (e.g., Clay, 1966; Ferreiro & Teberosky, 1982; Harste, Woodward, & Burke, 1984), this study engaged children in a series of carefully designed and validated tasks as a means of understanding their development of particular knowledge and skills.
<table>
<thead>
<tr>
<th>Concept*</th>
<th>Definition</th>
<th>Importance to Comprehension and Writing</th>
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<tbody>
<tr>
<td><strong>ACTION</strong></td>
<td>Static graphics can be interpreted as dynamic action.</td>
<td>Central to constructing the author’s intended meaning when that meaning involves dynamic action; can prompt readers to create an animated mental image related to the text</td>
</tr>
<tr>
<td><strong>EXTENSION</strong></td>
<td>Some graphics provide additional information that is not present in the written text.</td>
<td>Fundamental to recognizing the importance of “reading” the graphics in addition to the written text to construct meaning; encourages conveying information through one’s own graphics</td>
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<td><strong>IMPORTANCE</strong></td>
<td>Some information in a graphic may be more important than other information.</td>
<td>Fundamental to ascertaining the author’s intended meaning or conveying meaning as an author; helps avoid undue focus on minor or irrelevant graphical details</td>
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<td><strong>INTENTIONALITY</strong></td>
<td>Illustrators (who are sometimes also the author) choose or create graphics to accomplish a communicative purpose within a larger text.</td>
<td>Encourages careful examination of the graphics and consideration of the meaning the author is trying to convey with them</td>
</tr>
<tr>
<td><strong>PARTIALITY</strong></td>
<td>Not everything in written text must be represented in the graphics.</td>
<td>Central to understanding that graphics and written text are not always isomorphic or equivalent and that authors make decisions regarding what exactly to include in each</td>
</tr>
<tr>
<td><strong>PERMANENCE</strong></td>
<td>Graphics in printed texts are permanent and do not change.</td>
<td>Supports retelling and summarizing, which facilitate comprehension, as well as composing, revising, and other activities that assume the stability of the text</td>
</tr>
<tr>
<td><strong>RELEVANCE</strong></td>
<td>Graphics and written text are related.</td>
<td>Fundamental to understanding that graphics may aid in readers’ comprehension of written text, and identifying which parts of the graphic (i.e., those related to the topic of the text) can do so</td>
</tr>
<tr>
<td><strong>REPRESENTATION</strong></td>
<td>Illustrations and photographs represent objects, but do not have the same physical properties as those objects.</td>
<td>Fundamental to recognizing what graphics are and thus what they can do for the reader, underlying all other concepts</td>
</tr>
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* Concepts are listed alphabetically.
related to concepts of graphics. Systematic administration of specific tasks to young children has yielded many important insights about the development of concepts of print (e.g., Clay, 1966), and we believe the same will be true for research on the development of concepts of graphics. Of course, naturalistic observation also has a critical role to play, as will be discussed later in the paper. We administered multiple tasks for each of the eight concepts. We then placed each child in one of four categories according to the child’s level of acquisition of that concept.

Participants
Participants in the study were drawn from two Midwestern school districts. The first district was urban and ethnically and socioeconomically diverse; the second district was suburban and consisted largely of White residents of middle to low-middle socioeconomic status. In the first district, we drew children from two elementary schools and one preschool; in the second district, children were drawn from two elementary schools and three preschools (“preschools” included Head Start and child care centers). Because these districts differed, and our goal was to examine development, we took care to include the same proportion of children from each district at each grade level. To ensure that preK children in the study were as demographically similar as possible to the elementary school children, we worked only with preschools that fed directly into the participating elementary schools. Also, to minimize the influence of the practices of any one teacher on study results, we did not select more than three children from any one classroom.

We randomly selected participants from the pool of children who: (a) had parental consent, (b) were age-eligible, (c) agreed to participate, and (d) were neither enrolled in special education nor identified as speaking English as a second language. The final sample included 60 children: 12 each from preK, K, grade 1, grade 2, and grade 3. To maximize age separation between groups, we included only children with birthdays in the five months prior to data collection (i.e., preK children were all between 4 years 0 months and 4 years 5 months, kindergartners between 5 years 0 months and 5 years 5 months, and so on). Participants were 46% female and 54% male.

As intended, the sample was diverse in terms of socioeconomic status, which we gauged using maternal education: 32% of mothers had completed high school but no further education, 13% held associates degrees, 28% held a bachelors or other four-year degree, 22% held masters degrees, 2% held a doctoral degree, and 1.5% reported attending some technical school; 1.5% of mothers declined to respond to this question. Reported race or ethnicity was similar to the racial and ethnic composition of the state: 70% White; 13% African American (non-Hispanic), 7% Hispanic, 3% Asian/Pacific Islander, 2% Chicano/Mexican-American, and 2% American Indian/Alaskan Native; 3% of participating parents did not report race or ethnicity. (The sum of the percentages exceeds 100% because five parents selected two categories.)
Data Collection Procedures

Task Administration
To draw conclusions about developmental and individual differences in task responses, we administered the same 26 tasks to all children. Children completed the tasks in two or three separate sessions, with each session lasting approximately 15–20 minutes per child (depending on the child’s age). For each session, two researchers who had been trained to administer the tasks met with each child in a quiet place outside of the classroom (e.g., teacher’s lounge, library). One of the researchers followed a standardized script to administer the tasks (see “Tasks” below) while the other researcher audiotaped the session and circled (for closed questions) or recorded verbatim (for open-ended questions) the child’s responses on a written record sheet. Prior to beginning the tasks, each child was assured that some tasks might be more difficult than others and that they just needed to try their best. They were also told that it was okay to say, “I don’t know,” and to ask to have the page or question re-read.

We then administered tasks to assess the children’s grasp of each concept in the following order: Permanence, Intentionality, Representation, Relevance, Partiality, Extension, Importance, and Action. This order was deliberate, beginning with concepts whose tasks (not the concepts themselves, but the tasks designed to ascertain acquisition of those concepts) we saw as more straightforward and moving to those we thought were potentially more awkward. Within each concept, we used an invariant order, administering the more open-ended tasks first so they would not be influenced by the more closed-ended tasks.

Task Design
The design of the tasks was informed by previous research on children’s understanding of graphics and related aspects of literacy development (e.g., Clay, 2005; DeLoache, 1991; DeLoache & Burns, 1994; Harste, Woodward, & Burke, 1984), as well as our own informal interactions with young children and pilot work (in which we administered all prospective tasks to preK–grade 3 children and made modifications as needed to maximize clarity and utility).

Number of Tasks. We developed multiple (two to five) tasks for each concept so that children had different kinds of opportunities to demonstrate their understandings, and to lessen the possibility that the approach, wording, or materials of any one task might misinform our conclusions. The number of tasks per concept varied somewhat because some concepts, both conceptually and in pilot work, appeared to lend themselves to more straightforward assessment than others.

Task Wording. In developing task wording, we considered children’s language development at ages 4–8 years. We included both open-ended questions and opportunities for children to respond physically (e.g., by pointing, by acting out) or with relatively little language output (e.g., “Yes.” “It’s in a book.”).

Texts Used in Tasks. Except for the few graphics we created ourselves due to the specific constraints of the task, all graphics came from books written and pub-
lished for young children. Three criteria guided our text selection: (1) the text was an informative/explanatory text; (2) it was written or deemed appropriate for audiences aged 4–8 years; and (3) the text material was (a) likely to be familiar to children this age (e.g., ice cubes, chairs) or (b) if likely to be unfamiliar (e.g., koala eating habits), was either clearly explained as part of the task or unnecessary for accomplishment of the task. We conducted hand searches of our personal and local libraries, sorted the books which met these three criteria by the proposed concepts of graphics, and selected texts which contained the highest-quality graphics that most clearly illustrated each concept and varied in subject matter. All informative/explanatory texts used in the tasks included graphics that occupied the majority of each featured page. Except where noted below, as we asked each question, we first displayed the cover of the published book, then read its title, turned to the focal section, and read one to three pages aloud.

Task Validity
We used seven mechanisms to examine and maximize the validity of the tasks. First, as described earlier, we drew on past studies and extensive pilot work to develop the tasks. Second, with few exceptions, we used actual children’s books to increase the ecological validity of the tasks. Third, we administered tasks one-on-one using a protocol carefully designed for the target age range, including prompts to assist children if/when they had difficulty articulating their thoughts. Fourth, as noted earlier, we used multiple tasks for each concept to lessen the possibility that flaws in any one task would unduly influence study results.

A fifth strategy we used to maximize task validity was to conduct exploratory factor analyses to detect structures in the relationships between tasks associated with each concept. In all but two cases, tasks loaded onto their intended concept. In one of the two nonloading cases, we removed the task from our database and analyses. In the other of the two cases, the task was highly similar to a task that did load onto the intended concept, so we elected to retain it for our analyses.

A sixth procedure related to task validity focused on the concepts of Importance and Extension, as less than half of the children demonstrated full acquisition of these concepts even at the end of third grade. To ensure that the tasks for these concepts were not too difficult for a person of any age, we administered the tasks to a set of 10 doctoral students. Nine out of ten doctoral students demonstrated full acquisition of both concepts, and one doctoral student showed partial acquisition of each concept, suggesting that the tasks were not impossibly difficult but rather that these concepts are mastered sometime between the end of third grade and adulthood.

Finally, the seventh task validity strategy was expert review. We briefly explained each of the concepts to 10 doctoral students, presented half of the tasks (selected at random and in random order) to each doctoral student, and then asked each student to identify, individually, the concept or concepts he or she believed each task assessed. Doctoral students matched the tasks to the concepts we intended them to measure in 100% of cases for the concepts of Permanence, Importance, and Action, 88% of cases for Representation and Relevance, and 87% of cases
for Extension. The rate of agreement was only 68% for Partiality, and we thus deleted two tasks from our analyses. For Intentionality, the rate of agreement was quite low (27%), but this might be expected given the foundational nature of this concept (Purcell-Gates, 1996) and the fact that it is primarily the coding, rather than the tasks themselves, that distinguishes Intentionality from Relevance. Still, the reader is cautioned to keep in mind the particularly strong overlap between the Intentionality tasks and those of other concepts.

Tasks
In the following paragraphs, we provide a summary of the 26 tasks on which results reported in this paper are based. To obtain the full 12-page administration protocol, please contact the first author.

Permanence. (1) The child is shown a book page with a photograph of ice cubes (page one of a two-page book) and told, “This is a book that I am making. This picture shows two ice cubes on a plate.” The page is turned and the child is shown the second and final book page, on which is a photograph of melted ice cubes, and told, “Then the ice melted and now it is water.” The researcher then begins to turn back to the first page (but does not actually complete the action to show the page) and asks the child, “When I turn back to the first page, what will I see?” (2) The child is shown a real stuffed-animal bunny with a ball and a single page with a photograph of that stuffed-animal bunny and ball. The page is turned over. The researcher then removes the real ball from the child’s view, leaving only the bunny. Finally, the researcher moves as if to turn the page over (but does not actually do so) and asks the child, “When I turn this picture over now, what will I see?”

Intentionality. (1) The child is shown a book with a graphic missing. Pointing to the words, the researcher tells the child, “This book is called Watching the Stars [Eckart, 2004]. On this page the person who wrote this book wrote, ‘There are many stars in the sky.’ What picture would the author want to put here?” (2) The same task is administered with a different book and missing graphic. (3) The child is told, “Someone is making this book. It’s going to be called See, Hear, Touch, Taste, Smell [Berger, 1993]. On this page the author wrote, ‘We taste with our tongues….’ Just with this black pen, can you draw a picture or pictures to go with these words? [When the child has finished drawing:] Tell me about the picture or pictures.”

Representation. In tasks 1–3, the child is first asked to identify the item in the photograph on the page. (1) The child is shown a page of a book with a photograph of a toy car (Dorling Kindersley Publishing, 2002). The child is asked, “Can you open the door of this car right now?” and, after the child responds, he/she is asked why or why not. (2) The child is shown a page of a book with photographs of two chairs (Berger & Chanko, 1999). As the researcher points to one of the chairs, the child is asked, “Can you sit in this chair right now?” and, after the child responds, he/she is asked why or why not. (3) The child is shown a page of a book with a photograph of a wrapped present (Schwager, 1992). The child is asked, “Can you tell me what is inside this present right now?” and, after the child responds, he or she is asked why or why not. (4) The researcher says, “I am going to show you two apples,” and then places a page with a photograph of an apple and a real apple on
the table in front of the child. The child is asked, “Can you eat this apple?” for each apple in counterbalanced order. If the child answers no for the real apple, the child is asked, “Why not?” and if the child answers yes for the photograph of the apple, the researcher says, “Show me how you would take a bite.”

**Relevance.** (1) The child is asked, “When someone is making a book, how do they pick which pictures should go in it?” (2) The child is shown the cover and several pages of a book, each of which contains one to four photographs, one of which is not relevant to the text (we added the irrelevant photograph and constructed the book so that the added photograph blended seamlessly with the rest of the page; see Figure 1). The child is told, “In this book, I think some of the pictures might be wrong. Let me know if you see anything wrong.” The researcher then reads the text to the child. (3) The same task is administered with a different book and a different anomalous graphic. (4) The child is shown a book with a graphic missing and told, “This book is called *I Like Cheese* [Pickering, 2000a]. These words say, ‘I like cheese. Do you like cheese? There are many different kinds of cheese.’ On

![Image of photographs](image_url)

**Figure 1.** Material used in task 2 for the concept of Relevance, from Berger (2007). (Due to difficulty contacting owners of rights to the original photographs, substitute photographs are shown here. All four substitute photographs are from Flickr.com and are used under a Creative Commons Attribution-NonCommercial-ShareAlike 2.0 Generic license which allows sharing and remixing with credit to the original author. Top-left photograph by “srett”; top-right photograph by “I am Not Unique”; bottom-left photograph by “G.R.R.”; bottom-right photograph by “lbontxo.”)
this page [the researcher points to the blank space], we need a picture or pictures to go with these words. I’m going to read the words again. These words say, ‘I like cheese. Do you like cheese? There are many different kinds of cheese.’” The child is then shown four photographs: one of cheese (Pickering, 2000a), one of foods made from peanuts (Julius, 2001), one of ice cream (Pickering, 2000c), and one of a child coloring (Snyder, 2003). The child is then asked, “Do any of these pictures go here? Which?” and, for each of the four graphics, “Why can this picture go here?” or “Why can’t this picture go here?” (5) The same task is administered with a different book and set of graphics.

Partiality. (1) The child is shown a two-page spread (text on one page, graphic on the other) from the book And So They Build (Kitchen, 1993) and told, “These are words [as the researcher points to the words] and these are pictures [as the researcher points to the graphics].” The child is then asked, “Sometimes people who make books tell more in the words than they do in the pictures. Is that okay?” Depending on his or her answer, the child is then asked, “Why?” or “Why not?” (2) The child is shown a page with only words and a space where the graphic should go and is told, “I’m writing a book. These are the words I have written: ‘Shoppers use carts or baskets. They push the carts through the store. They carry baskets.’ I need to put a picture here [the researcher points to the blank space above the words].” The child is shown, in counterbalanced order, a photograph of a shopper with just a cart and a photograph of a shopper with just a basket and asked, for each, “Is it okay if I put this picture here?” (3) The child is told, “Somebody is working on making this book. These are the words he wrote: ‘Dragonflies can be many colors. They can be red, blue, green, or yellow.’ He doesn’t know which pictures he can use. He can use more than one.” The child is then shown three illustrations of differing numbers of dragonflies taken or modified from Dragonflies (Hilden & Billman, 2008)—one of which matches the words exactly, one of which shows one dragonfly, one of which shows five dragonflies, and one of which shows dragonfly eggs—and told, “Put the pictures he could use here [the researcher points to a blank space above the words]. Put the pictures he could NOT use on the table.”

Extension. (1) The child is shown the book The Post Office Book (Gibbons, 1982) and told, “These are words [the researcher points to the words] and these are pictures [the researcher points to the pictures]. Sometimes people who make books show things in the pictures that are not in the words. Is that okay?” Depending on his or her answer, the child is then asked, “Why?” or “Why not?” (2) The child is shown an illustration in a book and told, “This book is called About Birds [Sill, 1991]. These words say, ‘Birds use their bills to pick up food.’ Is there anything new a child can learn from the picture?” If the child says yes, he or she is asked, “What could a child learn?” followed by “Anything else?” (3) The same task is administered with a different book.

Importance. (1) The child is asked, “Some people think that some parts of a picture are more important than other parts. Other people think that all parts of a picture are all the same amount important. Do you think some parts are more important or that all parts are the same amount important?” Depending upon
his or her answer, the child is then asked, “Why?” or “Why not?” (2) The child is shown a page in a book (Dorling Kindersley Publishing, 2005) that consists of a photograph and written text and told, “This book is called Encyclopedia of Places. These words say, ‘All mountains are tall.’ Let’s look at this picture. Is one part of this picture more important than other parts of the picture?” If the child says yes, he or she is asked, “What part?” (the child can point in response) and “Why is that most important?” If the child says no, he or she is asked, “What do you think this picture is about?” (3) The same task is administered with a second book (Berger, 1985) and a different illustration.

**Action.** (1) The child is told, “This time you are going to use your body instead of your words. I am going to show you some pictures. I want you to show me what the pictures show.” The child is shown a page with a photograph of a child kicking a soccer ball (Zoehfeld, 2000) and told, “Show me what this picture shows. You can stand up if you want.” (2–3) The same task is administered using two additional illustrations.

In many of the tasks, we administered follow-up prompts after the initial question for several reasons. Often the initial question was worded in such a way that the answer could be as simple as *yes* or *no*. As mentioned previously, this was intentional, in order to allow for the limited expressive language skills of some of our younger participants. However, we asked a follow-up question when a *yes* or *no* answer was given in order to help those children who were able to further explain their thinking do so. Follow-up prompts typically consisted of a simple *why?* or *why not?* question to clarify the child’s reason(s) for placing a graphic in a certain group or to help clarify any unclear or ambiguous information a child might have given in response to an open question. We also used follow-ups whenever a question might reasonably be expected to elicit more than one answer, asking “Anything else?” until children declined to give any more responses.

**Data Analysis Procedures**

Coding proceeded in two main phases. In the first phase, using recording sheets from 50% of the participants, we developed a coding scheme with a code for every response given by a child. To begin, three to six team members read all responses to all questions and collaboratively created descriptive codes to match children’s answers. The codes and examples were recorded in the coding manual. Next, we reviewed each code for accuracy and fit. For each question, children’s responses were read aloud and verbally coded by each member of the research team. Codes that seemed to contain two or more distinct ideas were divided, ill-fitting codes were modified, and new codes were added as needed. Revisions continued until we reached a consensus on the code or codes that each response would receive. When this process was complete, two team members who had not participated extensively in the initial development of the descriptive codes independently coded each recording sheet, blind to child age or grade. Their codes were compared and all coding discrepancies were discussed and resolved, with modifications and additions made to the coding manual as needed. Next, two research team members independently coded the second 50% of the recording sheets (the half that had
The next phase of coding entailed looking at the patterns of response codes within items and across items (within concepts). First, for 20% of the sample (12 children), selected at random, two research team members looked across the overall pattern of codes within each task to place each child into one of four levels of acquisition as indicated by that task (see levels below). Interrater agreement was 98.1% for placement of children into one of the four levels of acquisition for each individual task. All coding discrepancies were resolved. Next, the research team developed an approach to scoring children's level of acquisition of each concept based on the overall pattern of response codes across tasks for that concept.

Given a theoretical framework that views acquisition of concepts as a slow process wherein children may demonstrate anything from naïve to more adult-like understandings, often going through intermediate periods of time in which children vacillate between levels of conceptual understanding and/or sometimes simultaneously apply competing concepts (e.g., Schwitzgebel, 1999; Siegler, 1996), we used four categories to score children's response patterns for each individual concept: (1) demonstrates lack of acquisition of the concept (assigned when a child stated or implied a belief counter to the target concept); (2) does not demonstrate acquisition of the concept (assigned when a child presented no affirmative evidence of acquisition of the concept or beliefs contrary to the concept); (3) demonstrates partial acquisition of the concept (assigned when a child seemed to have only a tenuous grasp of the concept, demonstrating acquisition of the concept on some tasks but not others); and (4) demonstrates full acquisition of the concept (assigned when a child's responses always or nearly always gave affirmative evidence of understanding the target concept). Because there was variation in the number of tasks per concept and also in how directly and comprehensively each task addressed the concept it was intended to assess, the patterns of performance that determined these category assignments varied somewhat from concept to concept. In all cases, it was not necessary for a child to display full acquisition in all tasks in order to be placed in the demonstrates full acquisition of the concept category overall. This allowed us to account for the limitations of any individual task and for the fact that children may show their understandings in different ways. Two members of the research team independently placed 12 children (20% of the total sample), selected at random, into acquisition categories for each of the eight concepts. Their interrater agreement was 100% for placement of children into one of the four categories for each concept overall.

Once coding was completed for the remaining recording sheets, we counted the number of children in each grade level who were placed in each of the four categories for each of the eight concepts. To ascertain whether children's acquisition of each concept followed a developmental arc of increasing acquisition across the years, we ran crosstab analyses between the number of children at each grade level demonstrating full acquisition and grade level. When crosstab analysis showed a statistically significant relationship between full acquisition and age, Cramér's V was
computed to determine the strength of dependency between children’s acquisition of each concept and their age, and then tested for statistical significance \( p < .05 \).

**Results**

Table 2 reports the number of children who were placed in each of the four categories of acquisition for each of the eight concepts of graphics. As is evident from the table, some children acquired specific concepts of graphics much earlier than others. The point at which all or nearly all children demonstrated *full acquisition* of a specific concept is as follows: Action—by the end of preK; Permanence, Intentionality, and Relevance—by the end of grade 2; Representation and Partiality—by the end of grade 3. There were two concepts—Extension and Importance—for which fewer than half of children demonstrated *full acquisition*, even at the end of grade 3.

As seen in Table 2, for several concepts, more children demonstrated *full acquisition* at higher grade levels than at lower grade levels. Crosstabs of concept by grade level were statistically significant for the concepts of Permanence (Cramér’s V = .398, \( p \approx .015 \)), Intentionality (Cramér’s V = .354, \( p \approx .034 \)), Relevance (Cramér’s V = .388, \( p \approx .008 \)), and Partiality (Cramér’s V = .391, \( p = .018 \)). That is,

**Table 2. Number of Children Placed in Each Category of Acquisition for the Eight Concepts of Graphics**

<table>
<thead>
<tr>
<th>Concept</th>
<th>PreK</th>
<th>K</th>
<th>Grade 1</th>
<th>Grade 2</th>
<th>Grade 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demonstrates Lack of Acquisition</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Demonstrates Partial Acquisition</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Demonstrates Full Acquisition</strong></td>
<td>11</td>
<td>10</td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td><strong>Demonstrates Lack of Acquisition</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Demonstrates Partial Acquisition</strong></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td><strong>Demonstrates Full Acquisition</strong></td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td><strong>Demonstrates Lack of Acquisition</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Demonstrates Partial Acquisition</strong></td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Demonstrates Full Acquisition</strong></td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Demonstrates Lack of Acquisition</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Demonstrates Partial Acquisition</strong></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Demonstrates Full Acquisition</strong></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Demonstrates Lack of Acquisition</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Demonstrates Partial Acquisition</strong></td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Demonstrates Full Acquisition</strong></td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Demonstrates Lack of Acquisition</strong></td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Demonstrates Partial Acquisition</strong></td>
<td>7</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td><strong>Demonstrates Full Acquisition</strong></td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Given concerns about task validity for some children (please see body of paper), we decided that no children would be placed in the *demonstrates lack of acquisition* category for this concept.*
for these concepts there was a statistically significant relationship between grade level and acquisition of the concept. Based on the distribution for the concept of Representation, one might also expect a statistically significant relationship between grade level and acquisition of this concept, but the crosstab in this case was not statistically significant (Cramér’s V = .272, p ≈ .354), perhaps due to the fact that the majority of children had already demonstrated full acquisition by the end of preK. With the concept of Action, because nearly all children demonstrated full acquisition by the end of preK, we could not ascertain whether the likelihood of acquisition increased with age. Similarly, acquisition of the concepts of Extension and Importance may prove to be likelier at each successive age if children are tested in later elementary grades, but no such pattern of development was evident in the grade levels involved in this study.

Considerable within-grade-level variation in acquisition of concepts was evident. For most concepts at most grade levels, there were some children who demonstrated full acquisition while others did not. Within any given grade level, some children displayed full acquisition of many more concepts than did other children. Figure 2, which illustrates the substantial variation within grade levels in the number of concepts of graphics for which children demonstrated full acquisition, reveals that even those children who demonstrated full acquisition of the same total number of concepts may not have acquired the same concepts. For example, two kindergartners in our study demonstrated full acquisition of four concepts with very little overlap: one had fully acquired the concepts of Representation, Partiality, Extension, and Action, while the other child had fully acquired the concepts of Intentionality, Relevance, Importance, and Action. Though they had the same total number of fully acquired concepts, their graphical literacy profiles, and thus their instructional needs, were quite different.

Within-grade-level variation became even more evident when we considered all four categories of acquisition. For instance, our first-grade sample had two 6-year-olds who demonstrated different levels of acquisition on nearly all of the concepts (seven of eight). Specifically, one child showed full acquisition of all concepts except Importance, while the other child’s grasp was much more tenuous—he showed partial acquisition of four concepts and did not demonstrate acquisition of the remaining four (including Importance).

When children did not demonstrate full acquisition, they fell into a range of other categories (see Table 2), from repeatedly demonstrating a belief contrary to a given concept (e.g., that graphics in informational books do not need to be relevant to the written text) to demonstrating partial acquisition of the concept. Some of those who demonstrated partial acquisition seemed to have an unstable or intermittent grasp of the concept, as is typical of young children’s development in many areas (Schwitzgebel, 1999; Siegler, 1996). In the following paragraphs, for each concept (presented alphabetically) we report and discuss instances in which our participants did not demonstrate full acquisition.
Action

The case of action is unique in that we found that full acquisition was demonstrated by most children by the end of preK. For the few children who did not display full acquisition of the concept (viz., “static graphics can be interpreted as dynamic action”), it is important to note that none of these children demonstrated a lack of acquisition of the concept. Rather, they showed inconsistent, or partial, acquisition in one case, and did not demonstrate acquisition in three cases. Two of the three children who did not demonstrate acquisition responded to the prompt (“[Use your body to] Show me what this picture shows”) by performing a frozen tableau of the action, while the third named the graphic in one case (i.e., saying “soccer” for a picture of a girl kicking a ball) and simply shrugged in response to the other two prompts. In all three cases, the children gave no indication that they believed graphics could not be interpreted as showing action, but also did not demonstrate a clear understanding of the concept. We suspect that the variation we found with these few children may be due to a very literal interpretation of the task instructions.
Extension
In any given grade, no more than half of the children demonstrated full acquisition of the concept of Extension (viz., “some graphics provide additional information that is not present in the written text”). Even in third grade, only four children showed full acquisition, thus suggesting that the concept of Extension develops later and more slowly than other concepts and is not typically acquired until some time after third grade (at least given current instructional emphases in schools; greater attention to graphical comprehension in early schooling might change this). Often, children who demonstrated a lack of acquisition (1) did not believe it was okay for the author/illustrator to include information in the graphics that was not in the words (i.e., there should be a one-to-one correspondence, they thought) and (2) could not identify any new information (not presented in the accompanying written text) that a child could learn from the graphics shown.

Importance
In the case of the concept of Importance (viz., “some information in a graphic may be more important than other information”), only one quarter of the children in our study showed full acquisition of the concept. Most of those who did not demonstrate full acquisition either displayed partial acquisition or did not demonstrate acquisition of the concept, suggesting that this concept is acquired some time after third grade (at least given current instructional emphases in schools; greater attention to graphical comprehension in early schooling might change this). Often, children who did not demonstrate full acquisition believed that all parts of the graphic were equally important for many reasons, stating, for example, that “they are all special” and “they are all part of the story.” Interestingly, even children who stated that, in principle, one part of a graphic can be more important than other parts, were often unable to identify what part of a particular graphic was most important, responding “I don’t know” or indicating an unimportant part.

Intentionality
In the case of the concept of Intentionality (viz., “illustrators, who are also sometimes authors, choose or create graphics to accomplish a communicative purpose within a larger text”), children who did not demonstrate full acquisition of the concept by the end of grade 3 often displayed partial acquisition. Specifically, they had inconsistent responses to the tasks, showing full acquisition on at least one task, but not demonstrating acquisition on others. Four children, all in preK, either did not demonstrate acquisition or displayed an outright lack of acquisition. In the latter case, the child consistently gave responses that indicated he believed that an author might select any graphic to go with the words on a given page. For example, when read an excerpt from a book about koalas and what they eat and asked, “What picture or pictures would the person who made this book want to put here?” one child responded by saying, “I’m going to think about it…dinosaurs,” displaying no evidence of understanding that illustrators include specific graphics to accomplish specific purposes.
Partiality
In the case of the concept of Partiality (viz., “not everything in written text must be represented in the graphics”), most of the participants who did not demonstrate full acquisition displayed partial acquisition, demonstrating full acquisition on one or more tasks but not on others. For instance, one second grader agreed it was okay to include more in the words than in the pictures. However, when read the text, “Shoppers use carts or baskets. They push the carts through the store. They carry baskets,” he rejected a photograph of only a shopping cart as well as a photograph of only a basket because “it only has one or the other and it should have both.” At times this child believed it was okay for the words to carry more information, but at others he insisted that there be a strict one-to-one match. There was also one preschooler who demonstrated a lack of acquisition; he believed it was not okay for the words to contain more information than the graphics and rejected any graphic that only partially matched the words.

Permanence
In the case of the concept of Permanence (viz., “graphics in printed texts are permanent and do not change”), children who did not demonstrate full acquisition often asserted either that the original photograph of the ice cubes would change (after seeing the subsequent photograph of melted ice cubes) or that the original photograph of the bunny and the ball would change (after seeing the bunny without the ball). Alternatively, they responded that they did not know whether one or the other of the graphics would change. In addition, there were two children, both in preK, who responded to both tasks by saying that they did not know whether the graphic would change; they were coded as not demonstrating the concept. In the Discussion section, we suggest a possible explanation regarding the thinking of students who did not demonstrate a consistent understanding of the unchanging character of graphics in text.

Relevance
Most of the children who did not demonstrate full acquisition of the concept of Relevance (viz., “graphics and written text are related”) were not able to explain why people put graphics in books and also did not notice when an irrelevant image was inserted into a text (e.g., a close-up picture of human teeth and gums inserted into a book about ants, as shown in Figure 1). However, all but three of the children who demonstrated partial acquisition were able to identify a relevant graphic for a text when given a set of relevant and irrelevant choices. Only three children did not show at least partial acquisition of this concept. When asked directly how people making a book pick which graphics should go in it, each of these children answered by naming a specific, irrelevant graphic they thought should be on a book page (e.g., “a butterfly” and “a butterfly one . . . and a cat”). None of the three noticed when an irrelevant graphic was inserted into a text, and none was able to identify a relevant graphic for a text when given a set of relevant and irrelevant choices.
Representation

Very few children did not demonstrate full acquisition of the concept of Representation (viz., “graphics represent objects but do not have the same physical properties as those objects”). Still, in light of prior research indicating that this type of discrimination is understood to varying degrees by even infants and toddlers (e.g., DeLoache, Pierroutsakos, & Uttal, 2003), we were surprised that even this proportion of children (10%) did not provide evidence of acquisition of this concept in the tasks we used. When asked whether they could “right now” open the door of a car depicted in a two-dimensional photograph, or whether they could “right now” sit in a pictured chair, children not demonstrating acquisition answered yes. They sometimes physically touched the photograph and tried to carry out the task and attributed their inability to do so to a problem with the object, such as “because [the car door is] sticking.” In the Discussion section, we explore possible explanations for these unexpected responses.

Discussion

Results of this study suggest that the eight concepts of graphics we proposed do indeed develop in early childhood, although they appear to develop at different rates depending upon the concept and the child. Some concepts, such as Action, seem to develop quite early. Others—namely the concepts of Permanence, Intentionality, Relevance, Representation, and Partiality—are apparently acquired during the pre-primary and primary grades in a developmental progression (with increased acquisition by grade level, though in the case of Representation, not at a level of statistical significance). The concepts of Importance and Extension, by contrast, appeared to be only partially acquired or not at all acquired by a majority of children in this study by the end of third grade.

We also found considerable variability within grade levels. As with concepts of print, at any given grade level, children showed different profiles of acquisition of concepts, with some children showing much greater acquisition of concepts than their peers, as well as acquisition of different sets of concepts. These results suggest we cannot assume that all children in a particular grade will have the same understandings about graphics and how they work. Just as there is a range of reading levels, spelling-ability levels, and math-skill levels, a range of understandings of concepts of graphics is likely to be present in most classrooms.

It is interesting to consider possible explanations for the unexpected results we observed for particular concepts, specifically Permanence, Representation, Extension, and Importance. With regard to the subset of children who did not show acquisition of Permanence (2 of 60 did not demonstrate acquisition and fourteen demonstrated only partial acquisition), one possibility is that these children’s responses may have been influenced by their experiences with nonprint media, including graphics on computer screens and television screens that do change from one moment to the next. Another possibility is that these young children recognize the permanence of graphics in familiar texts, but have not yet recog-
nized that this predictability or permanence applies to all graphics in all books and other printed texts.

With regard to the concept of Representation, it is possible that the roughly one-fourth of our sample (14 children) who did not demonstrate *full acquisition* in fact understood the difference between a real car and a photograph of a car, or a real chair and a photograph of a chair, but interpreted the researcher’s questions as requests for information about their real-world abilities relating to the pictures’ referents, not recognizing the meaning of the deictic markers (“this chair,” “this car,” “right now”) in the task questions. We included these markers precisely to underscore the distinction between the photographs (physically present in the room) and the represented objects (not physically present) and to reduce the likelihood that a child would interpret the question as a probe about his/her world knowledge regarding cars or chairs. Another possible explanation is that young children’s grasp of the concept may be intermittent or unsteady. According to this explanation, children may go through a stage in which they sometimes—and with varying levels of seriousness or playfulness—view representational graphics as isomorphic with the things they represent. In support of this explanation, we noticed that a majority of the children who did not demonstrate *full acquisition* received inconsistent scores on roughly similar, consecutive tasks (with 8 of the 14 children receiving a *does not demonstrate acquisition* score on one Representation task and then receiving at least one *full acquisition* score on a different Representation task). In the end, though, both of these tentative explanations suggest possible threats to the validity of our tasks for a subset of children. In acknowledgment of these concerns, we decided that no children would be placed in the *demonstrates lack of acquisition* category for this concept.

We hypothesize that the results for Extension may be explained by the reading and writing instruction that occurs in elementary school classrooms. First, although little to no research exists on teachers’ beliefs about graphics or whether and how teachers are teaching children to glean information from graphics as they read, we have observed, anecdotally, that teachers often emphasize the written text and downplay the graphics during reading and writing instruction. Perhaps children in preK to grade 3 are not taught to look to graphics for information not found in the written text. Second, eye-gaze research indicates that young children tend to focus much more on parts of graphics explicitly referred to in the running text, gazing both less frequently and for much shorter durations at other parts of a given graphic (Verhallen & Bus, 2011). This research presents the possibility that, in the absence of instruction on the topic, children age 6 or below are unlikely to figure out the concept on their own due to a general lack of attention to parts of the graphic not mentioned explicitly in the written text. For most children, acquisition of this concept may occur long after they have learned how to read—in the intermediate elementary years or beyond. This is problematic, as many texts for children in third grade and beyond are written under the assumption that readers will glean information from graphics that is not conveyed in the written text (e.g., Fingeret, 2012; Walpole, 1998/1999).
Similarly, although standards and literacy educators have placed a premium on helping children find the main idea or determine importance in written text, children at these ages do not appear to view graphics as having a main idea, or they struggle to identify that idea. It is possible that the difficulty is specific to graphics, or it is possible that these children would also struggle to identify the main idea in written text, as many young children do (Taylor, 1986; Yussen, Rembold, & Mazor, 1989). While recognizing that there can be many different defensible “readings” of a text can be important (Fish, 1980), it does seem unlikely to aid children’s comprehension and learning when decorative or off-topic details in a graphic, entirely unrelated to the author’s likely intent, are viewed as most important, as happened in some cases in this study. As with other concepts, it is quite possible that instruction in why and how to look for main ideas in graphics would result in children acquiring this concept earlier.

Limitations and Directions for Future Research
This study has a number of limitations that should be noted. First, our conclusions are necessarily limited by the nature of our tasks. While the seven mechanisms we used to establish task validity provide some degree of reassurance, it remains possible that some of our tasks, at least for some of the participants, may not have been situated in a context meaningful enough to allow the display of children’s full cognitive understandings as Donaldson’s work (e.g., 1992) showed with constructed tasks used to assess children’s development. Similarly, children might have displayed more advanced understandings with texts more familiar to them or if we had used graphics from text types other than informative/explanatory texts. For example, while a child may not yet have confidence that the graphics in the unfamiliar texts we presented are permanent, the child may be confident that the graphics in a favorite book read to him or her dozens of times are (as evidenced by a request to turn to a favorite picture over and over again). Additionally, task completion was dependent on children’s expressive language skills. Although we created some tasks that involved nonlinguistic responses and used follow-up probes and closed questions to scaffold children’s responses, the possibility remains that some children’s level of language development may have constrained their answers for at least some of the tasks. Indeed, our approach could be complemented by research using a more naturalistic approach, in which children’s spontaneous interactions with text are observed in their day-to-day lives. It makes sense to investigate children’s visual literacy development as intensively as possible and from as many angles as possible.

A second important limitation arises from our use of a cross-sectional design to draw developmental conclusions. Although we took great care to make each grade group as comparable as possible (see “Participants”), it is possible that some of what we observed was a function of group differences rather than grade differences. Future research might employ a longitudinal, within-child design to examine the development of concepts of graphics.

Third, we did not examine characteristics of children’s present and past home and school environments, or their performance on other academic tasks (e.g.,
informational reading comprehension tasks), in relation to their acquisition of concepts of graphics, though conceptual understanding of graphics, much like conceptual understanding of written text, is likely influenced by all of these factors. Thus, for example, longitudinal research examining a child’s educational experiences related to visual literacy development over several years in different classroom settings would likely yield valuable insights. A related and obvious next step in the research would also be to examine the effects of explicit classroom instruction of these concepts on children’s general comprehension of text.

Finally, while the number and diversity of children in this study was sufficient to support our conclusions that concepts of graphics are generally acquired in a developmental fashion, with considerable variation within grade levels, future research could establish more definitive grade expectations and ranges by administering the tasks to larger numbers of children.

These limitations notwithstanding, this study makes an important contribution to future research in this area by identifying concepts worthy of investigation and a set of tools for examining the development of concepts of graphics in young children. We expect that researchers will be able to improve upon these tasks, and complement them with more naturalistic observations of children’s development of concepts of graphics, in the years to come.

**Implications**

Given the points substantiated at the outset of this paper—the prevalence of graphics in texts for children, the large amount of time children devote to viewing these graphics, and the evidence that comprehension and recall of text can be enhanced when written text is accompanied by graphics—it is important for researchers and educators to know more about what children understand about graphics and how they work. This becomes all the more relevant in a society in which the ability to read graphics is becoming as important as the ability to read written text.

Many researchers, such as those who work within a “multiliteracies” perspective (e.g., New London Group, 1996), have long espoused the importance of children and adults developing to a high level their ability to comprehend “visual images and their relationship to the written word” (p. 61). The Common Core State Standards (Common Core State Standards Initiative, 2010) include visual text both in the anchor standards and in grade-level-specific standards beginning at kindergarten. Yet in many respects, research and practice have not caught up with these expectations.

We hypothesize that greater awareness of concepts of graphics could help teachers better respond to and support young children’s visual literacy and overall literacy development. For example, a teacher aware of the concept of Relevance and when it typically develops might better understand, and take as teachable moments, situations in which children produce drawings unrelated to the words they have just written or dictated. A teacher aware of the concept of Extension and when it typically develops might not assume children have learned content from a given graphic but rather deliberately scaffold that learning, asking children to
describe what information they could glean from a graphic that was not stated in the accompanying written text.

The considerable variation within grade levels in children’s development of concepts of graphics suggests the need for differentiating instruction. In the absence of studies addressing the question of whether and to what degree children’s development of concepts of graphics can be influenced by instruction, our results imply that informally assessing children’s relative acquisition of the concepts, particularly those most salient to the texts children are regularly asked to read to gain content knowledge, and then teaching targeted lessons to children whose level of acquisition is substantially different from their peers’ may be the most efficient use of teachers’ precious instructional time. If future research finds that acquisition of concepts of graphics is important to preK-to-third-grade and/or later literacy development, and that schooling can make a difference in that development, there will be a need for research and professional development related to teaching concepts of graphics.

The concepts of Extension and Importance may merit particular attention. Texts often used to teach various reading skills in today’s early-grade classrooms exhibit close matches between written text and graphics. While strong text-to-graphic matches may aid decoding, these kinds of texts may not help children learn to glean content available only in graphics or to find the main idea of graphics. Curriculum developers and teachers might consider purposefully selecting texts for young children in which graphics provide information not contained in the running text, such as the narrative picture book Officer Buckle and Gloria (Rathman, 1995) and the informational picture book Actual Size (Jenkins, 2004). Teachers might then explicitly attend to Extension and Importance while reading such texts and during writing instruction. For more recommendations about the teaching of concepts of pictures based on currently available research, see Roberts, Norman, Duke, Morsink, Martin, and Knight (2013). Also, a number of professional books provide suggestions for developing visual literacy more broadly (e.g., Frey & Fisher, 2008; Moline, 2012).

Visual literacy for children is not—and should not be seen as—an add-on to existing curriculum. Children are already thinking and communicating visually, through graphics. Consequently, when teachers infuse a visual literacy dimension into every part of curriculum and instruction, we can expect to see growth not just in students’ visual literacy knowledge and skills, but also in the extent and depth of their learning more generally. Given a “multiliteracies” perspective and the importance of graphical literacy in particular, this study constitutes a first step toward describing the conceptual infrastructure that needs to be in place for such literacy to develop and flourish. In so doing, this study suggests that the established list of concepts of print is insufficient for understanding text that also includes graphics, and that a broader, more inclusive view of key emergent literacy knowledge and skills would greatly benefit from the addition of concepts of graphics.
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Guidelines for the NCTE Promising Researcher Award Competition in Recognition of Bernard O’Donnell

The 2014 Promising Researcher Award Competition is open to individuals who have completed dissertations, theses, or initial, independent studies after the dissertations between December 1, 2011, and January 31, 2014. Studies entered into competition should be related to the teaching of English or the language arts (e.g., language development, literature, composition, teacher education/professional development, linguistics, etc.), and should have employed a recognized research approach (e.g., historical, ethnographic, interpretive, experimental, etc.). In recognition of the fact that the field has changed in recent years, the Committee on Research invites entries from a variety of scholarly perspectives.

Candidates must submit two (2) copies of a manuscript based on their research. Manuscripts should be written in format, style, and length appropriate for submission to a research journal such as Research in the Teaching of English, College Composition and Communication, Curriculum Inquiry, Teaching and Teacher Education, or Anthropology and Education Quarterly. Manuscripts normally range between 25 and 50 double-spaced pages.

Manuscripts can be sent to NCTE, Promising Researcher Award Competition, 1111 W. Kenyon Road, Urbana, IL 61801-1010, Attention: Felisa Jones. Manuscripts can be emailed to secondary@ncte.org. Manuscripts must be received on or before March 1, 2014. For more information, please go to http://www.ncte.org/second/awards/pra.