The Effects of Graphic Organizers and Content Familiarity on Second Graders' Comprehension of Cause/Effect Text

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Submitted in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy
under the Executive Committee
of the Graduate School of Arts and Sciences

COLUMBIA UNIVERSITY

2012

ABSTRACT

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The ability to comprehend expository text is vital for academic and professional success; however, many students struggle with this genre. While it has been found that text structure-based graphic organizers (GOs) may assist older students in comprehending expository text, it is uncertain whether this type of scaffold is effective for primary-grade students. The aim of this study was to investigate the effects of graphic organizers, level of text structure complexity, and content familiarity on second grade students' comprehension, recall, and sensitivity to cause/effect text structure. A mixed-factorial posttest-only design was utilized, with two between-subjects factors (graphic organizers and level of cause/effect structure complexity) and one within-subjects factor (content familiarity). Eighty second-grade students from two elementary schools were asked to read four cause/effect passages with familiar content (i.e. concerning objects and events that students encounter in their everyday lives) and four cause/effect passages with unfamiliar science content. Students were randomly assigned to either a graphic organizer condition or a control condition. Students in the graphic organizer condition read a cause/effect graphic organizer after reading each passage, while students in the control condition re-read the passage. Half of the students read passages with a one cause-one effect text structure and half read passages with a more complex one cause-multiple effects structure.

Text structure comprehension, recall, and sensitivity were measured via student performance on three tasks. In the first task, students answered questions designed to assess structural awareness and comprehension. The proportions of structure questions answered correctly were calculated for

the set of four passages used in this task. In the second task, students answered similar questions about non-structure sentences; again, proportion scores were calculated. Finally, students were asked to provide an oral free recall of text after reading each passage and its corresponding graphic organizer (or after reading and re-reading each passage). Protocols were scored for the proportions of structure and non-structure details correctly recalled for the four additional passages utilized in this task.

A mixed factorial analysis of variance (ANOVA) was conducted to analyze the data. Results indicated that reading the graphic organizer, as opposed to re-reading the passage, lead to significant improvements in both recall and text structure sensitivity. In contrast, students in the control group demonstrated lower recall and structural sensitivity. There was a significant main effect for level of causal structure (one cause-one effect and one cause-multiple effects) on comprehension questions requiring structure sensitivity, with students demonstrating higher performance on the simpler one cause-one effect passages. A significant interaction was found between GO condition and level of structure complexity, such that students who re-read the text experienced a decline in performance on comprehension questions at the one cause-multiple effects level. No other effects emerged for structure complexity. Students demonstrated significantly greater performance on structure and non-structure comprehension questions and structure recall when reading familiar rather than unfamiliar content. Additionally, a marginally significant interaction was found between GO condition and familiarity; students in the re-reading condition experienced a decline in structure comprehension question performance when reading unfamiliar content. These results may inform efforts toward improving second-graders' text structure sensitivity and expository text comprehension through the use of graphic organizers.

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ACKNOWLEDGMENTS

I remember my first day at Teachers College very well. At my doctoral student orientation that morning, there was an excited buzz in the room as all of the new students met for the first time. We eagerly discussed our plans for after graduation, dreaming and bragging of the wonderful career paths we would follow with our degrees in hand. Amused, our panel of speakers reminded us of one very important fact: namely, that we needed to *earn* those degrees first. Moreover, they told us, the road to the doctoral degree would in itself be long, arduous, and demanding. And it has been. All told, this has constituted one of the most exhilarating, interesting, challenging, circuitous, and breathtaking roads I have ever traveled. It was not one I traveled alone, to my great fortune, and I am delighted to finally thank all those who came with me along the way.

My first thanks go to my advisor and dissertation sponsor, Professor Joanna Williams. Professor Williams, it has been an honor to study under such a remarkable scholar and champion of the field. Put simply, your tutelage has been a gift that has quite literally changed my life. What a lucky day it was when I learned you would be my advisor! I would also like to thank the members of my committee, Professor Matthew Johnson, Professor Dolores Perin, Professor Stephen Peverly, and Professor Lisa Son. Your insight, guidance, and conversations have been invaluable throughout this process and have taught me so very much.

Many other teachers also assisted in this project. I would especially like to thank Deanna Bunucci, Kate Cahill, Lisa Tower, and Donna Zambrano for their warm welcomes and unwavering support. Nedra Miller, though we had not yet met in person, your encouragement and kindness knew no bounds (and thank you, Sharla Herbert, for introducing us). My dear, dear

Kristin LaSalle, you are a marvelous teacher and friend. This stack of paper sitting in your hands would not exist without your efforts.

Two exceptional teacher-mentors have also carried me through this process. Professor Tina Jacobowitz, your support and sage advice, offered from the kindness of your heart, allowed me to overcome numerous challenges. Professor Nancy Lauter, you should know that it was your encouragement that gave me the confidence to start on this path, and your friendship that kept me on it.

My friends and fellow students are important contributors as well. Amaya Garcia, we will always be the two peas in a pod that walked the halls of TC. Jill Ordynans and Jamie Krenn, you made this fun! I am so glad we did this together. Dr. Amy Endo Wong, Dr. Brooke Stafford-Brizard, Dr. Abi Nubla-Kung, and Dr. Simonne Pollini, you did it first and never failed to encourage those who came after. And finally, Lindsey Brown, you have been a part of my life since *I* was a second-grader, and it brings me great happiness to know that you still are.

Anyone who knows me knows that my family is always at the forefront of my life. This work is due to them as much as it is to me. Ruth Lane, you have gone above and beyond your role as a mother-in-law. Your pride in my work has been a source of continual motivation for me, and all those many hours of babysitting allowed much of this work to occur in the first place. Charles Lane, your encouragement (and proofreading!), combined with your unabashed delight in my small successes, pushed me to work harder than I would have otherwise.

I doubt it is possible to adequately thank my parents and brother, but I will try: Dad, you are the first Dr. Snyder, and you made me want to be the second. We didn't know it then, but when my seven-year-old self was sitting in on your college lectures on writing technical manuals, you and I were together forming the research plans that you see carried out here. What

I have accomplished here is a tribute to you, my Aged P. As for my mother, we are so tightly connected that we often joke that we communicate through E.S.P. Given this, Mom, I am assuming you already know how profoundly grateful I am to you. In addition to pulling me through the most difficult times of my life, you are the person who first brought me to T.C. What is more, you paved all the roads that came before the one I am on now. Thank you for teaching me how to work hard, study well, write research papers, and get the job done. Ben, my not-so-little brother, when you were young you taught me everything I needed to know about children and teaching. Now that you are a teacher yourself, I am so proud to call you a colleague as well. I look forward to all our future collaborations!

My husband, Matthew, deserves a medal. Matt, you gave me strength when I had none. You provided for our family so that I might pursue this dream. You stapled test protocols, read drafts, and wordlessly brought me coffee so that I could keep working. In sum, you have been the best partner anyone could ask for.

There is one last group of people I must acknowledge. A great many children took part in this study, some as participants, some as test readers, and all as young friends eager to read with me. These readers, and all the young readers who will come after, are my greatest inspiration.

One particular young reader, of course, deserves special mention. Sam, my sweet little boy and budding book-lover, I love you more than life itself. This one is for you.

This work is dedicated to Samuel Jacob Lane

Chapter I

INTRODUCTION

Narrative text, which is the focus of most primary grade reading programs, is an important part of a child's literary and literacy experience; however, the genre bias towards narratives may come at a price. It is known that mastering the ability to read and respond to a wider variety of texts, including genres other than narratives, has powerful implications for a child's future personal, academic, and career success (Best, Floyd, & McNamara, 2004; Duke, 2000; Hall & Sabey, 2007; Yopp & Yopp, 2006). Given this, effective reading instruction in multiple genres has the potential to positively influence the trajectory of a child's entire life course, since reading is a principal means for learning new information and for acquiring new skills (Caswell & Duke, 1998; Duke, 2000; Williams, et al., 2007). Work by Duke (2000) has, however, revealed a conspicuous gap in the reading experiences of children in the early grades: namely, our very youngest readers rarely encounter expository (also known as informational) text, despite research demonstrating that early readers not only have the capacity to read expository works, but that they also can become deeply engrossed in this genre (Caswell & Duke, 1998; Duke & Kays, 1998).

The problems stemming from the scarcity of expository texts in the primary grades first become apparent when one considers that students are expected to be able to comprehend and learn from this type of text starting around the fourth grade. Without early opportunities to learn the structures and patterns inherent in the informational genre, students may experience serious reading difficulties later on, as evidenced by the nationwide "fourth grade slump" in reading (Chall, 1983; Chall, Jacobs, & Baldwin, 1990). Consequently, these children may be unprepared

to learn factual information from what they read, though much of the material taught in the later school years is presented through expository text (Moss, 2005; Myers & Savage, 2005). Results from the recent National Assessment of Educational Progress (NAEP, 2010) serve as an indicator of the poor reading performance seen among these students, with only 31% of the nation's fourth graders achieving the "proficient" benchmark in reading. These results suggest that much work must be done to better support these young readers.

It should be acknowledged that learning to read is not an easy task, as the nature of reading itself is highly complex. The National Reading Panel (2000) has identified many processes involved in reading, including phonemic awareness, phonics development, vocabulary development, and comprehension. Mastery of all of these processes is essential for success in reading, with comprehension being of particular interest to many. It is at this point in the reading process that information moves from being decoded to being understood; through comprehension, textual information becomes cognitively available for learning and further application (Anderson & Pearson, 1984; Sweet & Snow, 2003). Difficulties in comprehension may lead, at least in part, to the alarmingly low reading performance of so many U.S. children, especially when they are reading expository texts.

Challenges of Expository Text

Expository text encompasses a range of text materials (Wolfe & Mienko, 2007) and is informational in nature; it is designed to communicate facts, present factual sequences of events, or state arguments (Duke, 2000; Jiang & Grabe, 2007). The ability to comprehend expository

text becomes increasingly important as students progress through the elementary grades, during which time instructional emphasis typically shifts from learning to read to "reading to learn." Starting from the fourth grade and continuing into high school and the post-secondary years, text becomes a primary source of knowledge (Calfee and Chambliss, 1988; Moss, 2005; Myers & Savage, 2005), with expository text comprising the bulk of what is read in school (Bernhardt, Destino, Kamil, & Rodriguez-Munoz, 1995). Students are not only expected to comprehend this text, they are also required to remember and apply the information that they read (Alfassi, 2004). This shift towards expository text is evident in the content of high-stakes tests as well, which in recent years have included increasing numbers of informational passages (Afflerbach, 2007). Regrettably, a concurrent decline in comprehension performance frequently accompanies the narrative-to-expository transition (Chall, 1983; Chall, Jacobs, & Baldwin, 1990; NAEP, 2010).

What accounts for the comprehension difficulties that students experience? As noted previously, the dearth of expository materials in the early grade classroom may be partly to blame. This trend been noted in various school settings by several researchers (Abadiano & Turner, 2002; Calfee & Chambliss, 1988; Campbell, Kapinus, & Beatty, 1995; Duke, 2000; Yopp and Yopp, 2006) despite the recommendation of the National Research Council that teachers include more informational text in the primary grades (Snow, Burns, & Griffin, 1998).

In addition, expository text may be more difficult to comprehend than narrative text. Expository passages often present readers with unfamiliar concepts, new vocabulary, and complex relationships between ideas (Goldman & Rakestraw, 2000; Griffin & Tulbert, 1995) with a greater density of information per sentence (RAND, 2002; Sweet & Snow, 2003).

Finally, the structural designs underlying expository text differ from the simple story structures of narrative text (Cain, Oakhill, & Bryant, 2004; Meyer & Poon, 2001). Thus, students

who are accustomed to narrative text are suddenly confronted with both unfamiliar content and unfamiliar organizational patterns when they enter the later elementary grades.

Factors in Expository Text Comprehension

Text Structure

The organizational patterns of text, known as text structures, are thought to play a key role in the comprehension of expository text (Armbruster, Anderson, & Ostertag, 1987). Several recurring top-level structures have been identified in this genre, including description, collection, sequence, comparison/contrast, cause/effect, and problem/solution (Cook & Mayer, 1988; Meyer & Freedle, 1984; Meyer & Poon, 2001; Richgels, McGee, Lomax, & Sheard, 1987). A single expository passage may contain more than one structure (Jiang & Grabe, 2007; Meyer, 2003), and some structures may be easier to comprehend than others (Ciardello, 2002; McCormick, 2003).

Many studies of readers' sensitivity to text structure have focused on older students. It was previously believed that students in the upper elementary grades and beyond were more capable of using structure to enhance recall and comprehension than younger students (e.g. Armbruster, Anderson, & Ostertag, 1987; Cook & Mayer, 1988; Meyer & Poon, 2001). Recently, however, studies have shown that much younger readers can be taught to recognize and utilize structure in the expository texts that they read (Hall, Sabey, & McClellan, 2005; Reutzel, Smith, & Fawson, 2005; Williams, Hall, & Lauer, 2004). This is a significant finding, as it suggests that teachers may help students improve expository comprehension in the later school years by teaching them how to use text structure while they are still primary students.

Content Familiarity and Text Structure

Students have varying levels of prior knowledge, or familiarity, with the content they encounter in text. This prior knowledge includes general knowledge that students have gained from personal experience as well as domain-specific knowledge (Adams, Bell, & Perfetti, 1995; Spires & Donley, 1998). Previous research has shown that content familiarity enhances comprehension of expository text (Armand, 2001; Rawson & Kintsch, 2002). Less clear is the relationship between text structure and content familiarity.

Results from studies on this relationship remain inconclusive. Some work has demonstrated that well-structured texts benefit students regardless of prior knowledge levels (Kendeou & van den Broek, 2007; McKeown, Beck, Sinatra, & Loxterman, 1992; Wylie & McGuinness, 2004). Others speculate that some form of interaction takes place between text structure and prior knowledge, but that this interaction may be dependent on other factors or the types of measures used. McNamara & Kintsch (1996), for example, have posited that a "reverse cohesion effect" may occur, such that readers with high levels of knowledge actually perform better when reading texts with less structure. Taylor and Beach (1984) also noted a text structure/prior knowledge interaction among middle-school students; in this case structure was most useful when students read texts with unfamiliar content. In a later study, O'Reilly and McNamara (2007) found that this interaction effect may be task-dependent and is also likely related to comprehension skill. Wylie and McGuinness (2004) found no interaction at all.

As seen from this wide range of results, the nature of the possible interaction between structure and content familiarity is apparently complex and task-dependent among readers in the middle grades on up. Only a very few studies, however, have examined this interaction among young readers (Lauer, 2002; Pollini, 2009). In these studies, as in studies with older readers, the

structure/familiarity interaction was apparently both task- and structure-dependent. Given that young readers often have low levels of domain-specific prior knowledge as well as little experience with expository structures, further research into this interaction among primary-grade readers is warranted.

Graphic Organizers

A number of tools and methods have been developed in order to enhance comprehension of expository text. One commonly used tool for this purpose is the graphic organizer (GO). Although the definition of a graphic organizer may vary depending on context, most experts agree that GOs are visual and spatial representations of text. These representations, usually depicted via the arrangement of words, lines, arrows, and other graphical markers, are designed to show the relationships between important concepts in text (DiCecco & Gleason, 2002; Robinson, Shaw, & Games, 2007; Stull & Mayer, 2007). A GO may be as simple as a list; however, more complex forms exist, including semantic/concept maps, cognitive maps, story maps, flowcharts, outlines, frames, matrices, Venn diagrams, and causal chains (Kim, Vaughn, Wanzek, & Wei, 2004; Stull & Mayer, 2007).

Many experts recommend using GOs as integral components of reading instruction (Blachowicz & Ogle, 2001; Graves, Juel, & Graves, 2006; Hall & Sabey, 2007; Vacca & Vacca, 1999). Because graphic organizers can visually depict complex relationships, they are an intuitive choice for teaching expository text structure. Indeed, when text structure is presented in textbooks it is often through GOs (e.g. Gunning, 2003; Thresher, 2004). In addition, several researchers have incorporated GOs in text structure studies, though few have examined GOs in

isolation from other structure strategy techniques (Richgels, McGee, Lomax, & Sheard, 1987; Meyer & Poon, 2001; Williams, et al., 2007; Williams, Stafford, Lauer, Hall, & Pollini, 2009).

It is important to note, however, that research into graphic organizers remains inconclusive. A large body of research exists which supports the use of graphic organizers in reading instruction (e.g. Alvermann, 1981; DiCecco & Gleason, 2002; Kim, Vaughn, Wanzek, Wei, 2004; Robinson & Kiewra, 1995). Some studies, however, have shown that GOs are ineffective in improving reading comprehension and recall. An early study by Bean, Singer, Sorter, and Frazee (1986), for example, demonstrated that training students to use GOs was no more effective than outlining if summarization training was not provided as well. Another earlier study found that GOs did not lead to any improved performance over traditional instructional techniques (Simmons, Griffin, and Kameenui, 1988). More recently, Griffin, Malone, and Kameenui (1995) trained fifth graders in the use of GOs and found transfer effects but no improved recall. A review of GO research published the same year further emphasized the incongruous results of previous studies, leading the authors to conclude that a clear trend in the effectiveness of GOs has yet to be seen (Griffin & Tulbert, 1995).

While a wealth of GO research exists, few studies have investigated how GOs influence reading among students below the fourth grade. None of the 13 studies reviewed by Griffin and Tulbert (1995) involved primary-level readers; of these studies, only four included participants who were in the fourth or fifth grades. Kim, Vaughn, Wanzek, and Wei (2004) also reviewed GO research: of the 17 treatment-comparison studies included, none investigated GO use at the primary level, and only 5 included elementary students. Likewise, in a meta-analysis of concept map research by Nesbit and Adesope (2006) none of the reviewed studies involved children

under the fourth grade. Additional research is needed to clarify the impact of GOs on primary grade readers' text structure awareness and comprehension of expository text.

The Present Study

The primary aim of the present study was to investigate the effects of graphic organizers (GOs) on text structure sensitivity and expository reading comprehension among second grade students. Specifically, the study examined how GOs support structure sensitivity and recall of cause/effect text, as previous research has shown that this structure may be successfully taught to 2nd graders (Williams et al., 2004, Williams et al., 2005; Williams et al., 2007), though it is one of the most difficult structures to interpret (Armand, 2001; Meyer & Freedle, 1984). Half of the participating students read a supporting GO after reading cause/effect text; the other half simply re-read the text.

Many variations of cause/effect structure exist, some more complex than others (Richgels, McGee, Lomax, & Sheard, 1987). For example, a simple causal structure includes a cause followed by a single effect, while a more complex structure can include multiple causes, multiple effects, or long causal chains. Work by Williams, et al. (2007) indicates that more complex causal structures may lead to increased difficulties in comprehension. In light of this research, we compared comprehension and recall performance at two levels of cause/effect complexity structures: one cause directly followed by one effect and one cause followed by multiple effects.

We also investigated the effects of content familiarity on student comprehension. By the third or fourth grade, students regularly encounter text with new, unfamiliar content (Bernhardt,

Destino, Kamil, & Rodriguez-Munoz, 1995; Calfee & Chambliss, 1988), yet the influence of prior knowledge on comprehension remains somewhat uncertain (Kendeou & van den Broek, 2007; Pollini, 2009). In the present investigation, two levels of content knowledge were included: familiar content (events and objects commonly encountered by young children) and unfamiliar content (science facts).

Additionally, the study examined possible interactions among graphic organizers, levels of structure complexity, and content familiarity. Previous research into the interaction between text structure and content familiarity has led to different conclusions; some believe that structure and prior knowledge do not interact (Lauer, 2002; Wylie & McGuiness, 2004). Others have found a significant, albeit complex, interaction (McNamara et al., 2006; Roller, 1990; Taylor & Beach, 1984). Similarly, studies of the interactions between graphic organizers and text structure (Armbruster, Anderson, & Ostertag, 1987; DiCecco & Gleason, 2002; Simmons, Griffin, & Kameenui, 1988) as well as graphic organizers and content familiarity (Lambiotte & Dansereau, 1992; O'Donnell, 1993; O'Donnell & Dansereau, 2000) have led to varying and rather ambiguous results. Little is known about these interactions among very young readers, though GOs are now frequently used in the classroom (Bellanca, 2007).

Research Questions

In sum, the present study investigated the effects of reading a graphic organizer with familiar or unfamiliar cause/effect text on reading comprehension as measured by recall and text structure sensitivity. The following questions were addressed:

1) Do second graders' recall and text structure sensitivity of cause/effect text change as a function of reading a graphic organizer (GO)?

2) Does text structure sensitivity change depending on the relative complexity of the cause/effect structure (a one cause-one effect paragraph as compared to a one cause and multiple effects paragraph)?
3) Do second graders' structure sensitivity and recall of cause/effect text differ depending on their familiarity with the content?
4) Is there an interaction between the presence of a GO and the level of cause/effect structure complexity?
5) Is there an interaction between the presence of a GO and content familiarity?
6) Is there an interaction between the level of cause/effect structure complexity and content familiarity?
7) Is there a three-way interaction between the presence of a GO, the level of structure complexity, and content familiarity?

Summary of Purpose

Graphic organizers provide a scaffold for developing an awareness of a text's structure. These organizers are commonly used in the classroom and in textbooks, but it is not clear when or how they should be used. Results of this study may offer instructors and textbook authors more information regarding the effective use of GOs in instruction, with the goal of improving young readers' comprehension and structure awareness of cause/effect text.

Cause/effect text structure may be the most difficult organizational design found in expository text (Armand, 2001; Ciardiello, 2002; McCrudden, Schraw, & Lehman, 2009; Richgels, McGee, Lomax, & Sheard, 1987). This structure type requires the reader to infer complex relationships between ideas while holding multiple concepts in mind at once

(McCormick, 2003). A text with a one cause-multiple effects structure, for example, requires readers to remember the primary cause while reading resultant effects; the effects themselves may be listed much later in the passage. Other cause/effect texts may require readers to infer unstated causal antecedents or recall complex causal chains. The present study contributes to our knowledge of how our youngest readers manage this challenging organizational pattern at two levels of structural complexity.

In addition, this study offers further insight into the question of content familiarity. If students demonstrate higher levels of structure sensitivity and comprehension for familiar content, then it may be most beneficial for teachers to begin text structure instruction with content that is already well known to students. This is particularly important, as much of the text students encounter in the later elementary grades includes unfamiliar rather than familiar content. Thus, it may be beneficial to establish structure sensitivity well prior to the later school years, when the shift to unfamiliar content typically begins.

An understanding of the possible interactions between graphic organizer use and content familiarity may also inform instruction. If comprehension performance is higher when students read a GO, teachers may choose to begin instruction in cause/effect text using this instructional support. Further, if performance using graphic organizers is best with familiar content, it might be preferable to introduce text structure with material that is already known to students. On the other hand, instruction may be sequenced differently if another pattern of comprehension emerges. Similarly, results of this study may help determine if it is possible to initiate GO instruction with relatively complex cause/effect structures, or whether it is more advisable to first establish an understanding of simple one cause-one effect structures.

Chapter II

LITERATURE REVIEW

Reading Comprehension and Text Structure

In 1960, William Gray proposed that reading comprehension involved three key processes: (1) reading lines, (2) reading between the lines, and (3) reading beyond the lines. Since this time, there have been many developments in our knowledge of the nature of comprehension, but it is still believed that these three processes are central to a reader's understanding of text (Kintsch, 1994; Temple, Ogle, Crawford, & Freppon, 2011). Reading the lines, also known as the literal level of comprehension (Klauda & Guthrie, 2008; McNamara, 2007; Sadoski, 2004) involves a basic understanding of the literal meanings of the words conveyed in written text. Reading between the lines, or the interpretive level of comprehension, requires readers to identify important concepts in a text, recognize a text's overall structure, derive basic inferences, and determine how text elements relate to each other (Herber, 1978; Sadoski, 2004; Searfoss & Readence, 1994). When readers read "beyond the lines" at the applied level of comprehension, they relate their prior knowledge and inferences about an author's message to the meaning of the text (Sadoski, 2004; Stewart-Dore, 1984). All told, this general view of comprehension implies that readers actively, rather than passively, process text at several levels simultaneously.

How do readers manage such complex interactions with text? According to schema theory, readers develop internal knowledge structures related to text, which in turn support comprehension of textual information. These knowledge structures, known as schemata,

interrelate with the information in text. Readers use their prior knowledge of text elements and content in order to make sense of what is read, at the same time assimilating new information into existing schemata (Anderson & Pearson, 1984; Armbruster, 1986; Kintsch & van Dijk, 1978; Robinson, 1998).

Some theorists posit that readers build two distinct types of schemata: *formal* schemata and *content* schemata. A formal schema is a reader's cognitive framework for understanding the organizational or rhetorical patterns of text; a content schema is a reader's general knowledge of the world and of specific content topics that may be presented within a text. It is believed that skilled readers are able to draw upon and modify both types of schemata concurrently (Armbruster, 1986; Myers, 1997). This ability is not innate, however, and must be developed by young readers (Anderson, 2005; Brown, 2001; Herber, 1978; Nubla-Kung, 2008). Thus, to support the growth of reading comprehension among young readers, it is necessary to understand the influence of each schemata type on the global comprehension process.

Formal Schemata: Text Structure Awareness

Much as the stability, function, and appearance of a building is supported by its foundational structure, so too is written text built upon an underlying structure. Text structure is the organizational pattern of a narrative or expository passage (Meyer, Brandt, & Bluth, 1980) such that "the elements of text...provide coherence by emphasizing ideas central to the author's main thesis and deemphasizing peripheral ideas" (Meyer & Poon, 2001, p. 141). Sensitivity to a text's overall structure, which is developed as part of a reader's formal schema, has been shown to play an especially important role in reading comprehension. Text structure sensitivity (also

termed structure awareness) assists readers in understanding the major concepts and relationships presented within a given passage. With an internal schema for text structure, readers are better able to make inferences (Kintsch, 1983), recall information (Cook & Mayer, 1988; Meyer, Brandt, & Bluth, 1980), and comprehend the text they read (Armbruster, Anderson, & Ostertag, 1987; Dymock & Nicholson, 1999; Richgels, McGee, Lomax, & Sheard, 1987).

Expository Text Structure Sensitivity

Although there may be some overlap between narrative and expository text structure types, the overall structures of the two genres are distinct. Narrative text most often contains a story structure constructed from sequences of events and character interactions (Simmons & Kameenui, 1998; Temple, Ogle, Crawford, & Freppon, 2011). In contrast, expository text is framed upon one or more of a number of general structures. The terms and classifications used to describe these structures vary, but studies of expository text structure generally focus on the following organizational continuum posed by Meyer and colleagues (Meyer, Brandt, & Bluth, 1980; Meyer & Freedle,1984; Meyer & Poon, 2001): description, sequence, compare/contrast, cause/effect, and problem/solution. These structures are described in Figure 1.

Figure 1: Categories of Expository Text Structures

Category of Expository Text Structure	Explanation of Structure
Description	Elements in a text are organized and grouped by association; these groups present the attributes of a topic.
Sequence	Elements are grouped according to a temporal order.
Compare/Contrast (Comparison)	Text elements are grouped on the basis of similarities and differences.
Cause/Effect (Causation)	Elements are presented as causes and effects; "the idea explained is the effect and the explanation is its cause" (Meyer & Poon, 2001, p. 143).
Problem/Solution	Similar to cause/effect. Elements are organized according to a problem or question and the solution or answer that solves that problem.

Numerous studies of expository text structure sensitivity have been conducted with readers at the late elementary, middle school, high school, and college levels. A number of measures have been utilized to assess structure sensitivity, including comprehension questions (Cook & Mayer, 1988; Pollini, 2009), summary tasks (Armbruster, Anderson, & Ostertag, 1987; Meyer & Poon, 2001; Richgels, McGee, Lomax, & Sheard, 1987; Taylor & Beach, 1984), structure recognition tasks (Englert & Hiebert, 1984; Meyer, Brandt, & Bluth, 1980; Nubla-Kung, 2008), and recall tasks (Meyer & Freedle, 1984; Meyer & Poon, 2001; Taylor, 1980; Taylor & Samuels, 1983). Despite differences in research designs and measures, the results of these studies have generally confirmed that structure sensitivity influences comprehension. In an

influential early study by Meyer, Brandt, and Bluth (1980), for example, it was found that text structure sensitivity was highly correlated with scores in reading comprehension. Prior to the study, high school students were classified as good, average, or poor readers based on the results of two standardized tests. All students then read two well-organized expository passages, one with a comparison structure and one with a problem/solution structure. Immediate and delayed written recalls were collected and analyzed for the quantity of information the students remembered. In addition, the researchers measured how well the passage structures were reflected in the recalls; this was their measure of text structure sensitivity. As the researchers hypothesized, the students with the highest comprehension scores demonstrated the highest structure sensitivity, the greatest use of the top-level structure of the text for recall, and the highest overall amount of information recalled. The authors concluded that the structure of the text served as a scaffold or mnemonic strategy for the most adept readers.

Similarly, in one of the few text structure studies to include multiple age groups, Taylor (1980) found that text structure sensitivity aided the recall of a well-organized expository passage with a description structure. Participants included adults, sixth-grade readers with high comprehension scores on a standardized test, sixth-grade readers with low comprehension scores, and fourth-grade readers with high comprehension scores. All participants provided oral recalls after reading the description text, both immediately and after a two-day delay. As expected, adults had the highest recall scores for both the immediate and delayed time periods. Both groups of sixth grade students performed equally well on the immediate recall, but the sixth-graders with the high comprehension scores recalled significantly more information on the delayed recall; the recalls of these students also reflected more of the text's structure. Fourth grade students had the lowest scores on the immediate recall, but there was no difference

between the fourth-graders and the sixth-graders with low comprehension on the delayed recall. The authors caution that none of the children efficiently utilized the text structure during their recalls, highlighting the need for further investigation into text structure sensitivity and structure instruction during the earlier grades.

It is worth noting that very few researchers have investigated text structure sensitivity among readers below the fourth grade, perhaps because much of the reading research at this level is focused on decoding, vocabulary, and fluency (Neuman & Dickinson, 2006; Temple, Ogle, Crawford, & Freppon, 2011). A study by Danner (1976) is one of the only existing structure sensitivity studies to include primary-grade students. With the goal of understanding the age-related development of text organization sensitivity among children, Danner read two descriptive expository passages to students in the second, fourth, and sixth grades. One of the passages was well-structured, while the other was scrambled so as to eliminate any obvious macrostructure. Children completed six tasks after the texts were read aloud; these tasks included (1) an oral free recall, (2) a subjective difficulty rating task, during which students indicated which passage they found easier to understand, (3) a detection task requiring students to discuss any differences in organization they noticed, (4) a grouping task in which students matched detail sentences to a main idea sentence, (5) a review task in which students chose sentences that would help them with future recalls of the passages, and (6) a topic generation task asking students to provide a main idea sentence for four of the detail sentences.

Results of this study demonstrated the influence of text structure on comprehension among students at all three grade levels. On the oral recall task, sixth graders performed better than fourth graders, who in turn performed better than second graders. However, the text organization by grade interaction was not significant; all readers at all levels had higher recall

scores after reading the well-structured text. In addition, nearly all of the students rated the well-structured passage as the easiest passage to understand. Explicit sensitivity to text structure, as measured by the detection task, varied significantly by age. Sixth graders had the highest levels of structure sensitivity, followed by fourth graders. Only two second-graders in the sample noted any differences in the structures of the passages. Likewise, few second-graders were able to correctly complete the grouping task, a task which most fourth- and sixth-graders performed without difficulty. The same trends were seen in the recall review task, with sixth-graders correctly identifying more important structure elements for future recalls than fourth-graders, who identified more elements than second-graders. In contrast, students in all three grades demonstrated some level of implicit structure sensitivity as shown in the topic generation task; every student correctly generated at least four of the six main topics in the passages. The author concludes that a reader's implicit sensitivity to text structure may not always match his or her explicit understanding of this structure, and that training in text structure at all ages may assist with both comprehension and recall.

Williams and her colleagues have conducted a number of studies to examine the effects of such training on expository comprehension. In one of these studies, Williams et al. (2005) designed an instructional program for teaching second grade students to recognize and utilize the compare/contrast structure commonly found in science and social studies texts. The text structure instruction program taught students to use specific strategies and devices for identifying the compare/contrast structure in science texts, including clue (or signal) words, structure-based questions, matrix graphic organizers, and summary writing. An additional, comparable program was written which contained the same science content but none of the text structure instruction. A total of 128 second-graders in a large urban school district participated in the study.

Classrooms were randomly assigned either to the text structure program condition, the content-only program, or a no-instruction condition. All students performed equally poorly on a pre-test containing structure and content measures.

When the 15-session programs were completed, a post-test was administered to all students. On two measures of text structure sensitivity (recall of clue words and compare/contrast sentence generation from a graphic organizer), students in the text structure training program performed significantly better than students in the content-only and no instruction groups. There were no significant differences on scores from a summary-writing task, but results indicated a trend toward better performance among students in the text structure program. Students were also measured on their ability to transfer structure strategies toward novel texts. Students in the text structure program achieved significantly higher scores than students in the other two groups on structure-based questions for passages containing a new combination of previously instructed materials; the same trend was seen in student performance for new texts with similar but novel content. There were no significant differences on a transfer task involving text with unrelated content or a text with an unfamiliar text structure, though students in the structure program tended to have somewhat higher scores. Interestingly, students in the structure program performed comparably on content-related tasks to students in the content-only program, supporting the view that learning about text structure within the context of content-area instruction can be achieved without detracting from learning the content (in this case, science).

In a related study, Williams et al. (2007) investigated the comprehension effects of an instructional program focused on cause/effect structure and social studies content. Fifteen teachers and 243 students in three urban schools participated in the program, which was closely modeled after the 2005 compare/contrast study. As in the previous study, classrooms were

randomly assigned to either a text-structure, content-only, or no-instruction condition. Two levels of cause/effect structure complexity were taught: one cause followed by one effect and one cause followed by multiple effects. As anticipated, students in the text structure program scored significantly higher on text structure strategy use, which included locating clue words and underlining cause and effect clauses. On two other structure measures (completing a graphic organizer and recalling cause/effect strategy questions) there were no significant differences, but the results favored students in the text structure instruction condition. Scores on measures of social studies content learning indicated comparable performance in the text structure and content-only groups, both of which scored higher than the no-instruction group. The researchers also measured transfer of structure skills to new paragraphs, including an authentic one cause-multiple effects passage taken from a text not used in the program. Significant differences emerged in questions involving effects; on these questions, the text structure instruction students received higher scores than students in the other two groups. The authors propose that transfer effects were not as strong in this study because of the higher relative difficulty of cause/effect structure as compared to other expository structures.

In summary, although there is a scarcity of research involving primary grade text structure sensitivity and instruction, existing work has shown that very young readers may possess some implicit understanding of the organization of text. Furthermore, text structure may be explicitly taught, even to students who have only just begun to learn to read.

Cause/Effect Text Structure

Compared to the other text structure types commonly found in expository works, cause/effect structure has been found to contain a number of distinguishing characteristics that

may render it one of the most difficult organizational patterns to identify and comprehend (Armand, 2001; McCrudden, Schraw, & Lehman, 2009). To understand why this is, it is helpful to examine cause/effect structure in relation to other expository structures. Meyer and Freedle (1984) offer such a comparison when they classify expository text structures along a component continuum. On the continuum, structures are ordered from the least to the most number of organizational components per structure. For example, description text structure has only one organizational component: grouping of text elements by association, while sequence structure contains both association grouping and temporal order. Cause/effect structure is more complex, as it is framed around the association and temporal components as well as a third component, the causal links between related text elements.

In addition, the top-level arrangement of causes and effects may vary widely, thus posing a further challenge to readers. At its simplest level, cause/effect structure contains a single cause linked directly and explicitly to a single effect within the same sentence (e.g. "The boy fell down so he hurt his knee."). From there, the variations multiply: text may contain one cause and multiple effects, one effect and multiple causes, effects listed prior to causes, or causal chains with effects that later serve as causal antecedents. Some texts describe multiple causes that lead to interrelated effects, while still others contain effects that are not apparent until long after the cause has been stated (Hare, Rabinowitz, & Schieble, 1989; Linderholm, et al., 2000; Richgels, McGee, Lomax, & Sheard, 1987). Given the limits of short-term memory, the conceptual relationships in the more complicated cause/effect structures may be especially taxing to readers. Linderholm, et al. (2000) state that when a causal consequent is not directly connected to its antecedent, a reader must try to either remember the missing causal element, infer the cause, or retrieve information from personal (and potentially erroneous) background knowledge. They

hypothesize that cause/effect text may then lead to breakdowns in comprehension, especially among young or less-skilled readers who are apt to have greater difficulty in predicting cause/effect relationships (see also St. George, Mannes, & Hoffman, 1997).

Though few have examined the relative difficulty levels of the various expository text structures, particularly among young readers, there is some empirical evidence to suggest that cause/effect text is indeed one of the hardest organizational patterns to recognize and interpret. In one study involving multiple text structures, students demonstrated poor overall sensitivity to cause/effect structure as compared to other structures (Richgels, McGee, Lomax, & Sheard, 1987). Sixth-graders in this study read a total of six expository content passages for each of four text structures: collection (similar to description), cause/effect, compare/contrast, and problem/solution. The cause/effect passages were arranged according to a one cause – multiple effects framework, and all passages included topic sentences, main idea sentences, and detail sentences. After reading the passages, students completed a number of tasks designed to evaluate structure sensitivity. After performing a matching task in which students paired a novel passage with a sample passage of the same structure, students then read two additional passages for each structure and completed a written recall. In another session, students wrote structure-based summaries using a pre-constructed outline. Finally, students were asked to rate their prior knowledge for the various topics included in the passages. The results of this study are striking: across all measures, students demonstrated significantly lower sensitivity to cause/effect structure, while scores were relatively high and comparable among the other three structures. Results on the recall measure also indicated that cause/effect was the only structure for which students recalled irrelevant details as frequently as they did main ideas, a finding that may also indicate a lack of causal structure sensitivity. Interestingly, this trend extended into student

writing, such that only one participant fully utilized cause/effect structure in the composition task, as compared to 48 for the compare/contrast outline, 28 for the collection outline, and 22 for the problem/solution outline.

Students in a study of main idea identification (Hare, Rabinowitz, & Schieble, 1989) also demonstrated difficulties with cause/effect structure. Participants included fourth-graders, sixth-graders, and eleventh-graders in a suburban school. In the second of two reported studies, students read science and social studies passages. All passages had been revised to reflect a listing, sequence, compare/contrast, or cause/effect structure. In half of the passages, the main idea was explicitly stated, while the other half required students to infer an implicit main idea. Students in each grade level read both third grade and grade-appropriate texts for each of the structures and then underlined or generated a main idea for each passage. When reading the third grade texts, students at all three grade levels received significantly lower scores on cause/effect passages, while scores on the other three text structures were comparable. When reading grade-appropriate texts, scores for the cause/effect and compare/contrast passage measures were significantly lower than scores for the listing and sequence passages.

The results from these studies confirm that cause/effect structure may pose a greater challenge to young readers than other discourse structures. Given the potential complexity of this organizational pattern, it seems logical that studies of text structure sensitivity or instruction should include a heavy focus on recognition and comprehension of cause/effect text. In addition, given that young readers often demonstrate difficulties with the inference and predicting processes involved in understanding cause/effect relationships (Linderholm, et al., 2000) these students may additionally require a support mechanism which renders these relationships more explicit (St. George, Mannes, & Hoffman, 1997).

Graphic Organizers

One such support mechanism is the graphic organizer (GO). Graphic organizers are visual and spatial representations of text. Many varieties of GOs have been developed, including lists, outlines, story maps, cognitive maps, link-node maps, causal chains, matrices, Venn diagrams, and myriad additional hybrid designs (Kim, Vaughn, Wanzek, & Wei, 2004; Robinson, 1998; Robinson & Kiewra, 1995; Stull & Mayer, 2007). All GOs depict the relationships between important text concepts or vocabulary via arrows, lines, and other graphical markers (DiCecco & Gleason, 2002; Robinson, Shaw, & Games, 2007; Stull & Mayer, 2007); they are therefore an intuitive choice for highlighting text structure. Indeed, many experts, including those on the National Reading Panel, have issued recommendations for the use of GOs as integral components of reading comprehension instruction (Blachowicz & Ogle, 2001; Graves, Juel, & Graves, 2006; Hall & Sabey, 2007; National Reading Panel, 2000; Vacca & Vacca, 1999). Teachers have followed suit; GOs are now commonplace in many schools (Bellanca, 2007) with one survey indicating that organizers are one of the most frequently used tools in the classroom (Barry, 2002). In addition, due to improvements in graphic design technology, GOs are now much more frequently included in textbooks and student materials (Lambiotte, et al., 1989; Robinson, 1998).

The GO evolved from Ausebel's (1960) cognitive theory, which posits that the process of learning new material depends on relating information to previously existing knowledge. Extending this theory, other researchers (see Barron, 1969; Earle, 1970) developed the concept of a visual-spatial display of text, in the hopes that this type of illustration would further connect text to previously learned material. As GOs evolved, and as studies demonstrated the positive

influence of GOs on reading comprehension and recall, researchers sought to understand the underlying processes behind these facilitative effects.

Once again, schema theory has informed these efforts. Robinson (1998) notes that GOs visually and spatially display a schematic for text concepts, thus essentially providing a ready-made schema that readers may integrate with their own prior knowledge. It is also thought that a diagram such as a GO frees cognitive resources and short-term memory. Since text is inherently linear, readers must typically connect new concepts to information that was provided earlier; sometimes the distance between important concepts is so great that the relationships between these concepts become opaque due to excessive demands on memory. Comprehension thus suffers as readers become more likely to forget information, become confused, or form an erroneous schema. A well-designed GO may ease this cognitive burden by explicitly supplying the correct schema and eliminating distance effects (Larkin & Simon, 1987; Robinson, 1998; Winn, 1988). Moreover, a GO singles out the most important relationships in text and eliminates extraneous details, thus performing what van Dijk and Kintsch (1978) termed the macro-structure deletion rule of reading. By deleting unimportant details in advance, the GO allows a reader to focus on the overall structure of the major ideas in a text.

Dual coding theory (Clark & Paivio, 1991; Kulhavy, et al., 1992; Paivio, 1983) may also inform our understanding of the cognitive mechanisms involved in reading GOs. Proponents of this theory believe that the human brain processes verbal and visual information differently and across distinct mental pathways. When information is presented both verbally and visually, memory is often enhanced (Anderson & Bower, 1973; Denis, M. & Mellet, E., 2002; Just, et al., 2004) since information is essentially encoded twice across two separate modalities. GOs offer a direct application of this theory, as nearly all organizer formats include a combination of verbal

and visual displays. Several studies have indicated that GOs do in fact improve memory of text (e.g. Alvermann & Boothby, 1986; Ritchie & Volkl, 2000; Robinson & Schraw, 1994) conceivably due to this separate, simultaneous processing across multiple channels in the brain.

Despite theoretical support for the use of GOs, it should be acknowledged that empirical GO research in reading comprehension remains somewhat inconclusive. Much of the research evaluating the use of GOs in reading instruction has indicated that GOs provide a valuable scaffold for readers (see Alvermann, 1981; DiCecco & Gleason, 2002; Kim, Vaughn, Wanzek, Wei, 2004; Robinson & Kiewra, 1995). Some studies, however, have shown that GOs are ineffective in improving reading comprehension and recall. An early study by Bean, Singer, Sorter, and Frazee (1986), for example, demonstrated that training students to use GOs was no more effective than outlining. More recently, Griffin, Malone, and Kameenui (1995) trained fifth graders in the use of GO and found transfer effects but no improved recall. Griffin and Tulbert (1995) reviewed GO research and found that results varied widely across studies. In other reviews, experts have noted that inconsistencies in GO design have hampered efforts to accurately measure the influence of these GOs on various cognitive processes; all have called for further research (Griffin & Tulbert, 1995; Jiang & Grabe, 2007; Moore & Readence, 1984; Nesbit & Adesope, 2006; Robinson, 1998).

Graphic Organizers and Text Structure

Various factors appear to be important in determining whether or not a GO is effective, particularly when the GO is intended to improve comprehension. Interestingly, among the most salient of these factors may be the relationship of a GO to a text's structure. In their review of

GO research, Griffin and Tulbert (1995) strongly recommend that teachers use GOs which fit the text structure of a passage, as opposed to GOs that organize a text's facts but do not mirror its structure (e.g. a simple list). Dunston (1992), Jiang and Grabe (2007), and Rice (1994) echo this recommendation, all speculating that the degree to which a GO follows a text's structure impacts its effectiveness in improving comprehension and recall.

Although most studies to date have not directly compared structure-aligned GOs to GOs that are designed independently of a text's structure, comparisons across studies with both types have shown that the latter, unstructured GO format does not typically lead to positive gains in comprehension or recall. The study conducted by Bean, Singer, Sorter, and Frazee (1986) is frequently cited as an example of the failure of unstructured GOs to improve reading performance. Tenth-grade participants in this study were randomly assigned to experimental groups. Two of the experimental groups received instruction in GOs; one of the two groups had already received 14 weeks of prior metacognitive training in summarization. The GOs used in the study were derived from a social studies textbook, but did not follow the text's structure (it should be noted that the students' social studies teacher provided the rules for constructing the GOs and did not follow models from previous GO or comprehension research). Students in a third group received instruction in outlining, with a focus on organization according to main ideas and details. Measures included five multiple choice quizzes administered during instruction, a sixth quiz completed after the end of the strategy instruction period, and a delayed written recall of a difficult high-level text. Student performance did not differ significantly among the three groups on the first five quizzes, although students in the GO-with-summarization cohort received higher scores on the sixth quiz and the delayed recall. Overall,

results indicated that without summarization training, studying with a GO was no more effective than outlining in terms of improved recall of content.

A GO study conducted by Simmons, Griffin, and Kameenui (1988) with sixth-grade science students provides a similar example. Although the organizers in this experiment contained important information from the text, they did not reflect the text's structure or depict important relationships between ideas. Students were randomly assigned to either a traditional instruction program, a program in which they read GOs in advance of the text (graphic advanced organizers, or GAOs), or a program in which they read GOs *after* reading the text (graphic post-organizers, or GPOs). Over a period of six sessions, students read passages and were taught content material from their science textbook. Students in the GAO condition read a GO prior to reading the passages, while students in the GPO program read the same GO after the passage. Students in the traditional program discussed content and answered questions about the reading material. Throughout the instructional programs, the researchers administered a total of six short-answer comprehension quizzes and found no significant differences in scores among the three groups. Scores on an immediate content comprehension post-test also revealed no significant main effect of treatment. On a delayed comprehension post-test, however, the GAO group had significantly higher scores, although no other differences or main effects emerged. Additional GO studies conducted by Griffin and colleagues, also utilizing unstructured GOs, led to similar results (Griffin, Malone, & Kameenui, 1995; Griffin, Simmons, & Kameenui, 1991).

In contrast to the results of these studies, other work involving *structured* GOs suggests that reading GO adjunct displays in conjunction with text may improve comprehension, text structure sensitivity, and/or recall, provided the text's discourse structure is somehow reflected in the design of the organizer. Among young readers, these improvements in reading were

illustrated in a seminal study by Armbruster, Anderson, and Ostertag (1987) in which fifth-graders, trained in text structure using a structure-aligned GO, scored higher on written comprehension measures than a traditional instruction comparison group. The GO used in this study was a frame/flow-chart hybrid organizer, which visually displayed the problem-solution structure with text boxes and arrows. Over a period of 11 days, students assigned to the structure program were instructed in the use of the frame GO and were given guidelines for writing summaries. Students assigned to the traditional instruction control condition read the same training passages, but these students answered comprehension questions instead of using GOs to learn about text structure. Subsequent to the training programs, students completed a comprehension essay test evaluating their understanding of the problem/solution macrostructure in a passage. Students also answered ten short response questions that primarily assessed comprehension of details not related to the text's structure. Two other measures, a summary-writing task and a discussion recall task, were completed during the last two days of the study. There were no differences in performance between the two instructional groups on the short response questions or the discussion recall. On the essay test, however, students in the structure training group received significantly higher scores and included a greater amount of relevant information in their writing. Similarly, students in this group included more of the important, structure-related ideas in their summaries of passages, and their summaries were rated significantly higher in terms of overall quality. In a follow-up study, Armbruster, Anderson, & Meyer (1991) used the frame GOs once again. In this investigation, fourth- and fifth-grade students who studied the structure-based frames learned more information from their social studies textbooks than students in a non-GO control group.

DiCecco and Gleason (2002) also utilized structure-based GOs, with the goal of understanding how these organizers influenced students' awareness of the relationships between major concepts in social studies text. In this instructional study, middle-school students with learning disabilities were randomly assigned to either a GO instructional program or a traditional program. Prior to the beginning of the program, students completed a standardized reading test, a content knowledge pretest, and a writing test to ensure that there were no initial differences between groups. Afterward, students received direct instruction in the reading of chapters from their social studies textbooks, as well as instruction in vocabulary and summary-writing. Students in the GO group read organizers that explicitly displayed the macrostructure and the important relationships presented in the text, while students in the traditional program discussed the texts and participated in hands-on activities related to the subject matter. Throughout the program, students completed content knowledge quizzes assessing their recall of the social studies material. After seven days, and again at the completion of the program, all students wrote prompted essays designed to evaluate the students' understanding of the structural relationships (cause/effect and sequence) between major concepts in the text. No differences in scores were noted on content knowledge; however, students who read GOs in the instructional program scored significantly higher on both essays, with the highest scores achieved on the final essay.

Structure-based GOs may also prove superior to other expository reading strategies, as demonstrated by Troyer (1994) in a study of science reading and writing performance amongst fourth-, fifth-, and sixth- grade students. Participants in this study were randomly assigned to one of three instructional treatment programs: (1) a mental model strategy program utilizing a popular "think aloud" technique for deconstructing meaning in text, (2) a GO instruction program involving organizers specifically designed to match text structures, or (3) a traditional

instruction group in which students answered questions prior to reading passages. Text passages were identical for each treatment program and contained science content written to conform to description, sequence, and comparison text structures. On short-answer question posttests administered after each text structure segment of the programs, the GO group significantly outperformed the other two groups and demonstrated greater recall of the science facts presented in the passages. Differences among the three groups on a delayed posttest did not reach significance, but data indicated that students in the GO tended to perform better than students in the other two groups.

Results of work by Robinson and Kiewra (1995) are largely consistent with the findings of other structure-aligned GO studies. This research is particularly illuminating, as it constitutes one of the only studies to directly compare structure-aligned GOs to GOs that do not reflect text structure. In the first of two experiments, college students read a long (6,500 words) passage from a well-structured psychology text. A third of the students then read matrix GOs displaying comparison/contrast relationships in the text, another third read outlines (considered to be simple GOs) displaying hierarchical relationships but not the overall text structure, and another third re-read the text. Students were also randomly assigned to immediate or delayed testing conditions. On a test of factual recall, students who read only the text recalled greater numbers of less-relevant details, but there were no other significant effects. On a written measure of learning, however, students who read the matrix GOs included a greater number of compare/contrast propositions than students in either of the other two groups. In addition, results on a knowledge application test demonstrated that performance among students who read the matrices remained high across immediate and delayed testing, while students in the outline and text-only groups experienced a steep decline in performance. Students in the outline and GO groups indicated that

they did not have enough time to study the adjunct displays, which prompted methodological changes for a second experiment. During this next experiment, students were given an extra 15-minute review session after a one-day delay subsequent to the first exposure to the passage. Materials and measures were identical to those used in the first experiment. Students in the matrix GO group achieved the highest scores on the test of relevant (non-detail) facts and also included greater numbers of correctly stated hierarchical and coordinate (text structure) relationships on written measures than students in the other conditions. Unlike in the first experiment, students who read the GOs also had the highest scores on the knowledge application test.

Although further comparisons of structure-based and unstructured GOs are still needed, the collective results of the aforementioned GO studies are fairly consistent and highlight the importance of designing organizers that closely mirror the discourse structure of text.

Graphic Organizers and Cause/Effect Structure

Given the relative difficulty of comprehending text with a cause/effect discourse structure, it is likely that a structure-based GO would particularly benefit readers of this type of text. As McCrudden and his colleagues reason,

> The linear structure of text may discourage the comprehension of causal relationships because these types of relationships are often implicit, placing greater demand on a learner's cognitive resources. It would seem that increasing the explicitness of implicit causal relationships with a visual/spatial display would facilitate comprehension of causal relationships because a visual display communicates not only individual elements of information but also relationships among those elements of information. (McCrudden, Schraw, Lehman, & Poliquin, 2007, p. 369)

Though no research has focused on the use of cause/effect-specific GOs with young readers, two studies by McCrudden and his colleagues indicate that GOs effectively enhance

cause/effect text comprehension among older readers. The first of these studies (McCrudden, Schraw, Lehman, & Poliquin, 2007) involved the use of causal diagrams as text supports. Causal diagrams are specialized GOs that include arrows indicating the direction and scope of causal relationships. College students were given either a standard linear cause/effect science passage or the passage with corresponding causal diagrams. After reading and studying the passage, students answered questions regarding the main ideas and causal sequences of the text. Students also were measured on their recall of the facts in the overall causal chain. There were no differences in scores of main idea comprehension, but performance on the causal chain questions among students who read the GO was significantly higher than that of students who only read the text. In a follow-up experiment using the same materials and measures, students read either the linear passage or the GO (without the text). Performance on both measures was equivalent across the two groups, such that readers who studied only a GO demonstrated as great an understanding of passage content and text structure information as the readers of standard linear text. The authors argue that these results, though not demonstrating the superiority of GOs to linear text, do indicate that GOs may be successfully used in place of standard texts.

In another experiment, McCrudden, Schraw, and Lehman (2009) constructed causal outlines and diagrams to match a science passage with a long causal chain. Students were asked to read the text and then either re-read the entire passage, read the causal outline, or read the causal diagram. On a test of recall for the steps on the causal chain, the outline and GO groups included more steps than those who re-read the text. In a second replication of the experiment with another science text, students in the GO group surpassed students in both of the other groups. Similarly, students in the GO group achieved higher scores on a test requiring the application of causal principles toward a novel situation. On a third measure, which the

researchers termed a holistic causal comprehension test, students were asked to infer the relationships between distant steps on the causal chain. The GO and list groups both achieved higher scores on this measure than the text-only group.

The McCrudden, et al. studies highlight the possible benefits of using a GO to assist readers in deconstructing difficult cause/effect text. The authors repeatedly call for more research, however, particularly since little is known about the influence of GOs on comprehension of more complex causal structures (e.g. one cause followed by multiple effects).

Content Schemata: The Effects of Prior Knowledge

As has been shown, formal schemata allow readers to create mental frameworks for a text's discourse structures; equally essential are mental frameworks for the subject matter contained in those texts. A *content* schema is a subject matter framework, without which a reader may struggle to read "between and beyond the lines" (Gray, 1960) via the creation of inferences and the application of new textual information toward novel situations. Content schemata, also termed prior knowledge, background knowledge, or content familiarity, may be further divided into two categories: general knowledge and domain knowledge. General knowledge includes the information that readers gather through their interactions with the world during everyday experiences (Lauer, 2002; McNamara & Kintsch, 1996; Spires & Donley, 1998) while domain knowledge encompasses information about specific fields or content areas (e.g. the rules of soccer, the internal mechanics of the combustion engine, the habitat of the gray wolf) (Adams, Bell, & Perfetti, 1995; Alexander, 1995). Readers frequently encounter both categories of content schemata in the text they read, although expository texts are more typically focused on

domain-specific information that is unfamiliar to many readers (Best, Floyd, & McNamara, 2008).

Just as sensitivity to a text's structure has a positive influence on comprehension, familiarity with the content of a text has also been shown to improve recall (Caillies, Denhiere, & Jhean-Larose, 1999; Linderholm, et al., 2000; McNamara & Kintsch, 1996), the generation of accurate inferences (Best, Floyd, & McNamara, 2008; Pearson, Hansen, & Gordon, 1979) and the acquisition of new information (Chiesi, Spilich, & Voss, 1979). It is believed that a strong knowledge of content material allows a reader to mentally repair breaks in text cohesion and fill gaps in important relationships that may have been omitted in a text. The impact of such a knowledge base on comprehension is powerful; several studies have demonstrated that prior knowledge of text content may even compensate for poor overall reading ability (Adams, et al., 1995; Best, Floyd, & McNamara, 2008; Chiesi, Spilich, & Voss, 1979; O'Reilly & McNamara, 2001).

It should be noted that some researchers have argued that familiarity with content is highly correlated with a reader's interest in a topic (Alexander, Kulikowich, & Schulze, 1994; Garner & Gillingham, 1991; Tobias, 1994). However, Baldwin, Peleg-Bruckner, & McClintock (1985), found that prior knowledge had a strong influence on the reading comprehension of middle school students, even when the potentially confounding variable of topic interest was taken into account. After completing an interest inventory for ten pre-selected topic passages from an encyclopedia, students in this study answered multiple choice test items in order to determine their level of prior knowledge for each of the ten topics. For every student, the researchers selected test passages which matched four categories: (1) high level of prior knowledge and high level of topic interest, (2) low prior knowledge and low topic interest, (3)

high prior knowledge and low topic interest, and (4) low prior knowledge and high topic interest. Students then read their pre-selected four passages and answered comprehension questions. Though topic interest was found to have some influence on comprehension, prior knowledge influenced performance above and beyond topic interest (as predicted, scores were highest for the high prior knowledge and high interest passages).

Content Familiarity and Young Readers

Prior knowledge is an essential variable to examine when considering the reading comprehension of younger readers. As noted previously, young readers, especially those in the early grades, are frequently exposed to narrative texts. Narratives typically include topics and sequences that are familiar to children (i.e. general knowledge). Thus, children tend to have strong knowledge base for narrative content, which in turn leads to relatively strong comprehension. In comparison, expository texts often contain unfamiliar content. Without sufficient domain knowledge, children may struggle to create necessary inferences and recall textual information, such that overall comprehension consequently suffers.

The effects of content familiarity on young readers' expository text comprehension were illustrated in an influential study by Pearson, Hansen, & Gordon (1979). Second grade participants were first evaluated in terms of their prior knowledge of a specific topic domain (spiders). After the prior knowledge test, students read an expository passage about spiders and answered comprehension questions. Half of the questions referred to information that was explicitly stated in the text, while the other half required students to infer the answers. Analysis of the responses indicated that students with high levels of prior knowledge about spiders provided the greatest number of correct answers. Further analysis revealed that this difference

between high- and low-knowledge readers existed primarily for the inference questions. In a second experiment, the paragraphs and questions were modified such that previously implicit questions were now explicit, and vice versa. The trends shown in the first experiment held true for the second, leading the authors to conclude that prior knowledge influenced higher-level comprehension of text even after changes in text construction.

A study of three instructional approaches to text supports this conclusion. Dole, Valencia, Greer, and Wardrop (1991) measured elementary students' performance on short answer and multiple choice comprehension tests for both narrative and expository texts. Students received three types of instruction prior to the tests. In one type, researchers provided students with explicit instruction in the content that was presented in text (vocabulary, important concepts, and relationships between ideas) with the goal of creating a knowledge base before reading each passage. In the second type of instruction, termed the "interactive approach," the researcher initiated a discussion about the content of the text topics. The same information was covered as in the explicit instruction, but students were more actively involved. The third type was the control condition, in which students read the text and answered questions without any form of prior knowledge creation or activation. Though the research design did not allow for accurate interpretation of interaction effects, there was a clear main effect for treatment. Performance on comprehension questions was highest for student in the explicit teaching condition, followed by students in the interactive approach condition, who in turn performed better than students in the no instruction control. Based on these results, the authors posited that the provision of a knowledge base beforehand assisted students in understanding narrative and expository texts.

While the results of these studies underscore the influence of content familiarity on reading comprehension, additional work is needed. Research into the content familiarity effects among very young readers is especially sparse, meriting further investigations.

Interaction of Content Familiarity and Text Structure

The literature has shown that both the prior knowledge of a text's content and sensitivity to its structure are important factors in overall reading comprehension. It remains uncertain, however, whether these two factors interact. In 1990, Cathy Roller reviewed the existing body of literature involving text structure sensitivity and levels of content knowledge. Some of these studies directly examined the interaction between these two factors, while others focused on different variables and only indirectly touched upon text structure and content knowledge. All studies, however, supported the hypothesis that an interaction did indeed exist. Notably, it appeared that text structure was most useful to readers when they possessed only moderate levels of knowledge about the content they were reading. Roller called for further research into this matter and proposed that future studies manipulate both variables simultaneously. Since that time, a number of studies have shed new light upon the structure/knowledge interaction.

Most of this work has focused on older readers, presumably due to their higher levels of background knowledge and expertise as compared to younger readers. In one study, Voss and Silfies (1996) examined the relationship between text structure and prior knowledge among undergraduate students. Participants possessed varying levels of history knowledge and reading comprehension skill. All participants were asked to read standard and expanded versions of two fictitious historical texts. The expanded texts included sentences that explicitly stated the causal structure of the historical events, whereas the standard texts did not include these sentences.

Results on content comprehension questions and essays supported the Kintsch (1988) model of reading; that is, that comprehension skill (but not prior knowledge) was significantly correlated with text-based understanding (such as when reading the expanded text). Conversely, prior knowledge, rather than comprehension skill, was correlated with improved comprehension of the standard text in which causal relationships were not explicitly stated. These findings illustrate the possible influence of prior knowledge on higher-level comprehension (e.g. inferencing) as well as the likelihood of an interaction between text structure and content familiarity.

Kendeou and van den Broek (2007) also studied the prior knowledge/text structure interaction among undergraduates by measuring recall and comprehension of two versions of a science text. One version of the text followed a refutation structure, in which common misconceptions regarding Newton's laws were addressed, while the other version was simply a shortened section of a textbook. In their first experiment, Kendeou and van den Broek asked undergraduate students to think aloud while they read. Students then completed a written recall after reading the text. Readers with low prior knowledge (high levels of prior misconceptions) made fewer correct inferences during the think-aloud than readers with high prior knowledge for both the refutation and non-refutation structures. Low prior knowledge readers additionally demonstrated an increased number of think-aloud strategies, indicating their changing understanding of the content. Recall scores were lower for readers with less familiarity with the content. Researchers in the second experiment recorded reading times for each sentence of the passages. Results supported the authors' earlier assertions that an interaction exists between prior knowledge and text structure. As before, recall scores were significantly lower for readers with less prior knowledge. In addition, students with low prior knowledge read target domain-specific

sentences more slowly than those with high prior knowledge, but only in the passage with a refutation structure; again, this substantiates the possibility of a familiarity/structure interaction.

Acknowledging the relative difficulty of cause/effect text, as well as the frequent presence of multiple text structures in authentic expository works, Armand (2001) anticipated a familiarity/structure interaction across several text structure types. An expository passage with a primary cause/effect structure was modified to incorporate one of two additional text structures (collection or compare/contrast). Sixth-grade students were given a test of prior knowledge for the text content and were then divided into low- and high-knowledge groups. After reading the causal/collection or the causal/comparison text, students completed a comprehension test containing open-ended questions as well as closed questions in multiple choice and fill-in-the-blank formats. A main effect for prior knowledge was significant, but the main effect for text structure type was not. Nevertheless, the interaction between the factors was significant, such that students with high prior knowledge performed best with the more difficult causal/comparison text and students with low prior knowledge had higher scores after reading the easier causal/collection text.

Following in this vein, researchers have also examined the effects of text structure cohesion on reading comprehension and recall. Text cohesion is closely related to text structure: in a cohesive expository text, the relationships between concepts and ideas are made explicit, meaning that cohesive text is inherently well-structured. Improving the structure of text through causal and relational cohesion has been shown to increase comprehension levels in a number of studies (Beck, McKeown, Sinatra, & Loxterman, 1991; Lehman & Schraw, 2002; Linderholm, et al., 2000).

Studies of the relationship between cohesion and content familiarity have shown that the interaction between structure cohesion and familiarity may be quite complex. In some cases, it appears that a "reverse cohesion" effect may take place, in which students with higher knowledge levels actually perform *better* with less cohesive texts (McNamara & Kintsch, 1996). This counterintuitive finding is thought to occur because high knowledge readers are forced to more actively process less cohesive texts. To investigate this phenomenon further, O'Reilly and McNamara (2007) gave 143 college students either a high- or low-cohesion science text. The high-cohesion text had been altered to provide readers with more explicit explanations and structural support. Students also completed a content knowledge test in order to determine both their general and domain-specific knowledge levels. Students were then divided into high- and low-knowledge groups across a median score split on this test. Results indicated that the reverse cohesion effect appeared to be mediated by a third variable, overall comprehension skill. In this study, only readers who had demonstrated low comprehension skill while possessing high levels of prior knowledge demonstrated the reverse cohesion effect. In contrast, highly skilled, high-knowledge readers actually benefited from greater levels of cohesiveness. Furthermore, these findings only applied to text-based questions rather than inference questions. Overall results largely supported the presence of a structure/content familiarity interaction, though questions about the reverse cohesion effect remained.

Not all research involving content familiarity and text structure has revealed interactive effects. For example, Wylie and McGuinness (2004) initially hypothesized that text structure and levels of prior knowledge would both have compensatory effects on comprehension for students reading expository psychology passages. That is, they believed that highly structured texts would compensate for low prior knowledge and conversely, that higher levels of prior knowledge

would assist students when reading texts with low levels of structure. The researchers selected twenty excerpts from psychology textbooks to use as their passages, and then asked 120 readers to determine the main points of each passage. In addition, another set of twenty-seven readers rank ordered the passages according to a structure continuum. This continuum, ordered from least- to most-structured, was as follows: generalization, enumeration, classification, sequence, and compare/contrast. A total of 195 undergraduate psychology participants classified as either high or low prior knowledge were then given two of these passages to read (both of the same text structure type). Students were asked to write a recall immediately and then again two weeks after reading the passages. Recall was highest with high levels of structure and prior knowledge, but the expected interaction effect was not observed among low prior knowledge participants. Recall of the less-structured texts was equally poor among both the high- and low-prior knowledge students. The authors concluded that there is no significant interaction between text structure and prior knowledge.

Boscolo and Mason (2003) also predicted a compensatory interaction between text structure and knowledge levels, additionally speculating that topic interest plays a role in recall and comprehension. In this study, 160 high school students were classified into groups based on their measured levels of topic knowledge and topic interest. Students were then randomly assigned to read one of three possible versions of a text concerning the greenhouse effect. One version had very little structural cohesion, the second had increased "local" cohesion (relationships between concepts and across sentences was made explicit), and the third had increased local cohesion as well as topic headings. Students were asked to complete a causal diagram in order to demonstrate their understanding of the causal relationships in the text. In addition, students were given a written free recall task as well as open-ended inference and

problem-solving questions. Results showed no significant interaction between the structural cohesiveness of the text and prior knowledge. It is interesting to note that the data did show a positive trend in the quality of the causal diagrams for students who read the well-structured, cohesive texts. On other measures, the high knowledge (and high interest) group demonstrated superior results when reading the less-structured text, therefore demonstrating the reverse cohesion effect. In the diagram measure, however, the reverse cohesion effect vanished, such that high knowledge readers performed better on the diagram with the highest levels of text structure.

Additional research is needed before a conclusion may be drawn regarding the relationship between a text's structure and a reader's knowledge of that text's content. Research designs vary widely among the present studies in this field, as do the variables investigated and the measures used to assess comprehension and recall. Moreover, little has been done to determine whether a structure/familiarity interaction exists among younger readers, or how such an interaction would affect the comprehension of these readers.

Content Familiarity and Graphic Organizers

Graphic organizers are used as tools to build schema and enhance content knowledge (Dunston, 1992; Griffin & Tulbert, 1995; Robinson, 1998); to that end, most researchers have focused on learning outcomes rather than potential interactions between prior knowledge and GOs. Nonetheless, a small body of work offers some evidence that such an interaction may exist. In a study by Lambiotte and Dansereau (1992), college participants were measured on their recall of lecture material after reviewing one of three types of study supports: a GO, an outline, or a list. No overall differences in student recall were reported across the three types of supports.

However, more detailed analysis revealed a difference in performance among students with high prior knowledge of the lecture material and those for whom the material was unfamiliar. Students with low levels of prior knowledge benefited most from the GOs, while students with high prior knowledge performed best with the simple lists.

This same pattern of results was found in an additional study by Lambiotte, Skaggs, and Dansereau (1993), in which undergraduate students studying alone or in pairs were measured on their recall of an audio lecture on statistics. Students who had indicated high levels of prior knowledge and confidence about the material performed better after studying from lists, while students with lower levels of knowledge and confidence performed best after studying from GOs. The authors speculate that this type of interaction may reflect an "expertise reversal effect," similar to the reverse cohesion effect described in text structure studies (e.g. McNamara & Kintsch, 1996). That is, the explicit representation of information in GOs may paradoxically hamper deep processing of text content among readers with high levels of prior knowledge. Readers with less knowledge benefit from GOs, however, since they do not already have an explicit mental schema in place for the text material.

The expertise reversal effect did not hold true in a study by O'Donnell and Dansereau (2000), though an interaction between the factors was confirmed. In contrast to other instructional studies, the undergraduate participants themselves served as instructors in this study. All students were placed in teacher-student dyads, in which students took turns learning from and then teaching information from expository passages. Each student was randomly assigned to one of four groups: (1) learning from text and teaching with an outline, (2) learning from text and teaching with a GO, (3) learning from a GO and teaching from a GO, and (4), learning from a GO and teaching from an outline. Overall, students with high prior knowledge

performed best on a free recall when learning or teaching from a GO, while students with low levels of prior knowledge achieved the highest scores when learning from or teaching with the text. These results were in direct opposition with the interaction patterns found in the Lambiotte, et al. studies, despite similarities in the research designs, materials, and measures.

O'Donnell (1993) also examined prior knowledge and graphic organizer formats on comprehension at the undergraduate level, but did not find a significant interaction between these factors. O'Donnell created differences in prior knowledge in advance by exposing students to either a text-relevant audio lecture (high prior knowledge) or a lecture on an unrelated subject (low prior knowledge). After listening to the lectures, students either read a GO or an equivalent text. All students answered a battery of sentence completion questions, ranging in relative difficulty from simple questions with explicitly provided answers to difficult application questions and questions requiring inferences. Students who had listened to the relevant audio lecture, and therefore possessed the higher level of prior knowledge, made a significantly greater number of question attempts and answered more questions correctly than those who had listened to the unrelated lecture. Because the main effect of text format (GO or plain text) was only marginally significant, further analyses of interactions with text format were not carried out. Trends in the data pointed toward a potential interaction, however, as GOs were shown to be most beneficial for the text-explicit questions not requiring prior knowledge, while high prior knowledge levels were necessary for success in the inference questions.

All told, the limited inquiries into the relationship between content familiarity and GOs indicate that any interaction between these factors is complex and may be influenced by variables that have not yet been measured. Studies of this interaction among young readers are of particular use, since many young children are unfamiliar with the content presented in expository

text. It would be beneficial to more clearly understand how GOs may assist (or hinder) young readers as they strive to comprehend material for which they have no prior knowledge. Such an understanding has the potential to assist researchers and educators in the development of appropriate teaching strategies and textual supports.

Chapter III

METHOD

Purpose

The ability to comprehend text is one of the most important skills a child must acquire during the school years. Children in the early grades are typically quite familiar with narrative text but struggle with the transition to informational texts in the later grades (Chall, Jacobs, & Baldwin, 1990; Goldman & Rakestraw, 2000; Griffin & Tulbert, 1995).

Learning to utilize the structures inherent in expository text may help students to build connections between ideas and therefore improve comprehension. Studies have demonstrated that readers, including the very young, have the capacity to develop text structure sensitivity (Kintsch & van Dijk, 1978; Lauer, 2002; Pollini, 2009; van Dijk & Kintsch, 1983; Williams, Hall, & Lauer, 2004, Williams et al., 2007; Williams et al., 2009). In addition, the use of specific reading supports such as graphic organizers (GOs) has been shown to improve comprehension (Blachowicz & Ogle, 2001; Jiang & Grabe, 2007). Few researchers, however, have investigated structure sensitivity and GO use among primary-grade students (Griffin & Tulbert, 1995; Nesbit & Adesope, 2006).

To better understand how graphic organizers may support expository reading among these young readers, we investigated the effects of three factors (presence of graphic organizer, level of text structure complexity, and content familiarity) on text structure sensitivity, comprehension, and recall of cause/effect text.

Cause/effect text structure, which is frequently found in science and social studies passages, has been shown to be one of the most difficult structures to interpret (Armand, 2001;

Richgels, McGee, Lomax, & Sheard, 1987). This structure may be presented in a very simplistic form (e.g., one cause and one effect stated within a single sentence) or in a variety of more complex forms (e.g., one cause with multiple effects stated across several sentences). To date, no researchers have directly compared second-graders' comprehension across multiple levels of cause/effect complexity.

To address these gaps in prior research, the present study utilized a mixed factorial design to investigate the two between-subjects factors (graphic organizers and level of cause/effect structure complexity) and one within-subjects factor (content familiarity). Students were randomly assigned to either a graphic organizer condition or a control condition. Students in the graphic organizer condition read a cause/effect graphic organizer after reading a standard linear cause/effect passage, while students in the control condition re-read the linear passage. Half of the students read passages with a one cause-one effect text structure and half read passages with a more complex one cause-multiple effects structure. All students read a total of four passages with familiar content and four passages with unfamiliar content.

The primary hypotheses of interest in this study were as follows:

1) Second graders' text structure sensitivity and comprehension are higher when reading a GO than when re-reading text.
2) Students demonstrate greater text structure sensitivity when reading the less complex, one cause-one effect passages than when reading the more complex one cause-multiple effects passages.
3) Second graders' structure sensitivity is higher when reading familiar content as compared to when reading unfamiliar content.

In addition, interactions between these three factors (graphic organizers, cause/effect complexity, and content familiarity) were examined. Hypotheses regarding these interactions are listed below:

1) There is an interaction between the presence of a GO and the level of cause/effect structure. Students who read the one cause-one effect texts with a GO outperform those reading the one cause-multiple effects texts with a GO. In comparison to students reading GOs, scores are lower among students who re-read the text without a GO and these students experience a steeper decline in performance when reading the more difficult one cause-multiple effects structure.
2) There is an interaction between the presence of a GO and content familiarity. Students who read familiar content with the aid of a GO have higher scores than students reading unfamiliar content with a GO, who in turn have higher scores than both control groups.
3) There is no interaction between the presence of a GO and the level of cause/effect complexity, since the content of passages and GOs at both complexity levels is essentially the same.
4) No hypothesis was formulated regarding a possible interaction between the three primary factors: presence of a GO, content familiarity, and the level of cause/effect complexity. This is due to a lack of precedent among existing studies involving these factors.

Participants

A total of 80 second-grade students from four classrooms participated in this study. Data were collected during the second half of the school year in 2010 (n=28) and during the same time period in the 2011 school year (n=52). The same classrooms participated during both years (new

students participated the second year). All students were randomly assigned to one of four groups: graphic organizer absent/one cause-one effect, graphic organizer present/one cause-one effect, graphic organizer absent/one cause-multiple effects, or graphic organizer present/one cause-multiple effects.

The four classrooms are part of two elementary schools in a middle-income public school district in New Jersey. None of the students in this district qualify for free or reduced-rate lunches. Total enrollment in the school includes 90.5% Caucasian, 5.5% Asian, 2.5% Hispanic/Latino, and 1% African American students.

Materials

Passages

Sixteen expository passages were developed by the author (see Appendix A). Half of the passages included familiar content, defined as events, objects, and actions that second-graders are likely to encounter in their everyday lives (e.g. the effects of buying a new puppy). The other half of the passages included unfamiliar science content involving events, objects, and actions that second-graders do not typically encounter (e.g. the effects of a high metabolic rate among birds). This distinction between familiar and unfamiliar content followed the same criterion used in the earlier work of Lauer (2002) and Pollini (2009). As Pollini notes, it is possible that students may not have encountered the exact situations described in a passage with familiar content, but students should be able to easily imagine these situations, whereas it is more difficult to imagine the information presented in a passage with unfamiliar content.

To determine topics suitable for the unfamiliar content passages, the school and New Jersey state science curricula and standards were consulted. Any topics that were listed as subjects of study in kindergarten, first grade, or second grade in either the district- or state-level curriculum plans were eliminated as a possible passage topics. Two of the four passages were initially constructed with science topics not studied in school (the disappearance of honeybees and the effects of hurricanes). However, several teachers who rated these topics for familiarity (see "Passage Equivalency") indicated that the passage content might have been recognizable to some students. These two passages were subsequently eliminated. Two new topics were chosen (bird metabolism, lack of atmosphere on the moon) and teachers agreed these were likely to be highly unfamiliar to students in the district. The other two passage topics (properties of steel and weather on the tundra) were also rated as unfamiliar.

The familiar and unfamiliar passages were written at two different levels of cause/effect complexity. Both levels of causal complexity were modeled directly after the paragraph structures used in a previous study of cause/effect comprehension among second-grade students (Williams, Nubla-Kung, Pollini, Stafford, Garcia, & Snyder, 2007). At the simpler level of complexity (one cause-one effect), each passage was comprised of a paragraph with a main idea sentence, four structure sentences, and three non-structure detail sentences. The structure sentences in these passages were intact single cause/single effect sentences; it was these sentences that contained the important macrostructure information of the text. All causal sentences at this level were written with the cause followed by the effect. The detail sentences provided additional content but did not contribute to the overall cause/effect structure of the passage. Three of the four structure sentences were immediately followed by a detail sentence.

The more complex level of cause/effect text (one cause - multiple effects) involved the same essential content as the one cause-one effect level, but a more intricate causal structure. As in the one cause-one effect passages, each paragraph began with a main idea sentence. At this level, however, the second sentence included an overarching main cause that was connected to four separate effects. The first effect was presented in the same sentence as the cause. The other effects were presented as single sentences distributed alternately between detail sentences.

The following samples illustrate familiar content passages at each level of cause/effect complexity:

Figure 2: Familiar Passage Samples

Familiar Content: One cause-one effect level of complexity

Many things happened when Maria bought a new puppy. Maria bought a new puppy, so she felt very excited and happy. *The puppy had brown fur with white spots.* The puppy needed lots of supplies, so Maria had to go to the pet store. *She bought a soft dog bed made out of cotton.* The puppy needed exercise, so Maria walked the puppy after school. *They walked to the big dog park near the supermarket.* The puppy got sick, so Maria had to find a veterinarian to take care of him.

Familiar Content: One cause – multiple effects level of complexity

Many things happened when Maria bought a new puppy. Maria bought a new puppy, so she felt very excited and happy. *The puppy had long brown fur with white spots.* Maria had to go to the store and buy lots of dog supplies. *She bought a soft dog bed made out of cotton.* She had a new chore of walking the puppy after school. *They walked to the big dog park near the supermarket.* Maria had to find a veterinarian to take care of the puppy when he got sick.

Note: In the sample passages, structure sentences are underlined and detail sentences are italicized. Student copies did not contain underlines or italics.

Passages with unfamiliar content followed the same format, as seen in the examples below:

Figure 3: Unfamiliar Passage Samples

Unfamiliar Content: One cause-one effect level of complexity

The tundra is the coldest, driest place in the world. The tundra is very cold and dry, so the ground there is too frozen for trees to grow. *There is a tundra in Alaska.* The tundra weather is very cold, so only a few animals are able to live there. *One tundra animal is the gray wolf.* Tundra grass is always dry, so grass fires start often. *There was a big tundra fire three years ago.* It almost never rains on the tundra, so there is not much water to drink there.

Familiar Content: One cause – multiple effects level of complexity

The tundra is the coldest, driest place in the world. The tundra is very cold and dry, so the ground there is too dry and frozen for trees to grow. *There is a big tundra in Alaska.* Only a few animals are able to live in such cold, dry tundra weather. *One kind of animal that lives on the tundra is the gray wolf.* Fires start often on the dry tundra grass. *There was a big fire in Alaska three years ago.* There is not much water to drink on the tundra.

Passage Equivalency

To ensure that the cause-effect structures were both clear and comprehensible within each the passages, three adult readers read eight of the passages to be used in the study. Readers categorized these passages as including either a one cause-one effects or a one cause-multiple effects structure. Four of the passages included a one cause-one effect structure; their equivalent one cause-multiple effects passages were not used in this survey. The other four passages in the survey followed a one cause-multiple effects structure. Two of the readers sorted 100% of the passages into the intended structure type category; one reader sorted one of the passages into the opposite structure category but wrote a note indicating she felt unsure of her choice.

In addition, a total of 22 current and former primary-grade teachers were consulted in order to confirm that the passage content would be familiar (or unfamiliar) to second grade students. Teachers' levels of experience ranged from 1 to 37 years, with a mean of 14.5 years (SD = 12.48). Of these teachers, two taught within the participating district. Neither teacher was an actual participant in the study. Both of the teachers in the participating district were familiar with the reading and science curricula taught in the schools.

Seventeen of these 22 teachers (including the two in the district) read a series of one cause-one effect passages in a randomized order. After reading each passage, teachers were asked to rate the content as either familiar or unfamiliar for a second-grade audience. As noted previously, two of the passages intended as unfamiliar were rated by several of the teachers as familiar. These passages were eliminated and two additional unfamiliar content passages were written. The 17 teachers were asked to rate the new passages for familiarity, and all agreed that these new passages contained unfamiliar content. Five additional teachers were then asked to rate the one cause-multiple effects passages for familiarity; 100% of the ratings matched the intended familiarity type. In addition, these teachers compared the similarity of the content in the eight one cause-one effect passages to the content in the eight one cause-multiple effects passages. All passage pairs (both levels of cause/effect complexity) were rated for content similarity along a four-point scale (very dissimilar, somewhat dissimilar, somewhat similar, almost identical). All five teachers rated the content similarity as "almost identical" across all eight passage pairs (see Appendix B for a sample question from the content survey).

All passages followed the text constraints modeled in similar studies (e.g. Lauer, 2002; Nubla-Kung, 2008; Pollini, 2009; and Williams, et al., 2007). Specifically, the passages were developed to meet a second-grade level of readability (Spache, 1953) and each passage contained

eight sentences, including one main idea sentence, four structure-based sentences, and three non-structure detail sentences. As in previous studies, the length of the passages at both levels of structure complexity was approximately 90 words (range = 89 – 94 words; mean = 90.88). Because the content was kept equivalent across levels of cause/effect complexity, the length of the one cause-one effect passages (M = 92.00, SD = 1.31) was significantly greater than the length of the one cause-multiple effects passages (M = 89.75; SD = 1.04); $F(1,14) = 14.54$, $p < .05$. This difference in length was unavoidable, as the structure of the embedded one cause –one effect passages necessitated four causal clauses, whereas the one cause – multiple effects structure only required one main causal clause. There were no significant differences in passage length with respect to content familiarity, $F(1,14) = 1.57$, nor was there a significant interaction between content familiarity levels and structure complexity levels in terms of length $F(1,12) = 0.00$. Additionally, there were no differences in passage readability with respect to content familiarity, $F(1,14) = 0.37$, level of complexity, $F(1,14) = 2.00$, or the interaction of content familiarity and level of structure complexity, $F(1,12) = 0.00$ (see Appendix C).

All students in both the one cause-one effect and one cause-multiple effects conditions read a total of eight passages. Four of the passages (two with familiar content and two with unfamiliar content) were utilized for a comprehension questions measure, while the other four (two familiar and two unfamiliar) were utilized for a recall measure.

Graphic Organizers

Students who were randomly assigned to the graphic organizer group read a graphic organizer immediately after reading each passage. The GO was presented as a post-organizer, since prior research has shown that graphic organizers are typically more effective when they are

implemented after a text, as compared to before or during the reading of a passage (Griffin & Tulbert, 1995; Jiang & Grabe, 2007; Moore & Readance, 1984).

Several variations of cause/effect GOs exist; these range from herringbone analyzers to modified flow charts (horizontal or vertical), T-charts, and simple non-directional webs (see Figure 4 for examples of these types, each displaying a one cause-multiple effects structure). In the present study, a horizontal flow chart organizer was utilized, similar to those used in a previous study of cause/effect text comprehension among second-grade students (Williams, et al., 2007).

Because participants in the control group re-read each passage in its entirety (see Dowhower, 1987, for more information on repeated reading among second-graders), it was necessary to incorporate all passage text, including the main idea sentence and non-structure detail sentences, on the graphic organizer pages that were given to students in the GO group. This ensured that the text that students read in both groups was identical. All non-structure sentences were listed at the top of the page and the organizer component was presented below those sentences.

At the one cause-one effect level, students in the GO condition first read a standard linear passage and then read its corresponding GO. As shown in Figure 5, the GO was presented on a separate page, with the non-structure sentences listed first and the four cause/effect pairs displayed next as individual horizontal flow charts (one pair for each cause-effect sentence). Each student in this condition thus read a total of 8 passages and 8 corresponding GOs. Students in the control condition read each of the 8 passages twice and did not view the GOs.

Figure 4: Examples of Causal Graphic Organizers

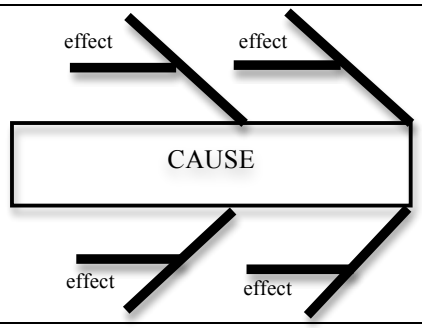
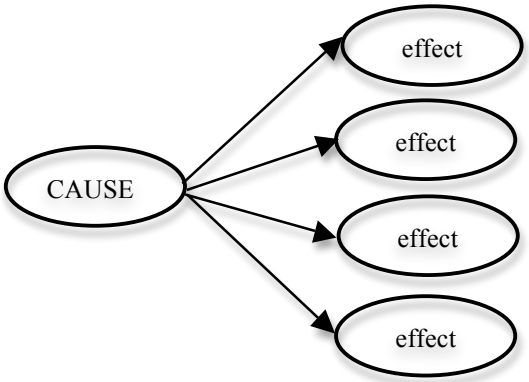
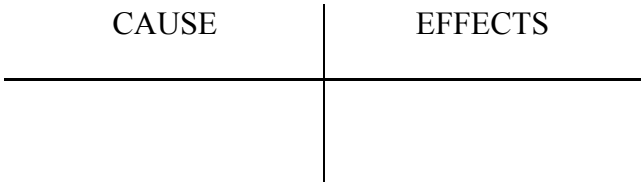
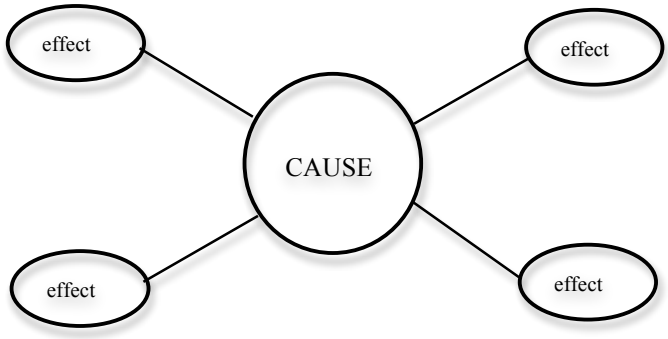
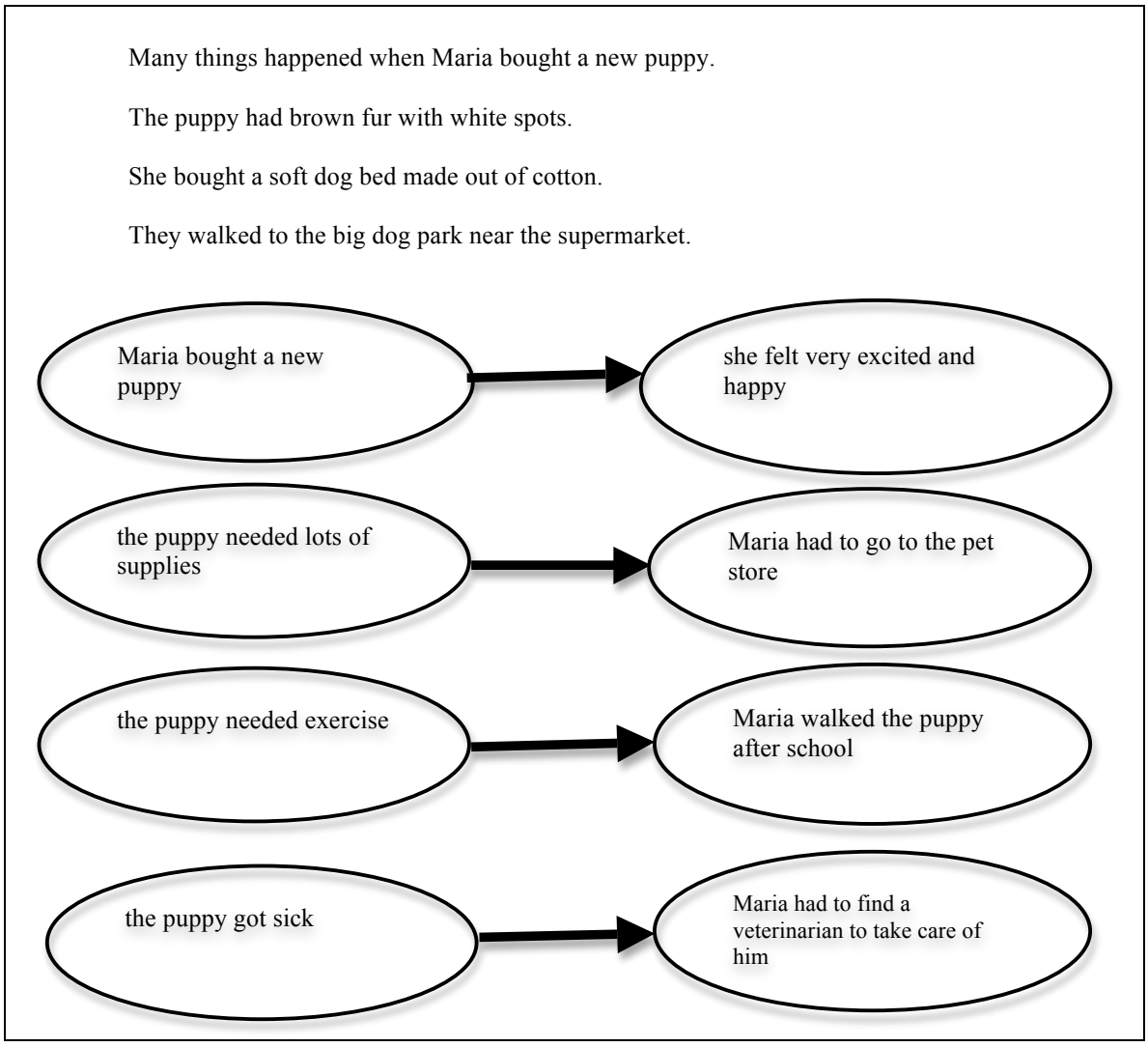
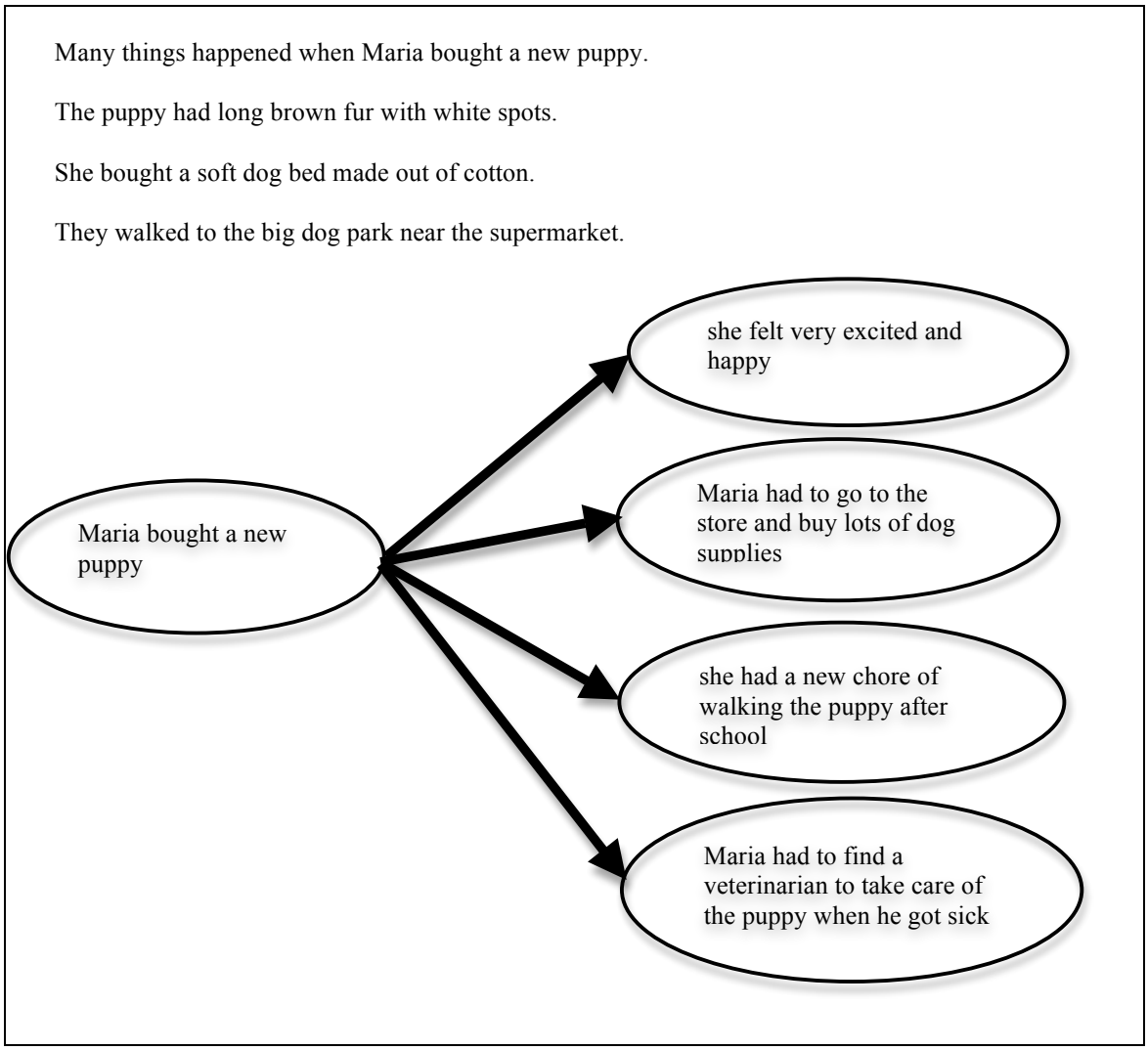
Herringbone Analyzer	
Flow Chart (horizontal)	
T-Chart	
Information Web	

Figure 5: Example of a One Cause-One Effect Graphic Organizer



At the one cause-multiple effects level, students in the GO condition also read a standard linear passage, followed by its corresponding GO on a separate page. As in the one cause-one effect GOs, the non-structure sentences were presented at the top of the page (see Figure 6). Underneath these sentences, students read a single horizontal flow chart displaying the overarching cause/effect structure .

Figure 6: Example of a One Cause-Multiple Effects Graphic Organizer



Student Familiarity with Graphic Organizers

Teachers in the participating district reported using graphic organizers regularly in classroom instruction; this was verified through inspection of curriculum materials. These GOs, however, were dissimilar to the GOs used in this study, primarily because the curriculum GOs did not address or reflect text structure. Nearly all of the GOs used in the curriculum were information webs, information charts such as K-W-L matrices (Ogle, 1986), or simple bulleted

lists. These types of GO formats list relevant text information but do not display the relationships between concepts nor the structure of text. Thus, while participating students were highly familiar with GOs in both reading and other content areas, it is unlikely they were exposed structure-based GOs on a regular basis, if at all.

Measures

So that we could examine text structure sensitivity, comprehension, and recall of the cause/effect texts, we asked participants to complete three tasks: (1) a structure comprehension questions task, (2) a non-structure comprehension questions task, and (3) a free recall task.

Comprehension Questions Tasks

Structure Comprehension Questions: The structure comprehension questions required students to use the text to identify the information in each sentence that corresponded to the overall causal structure. Although the structure questions were designed to assess sensitivity to cause/effect structure, it was felt that the questions themselves should incorporate generic language rather than specific terms such as *cause* or *effect.* The Williams, et al. (2007) cause/effect structure study followed this same protocol, since not all second-graders are necessarily familiar with causal terminology. Thus, a question asking students to identify a cause was framed as in this example: "Why did the children go swimming?" Similarly, effect identification questions began with the phrase "what happened?" (e.g. "What happened because it was a very hot day?"). Question type and causal order were balanced across familiar content and unfamiliar content passages.

Participants answered four structure comprehension questions about each passage at the one cause-one effect level of structure complexity. Two of the questions required students to identify the cause, following the same format as noted above. The other two questions required identification of the effect. The order of the cause and effect questions was balanced across all passages to ensure against possible order effects.

The one cause-multiple effects structure only contained one total cause, so only one cause-identification question was asked at that level (rather than four questions). Because this level contained four total effects related to the main cause, the effect question (e.g. "What happened because it was a hot day?") was followed by a prompt of "is there anything else?" a maximum of three times to provide students with the opportunity to respond with all four effects.

Non-structure Comprehension Questions. Participants answered three non-structure comprehension questions for each passage. These questions required students to identify information in the passage that was not related to the overall structure
(i.e. details). One example of a non-structure comprehension question is, "How long does it take for the moon to circle around the Earth?"

Students answered all structure and non-structure comprehension questions with the passage available, since this measure was intended to assess sensitivity to text structure rather than recall (see Appendix D for further examples of structure and non-structure questions used with one cause-one effect and one cause-one multiple effects passages).

Recall Task

Free Recall. After re-reading the passage or reading the GO, students were asked to provide an oral recall of the text after the following prompt: "*Tell me everything you remember*

about the paragraph you just read." Students were then given a second prompt after a 5-second delay in their recalls: "*Is there anything else you remember about what you just read?"* As in previous studies (e.g. Griffin, et al, 1991; Nubla-Kung, 2008; Williams, et al., 2007) students provided an oral rather than written recall, since large differences in writing ability often exist at this age level and have the potential to confound the results.

Procedure

Permission to recruit students was granted from the Institutional Review Board at Teachers College, Columbia University. The principal investigator held a series of meetings with the participating school district's superintendent, the assistant to the superintendent, the language arts supervisor, and all second-grade teachers. All members of the meetings agreed to authorize student recruitment for the present study. Parental and student consent was obtained for recruited students.

Students were randomly assigned to one of four conditions: (1) GO present, one cause-one effect level of cause/effect complexity; (2) GO absent, one cause-one effect level; (3) GO present, one cause-multiple effects level; or (4) GO absent, one cause-multiple effects level. We administered, as a group, the comprehension subtest of the Gates MacGinitie Reading Test (GMRT; Form S, 2000) to ensure that there were no differences in initial comprehension ability among the randomly assigned experimental groups.

Students read four passages in one session and an additional four passages in a second session. To control for possible order or fatigue effects, the order of the passages was randomized for each student; randomization was blocked by condition.

Each student met with the principal investigator or another researcher on three separate occasions (two individual sessions and one group session). The individual interviews took place during the school day in a quiet room outside of the classroom. Prior to beginning each session, the principal investigator told students that they would be reading and answering questions. All students were informed that these activities were not tests and did not carry grades. The researcher also explained that student responses would be typed on a laptop computer for future reference. With students who gave consent for audiotaping, the researcher demonstrated the use of a voice recorder for recording and preserving student responses. Because not all second-grade students are fluent readers, and because the primary focus of the present study is comprehension rather than decoding, the researcher read aloud all passages and graphic organizers. Similarly, all student *responses* were given orally to avoid potential confounds due to differences in writing ability. It should be noted that previous research has indicated that listening comprehension involves the same cognitive processes (Perfetti, Marron, & Flotz, 1996; Williams, et al., 2007) and patterns of brain activation (Buchweitz, Mason, Tomitch, & Just, 2009) as reading comprehension. By asking students to listen to the text while viewing the page, we examined these cognitive processes utilizing both modalities, with the goal of allowing students to demonstrate comprehension even if their beginning decoding and writing skills were not highly developed.

During the first session, students were shown a folder containing two familiar content and two unfamiliar content passages for the structure comprehension and non-structure comprehension questions tasks. All passages were counterbalanced to ensure there were no order effects. One of the researchers read aloud one passage at a time (students in both groups first viewed and listened to the same standard linear passage). After a pause of approximately five

seconds, students in the GO condition viewed the corresponding cause/effect GO and listened as the text in the GO was read aloud, while students in the control condition simply listened to the linear passage a second time. The researcher then read the structure and non-structure comprehension questions and recorded student responses. This process was repeated for all of the passages in the folder.

During the second session, the researcher followed the same procedure by reading aloud another two passages with familiar content and another two passages with unfamiliar content. After reading each passage and its corresponding GO (or re-reading the text) the researcher placed all materials out of the student's view and then read the recall prompts. Students were given stickers at the end of each session in recognition of their participation. Each session lasted approximately 20 minutes.

In the third and final session, the researcher administered the comprehension subtest of the GMRT (Form S, 2000) to all students with parental consent. The GMRT was administered as a group test under standard test conditions. This session lasted approximately 45 minutes.

Scoring of the Dependent Measures

Scoring guidelines for each measure were developed from a small sample of randomly selected test protocols (n = 9).

Structure Comprehension Questions Scoring

Responses for the structure comprehension questions were scored by awarding one point for each question answered correctly. At the one cause-one effect level of structure complexity

(for both control and GO groups), there were four structure comprehension questions for each of the four passages used for this measure, with a maximum possible score of 16 points across all four passages.

Because the causal organization of the passages at the one cause-multiple effects level was somewhat different (for both the control and the GO groups), there were only two structure questions at this level: a cause question and an effects question. The cause question for each passage contained one possible correct answer for a maximum score of one point. The effects question for each passage had four possible correct responses; these were based on the four effects contained in the paragraph. The total possible score for a single passage at this level was thus five points; across all four passages, the maximum possible score was 20 points (see Appendix E for comprehension question scoring guidelines).

The raw scores on the structure comprehension questions were converted to mean proportion correct scores by dividing the total raw score of number of responses by the maximum possible number of possible points for the passages. These proportion scores allowed for more meaningful interpretations of the data and comparisons across conditions, while still producing the same statistical results.

Non-Structure Comprehension Questions Scoring

Three non-structure comprehension questions were asked for each passage at both the one cause-one effect and one cause-multiple effects levels, for a total of 12 questions across all four passages. These questions were based on details not related to the overall structure of the text. One point was awarded for each correct response; students could therefore receive a maximum of 12 points for the four passages (see Appendix E).

As with the structure comprehension questions measure, raw scores on the non-structure questions were converted to mean proportion scores by dividing the number of correct responses by the maximum number of total points possible (12).

Recall Scoring: Structure Elements

The recall responses were scored for all structure elements that were correctly generated. Each of the four passages at the one cause-one effect level contained four causes and four effects; one point was awarded for each structure element correctly recalled. The maximum structure score for all four passages at this level was 32 points.

Each of the one cause-multiple effects passages contained one main cause and four effects, worth one point each, for a total of five possible points per passage. The total possible score across all four one cause-multiple effects passages was 20 points (full recall scoring guidelines are presented in Appendix F).

Once again, mean proportion scores were calculated by dividing the raw number of correct responses by the total number of possible points.

Recall Scoring: Non-Structure Elements

Non-structure elements in the recall task were also scored. At both the one cause-one effect and one cause-multiple effects levels, each passage contained three non-structure sentences. Correct non-structure responses were awarded one point each, for a maximum of 12 points across all four passages. Mean proportion scores were calculated as before, by dividing the number of correct responses by the total number of possible points (see Appendix F for scoring guidelines).

Inter-rater Reliability

The author and another researcher trained in text structure both scored 15% of the test protocols in order to achieve inter-rater reliability. Both scorers were provided with a scoring guide for all measures (see Appendices E and F). The percentage of agreement between scores was calculated and was found to be above 0.90 for all measures. The author then scored the remainder of the protocols.

Analysis

The design of this study included two between-subjects variables (graphic organizer and level of cause-effect structure complexity) and one within-subjects variable (content familiarity). A 2 (graphic organizer) x 2 (content familiarity) x 2 (level of structure complexity) repeated measures analysis of variance (ANOVA) was conducted for each measure (structure comprehension questions, non-structure comprehension questions, and recall). When an interaction was significant on these repeated measures ANOVAs, simple effects were examined.

Chapter IV

RESULTS

Participant Characteristics

To determine whether there were prior differences in age, gender, and reading comprehension among the four randomly assigned groups, analyses were carried out for each of these variables. In addition, the data collection year (2010 or 2011) was entered as a factor to determine whether there were differences in age or standard scores on the Gates-MacGinitie Reading Test across years.

A significant difference in age was found across years, $F(1,78) = 7.20$, $p < .05$. Although data were collected during the same time period in the school year, the mean age of students who participated in 2010 was 8.13 years (SD = 0.35) and was 7.92 years (SD = 0.35) in 2011 (see Tables 1a and 1b).

Table 1a

Participant Characteristics: Mean Age (and Standard Deviations) for Spring 2010 (n=28)

	Graphic Organizer Present		**Graphic Organizer Absent**	
	One Cause-One Effect level **Means (SD)** n = 7	**One Cause-Multiple Effects level** **Means (SD)** n = 7	**One Cause-One Effect level** **Means (SD)** n = 7	**One Cause-Multiple Effects level** **Means (SD)** n = 7
Age (years)	8.20 (0.41)	8.25 (0.30)	7.98 (0.26)	8.10 (0.42)

Table 1b

Participant Characteristics: Mean Age (and Standard Deviations) for Spring 2011 (N=52)

	Graphic Organizer Present		**Graphic Organizer Absent**	
	One Cause-One Effect level **Means (SD)** n = 13	**One Cause-Multiple Effects level** **Means (SD)** n = 13	**One Cause-One Effect level** **Means (SD)** n = 13	**One Cause-Multiple Effects level** **Means (SD)** n = 13
Age (years)	7.77 (0.37)	7.90 (0.32)	8.07 (0.32)	7.92 (0.36)

A Mann-Whitney U test was conducted to determine whether there was a difference in distribution of gender between 2010 and 2011. There was no significant difference, $p = .87$.

Additionally, there was no significant main effect of year on standard scores on the Gates-MacGinitie Reading Test (Form S, 2000), $F(1,72) = 0.47$, nor were there significant interactions on this measure between year and GO condition, $F(1, 72) = 0.03$ or year and level of structure complexity, $F(1, 72) = 1.15$. Therefore, gender and standard score data from both years were combined for analysis.

There were no differences in standard scores on the Gates-MacGinitie comprehension subtest (Form S, 2000) across graphic organizer groups, $F(1,76) = 0.19$ or structure complexity levels, $F(1,76) = 0.77$. A Chi-Square analysis of gender indicated no significant differences in gender distribution across all four groups, $\chi^2 (1, N = 80) = .05$, n.s. (see Table 2).

Table 2

Participant Characteristics: Means (and Standard Deviations) for Gates-MacGinitie Reading Test Scores and for Gender (n=80)

	Graphic Organizer Present				**Graphic Organizer Absent**			
	One Cause-One Effect level **Means (SD)** n = 20		**One Cause-Multiple Effects level** **Means (SD)** n = 20		**One Cause-One Effect level** **Means (SD)** n = 20		**One Cause-Multiple Effects level** **Means (SD)** n = 20	
Gates-MacGinitie Reading Test: Comprehension Subtest								
Standard Score	456.00 (34.12)		446.50 (35.80)		456.65 (32.61)		452.65 (35.43)	
Grade Equiv. Score	3.40 (1.65)		3.02 (1.17)		3.36 (1.51)		3.35 (1.69)	
Gender	**Male** 11	**Fem.** 9	**Male** 7	**Fem.** 13	**Male** 10	**Fem.** 10	**Male** 13	**Fem.** 7

Data Analysis

Dependent Variables

A total of four dependent variables were analyzed; these included (1) number of correct responses on structure comprehension questions, (2) number of correct responses on non-structure comprehension questions, (3) number of cause/effect structure clauses recalled, and (4) number of non-structure clauses recalled.

The mean scores of each participant were calculated for structure and non-structure questions variables across both the familiar and unfamiliar content passages. In addition, mean scores were calculated for the structure and non-structure recall variables. All scores were converted to mean proportion scores by dividing each score by the maximum possible number of correct responses for each variable. These proportion scores allowed for more meaningful interpretations of the data while still producing the same statistical results.

Year of Data Collection

Because data were collected across two years, the year of data collection was entered as a factor into the analyses of each dependent measure to determine whether significant differences occurred between each collection time period. In addition, each year was analyzed separately to compare overall patterns of results. Content familiarity approached but did not reach significance levels on the structure comprehension questions in Year 1, and level of structure complexity approached but did not reach significance in Year 2; otherwise, results followed the same patterns for each measure across both years. Full results are presented for both years in Appendix G.

Structure Comprehension Questions

After reading the passages, students answered questions requiring awareness of the text's cause/effect macrostructure. In order to avoid confounds with recall, the passages were available for reference during this task.

Year of data collection was entered into analysis to determine whether there were differences in structure comprehension question performance across collection periods (2010 and 2011). The main effect of year was not significant, $F(1,72) = 0.20$. In addition, there were no significant interactions between year and GO condition, $F(1,72) = 0.04$, year and level of structure complexity, $F(1,72) = 0.99$, or year and content familiarity, $F(1,72) = 1.25$. Given this, data from both years was combined for analysis; these results are presented below.

To allow for comparisons across levels of structure complexity, the mean proportion of correct structure responses was calculated for the sum of each of the two familiar and unfamiliar content passages, respectively. The total possible scores for each pair of passages (familiar and unfamiliar) at the one cause-one effect level was 8 points (16 points for all four passages). At the one cause-multiple effects level, the total possible score for each pair of passages was 10 points (20 points for all four passages). Means and standard deviations for these proportion scores are listed in Table 3.

There was a significant main effect for the presence of a GO, $F(1,76) = 138.78$, $p < .001$, Cohen's $d = 2.36$, such that students who read the GO after each passage ($M = 0.79$, $SD = 0.18$) correctly answered a greater number of structure questions than students who re-read each passage ($M = 0.34$, $SD = 0.20$). A main effect was also found for level of cause/effect complexity, $F(1,76) = 4.28$, $p < 0.05$, Cohen's $d = 0.31$. Students who read the one cause-effect

texts (M = 0.61, SD = 0.24) correctly answered a greater proportion of structure questions than those who read the one cause-multiple effects texts (M = 0.52, SD = 0.34). Additionally, there was a main effect for content familiarity, $F(1,76) = 5.63$, $p < .05$, Cohen's $d = 0.16$. When reading texts with familiar material (M = 0.59, SD = 0.29) students correctly answered a greater proportion of structure questions than when reading unfamiliar material (M = 0.54, SD = 0.33).

As illustrated in Figure 7, the interaction between the presence of a GO and the level of cause/effect complexity was significant, $F(1,76) = 12.53$, $p < .001$. Post-hoc analyses using Bonferroni adjusted alpha levels of .025 (.05/2) indicated that among students who read the GO, there was no significant difference in performance between those who read the one cause-one effect passages (M = 0.77, SD = 0.15) and those who read the one cause-multiple effects passages (M = 0.82, SD = 0.21), $F(1,39) = 0.97$. Among students who re-read the passage (without a GO), however, performance was significantly higher when reading the one cause-one effect passages (M = 0.45, SD = 0.20) than when reading the one cause-multiple effects passages (M = 0.23, SD = 0.12), $F(1,39) = 17.57$, $p < .001$.

An interaction between the presence of a GO and content familiarity was marginally significant, $F(1,76) = 3.76$, $p = .056$, as depicted in Figure 8. Post-hoc analyses of simple effects were again conducted with adjusted alpha levels of .025. Results indicated that students who read a GO performed equivalently when reading texts with familiar (M = 0.80, SD = 0.20) and unfamiliar (M = 0.79, SD = 0.20) content, $F(1,39) = 0.14$. In contrast, students in the re-reading condition demonstrated superior performance when reading familiar passages (M = 0.39, SD = 0.22) as compared to unfamiliar passages (M = 0.29, SD = 0.23), $p < .05$, $F(1,39) = 7.19$.

Interactions were not significant between level of cause/effect structure complexity and content familiarity, $F(1,76) = 1.21$, or among the three variables, $F(1,76) = 0.24$.

Table 3

Means and Standard Deviations for Proportion of Correct Structure Question Responses

	One Cause-One Effect Means (SD) (n = 40)		**One Cause-Multiple Effects Means (SD)** (n = 40)	
Graphic Organizer	Familiar Content	Unfamiliar Content	Familiar Content	Unfamiliar Content
GO Present (n = 40)	0.79 (0.16)	0.74 (0.20)	0.81 (0.23)	0.84 (0.20)
GO Absent (n = 40)	0.50 (0.19)	0.39 (0.27)	0.27 (0.15)	0.19 (0.13)

Figure 7

Interaction between Presence of Graphic Organizer and Level of Structure Complexity on Mean Proportions of Correct Responses on Structure Questions

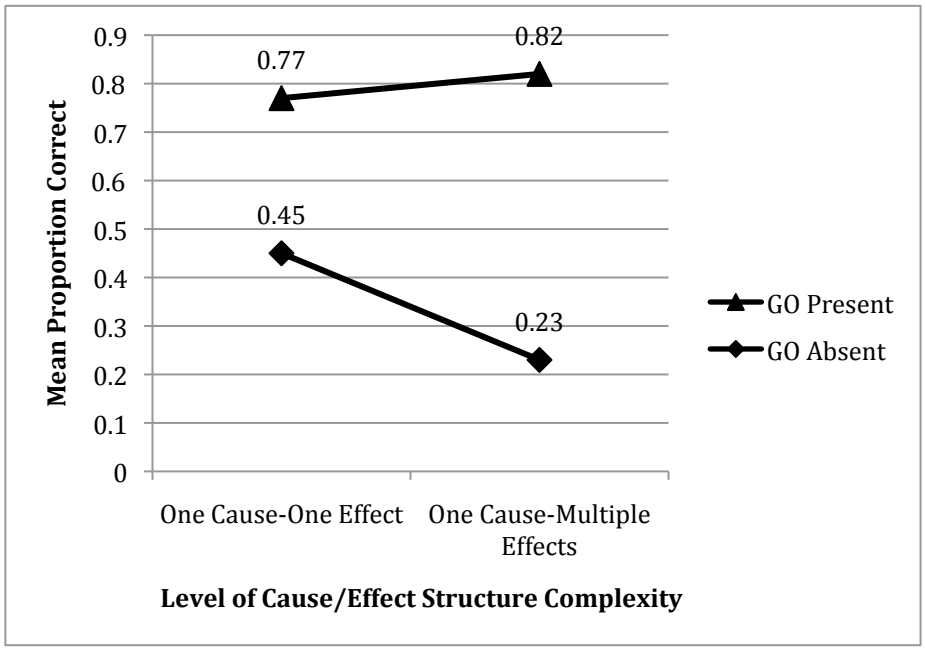
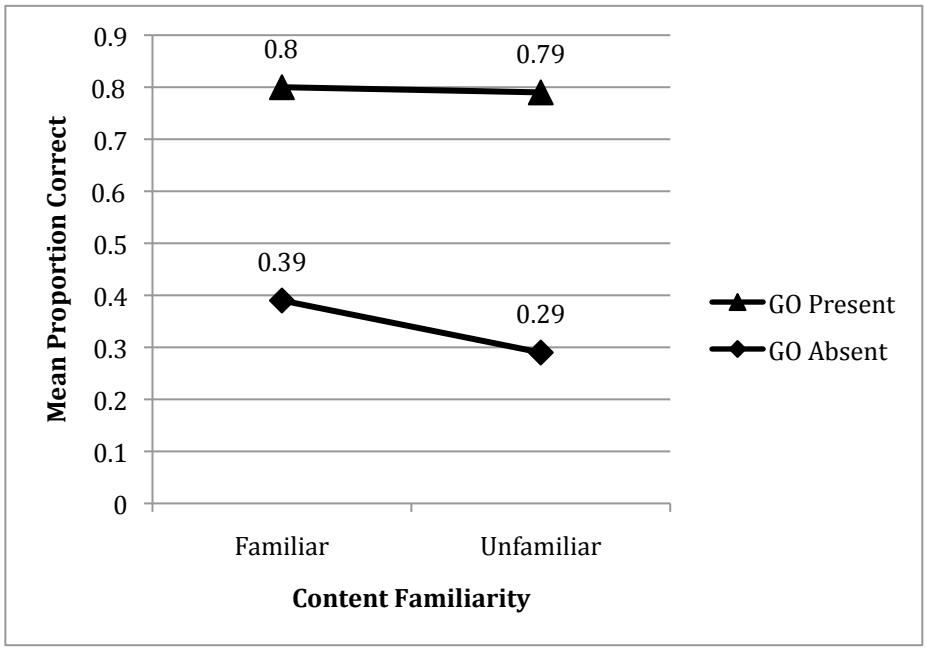


Fig. 8

Interaction between Presence of Graphic Organizer and Content Familiarity on Mean Proportions of Correct Responses on Structure Questions



Non-Structure Comprehension Questions

All text passages contained sentences with detail information not related to the text's overall macrostructure. After reading the passages, students answered non-structure questions regarding these details, again with the passage present. As before, a mean proportion score for correct answers was calculated for the pair of familiar passages and the pair of unfamiliar passages (with a total of 12 possible points across all four passages at both levels of cause/effect complexity). Table 4 lists means and standard deviations for scores on the non-structure questions.

Table 4

Means and Standard Deviations for Proportion of Correct Non-Structure Question Responses

	One Cause-One Effect Means (SD) (n = 40)		**One Cause-Multiple Effects Means (SD)** (n = 40)	
Graphic Organizer	Familiar Content	Unfamiliar Content	Familiar Content	Unfamiliar Content
GO Present (n = 40)	0.82 (0.21)	0.62 (0.31)	0.88 (0.14)	0.73 (0.21)
GO Absent (n = 40)	0.82 (0.24)	0.65 (0.24)	0.78 (0.14)	0.63 (0.23)

As before, year of data collection was entered as a factor into an initial analysis. No significant differences in non-structure question performance were found across years, $F(1,72) = 0.19$. In addition, there were no significant interactions between year and GO condition, $F(1,72) = 0.26$, year and level of structure complexity, $F(1,72) = 1.63$, or year and content familiarity, $F(1,72) = 0.01$. Given this, data for this measure for both years were combined for further analysis.

Results revealed a significant difference in performance on non-structure questions for familiar and unfamiliar passages, $F(1,76) = 37.83$, $p < .001$, Cohen's $d = .77$. Specifically, regardless of GO condition or level of cause/effect complexity, students achieved higher scores on familiar passages ($M = 0.82$, $SD = 0.19$) than on unfamiliar passages ($M = 0.65$, $SD = 0.25$). There were no significant effects for the presence of a GO, $F(1,76) = 1.00$ or for the level of cause/effect complexity, $F(1,76) = 0.36$. Similarly, there were no significant interactions between GO condition and level of cause/effect complexity, $F(1,76) = 1.97$; GO condition and content

familiarity, $F(1,76) = 0.09$; content familiarity and level of cause/effect complexity, $F(1,76) = 0.10$; or GO condition, content familiarity, and structure complexity, $F(1,76) = 0.10$.

Recall Measure

The recall measure was designed to assess students' memory for text structure elements and non-structure elements in the passages. Students received two passages with familiar content and two passages with unfamiliar content. Each student's recall responses for these passages were scored for the number of each element type correctly generated. Correct responses for structure elements included information central to the text's overall cause/effect macrostructure (i.e., a cause or an effect). Non-structure elements included details not relevant to the macrostructure. As in the comprehension question measures, these scores were converted to mean proportion scores.

Structure Elements

At the one cause-one effect level of structure complexity, there were a total of 32 possible structure elements (four causes and four effects per passage). Due to the differences in the overall structure at the one cause-multiple effects level, there was only one overarching cause and four possible effects per passage, and thus a total of 20 possible cause/effect elements for all four passages at this level. The mean proportion of correctly recalled structure elements was calculated by dividing the number of correctly recalled structure elements by the total number of possible structure elements for the passages at each respective level of structure complexity.

Means and standard deviations for mean proportions of recalled structure elements are illustrated in Table 5.

Table 5

Means and Standard Deviations for Proportion of Correctly Recalled Structure Elements

	One Cause-One Effect Means (SD) (n = 40)		**One Cause-Multiple Effects Means (SD)** (n = 40)	
Graphic Organizer	Familiar Content	Unfamiliar Content	Familiar Content	Unfamiliar Content
GO Present (n = 40)	0.53 (0.18)	0.38 (0.18)	0.58 (0.15)	0.42 (0.15)
GO Absent (n = 40)	0.33 (0.17)	0.18 (0.11)	0.33 (0.16)	0.17 (0.15)

No significant main effect of year was found for this measure, $F(1,72) = 1.34$, nor for interactions between year and GO condition, $F(1,72) = 0.35$, year and level of structure complexity, $F(1,72) = 2.40$, or year and content familiarity, $F(1,72) = 1.18$. As in the structure and non-structure comprehension measures, data were combined from both years for analysis.

A main effect for GO condition was found, $F(1,76) = 51.59$, $p < .001$, Cohen's $d = 1.57$. Students who read a GO after a passage (M = 0.47, SD = 0.15) recalled more structure elements than students who re-read the standard linear passage (M = 0.25, SD = 0.13) irrespective of the familiarity of the content or the level of cause/effect complexity. There was no

significant effect of structure complexity on recall of structure elements, $F(1,76) = 0.11$. However, a significant effect was found for content familiarity, $F(1,76) = 80.77$, $p < .001$, Cohen's $d = 0.84$. When reading passages with familiar content, students demonstrated greater recall of structure elements ($M = 0.44$, $SD = 0.20$) than when reading passages with unfamiliar content ($M = 0.28$, $SD = 0.18$).

Contrary to the hypotheses, there were no significant interactions for GO condition and level of cause/effect complexity, $F(1,76) = 0.80$, GO condition and content familiarity, $F(1,76) = 0.02$, or content familiarity and level of structure complexity, $F(1,76) = 0.03$. Similarly, the interaction among all three factors was not significant, $F(1,76) = 0.02$.

Non-Structure Elements

The total number of correctly recalled non-structure text elements (i.e. factual details not related to the cause/effect structure) was tallied for each passage. Three non-structure detail sentences were present in each of the four texts, for a total of 12 possible details at both the one cause-one effect and one cause-multiple effects levels. Mean proportions of correctly recalled non-structure elements were calculated; means and standard deviations are reported in Table 6.

Year of data collection did not significantly influence recall of non-structure elements, $F(1,72) = 0.46$. In addition, interactions were not significant between year and GO condition, $F(1,72) = 0.02$, year and level of structure complexity, $F(1,72) = 2.31$, or year and content familiarity, $F(1,72) = 0.77$. Data from both years were consequently combined for analysis.

Recall of non-structure elements was equivalent across all between-subjects conditions. There were no significant main effects for GO condition, $F(1,76) = 0.08$, level of cause/effect structure complexity, $F(1,76) = 0.13$, or content familiarity, $F(1,76) = 0.40$. Additionally, there

were no significant interactions for GO condition and level of structure complexity, $F(1,76) = 0.20$, GO condition and content familiarity, $F(1,76) = 1.12$, level of structure complexity and content familiarity, $F(1,76) = 0.84$, or all three factors, $F(1,76) = 0.84$.

Table 6

Means and Standard Deviations for Proportion of Correctly Recalled Non-Structure Elements

	One cause-one effect Means (SD) (n = 40)		**One cause-multiple effects Means (SD)** (n = 40)	
Graphic Organizer	Familiar Content	Unfamiliar Content	Familiar Content	Unfamiliar Content
GO Present (n = 40)	0.37 (0.27)	0.42 (0.21)	0.33 (0.22)	0.38 (0.30)
GO Absent (n = 40)	0.42 (0.30)	0.35 (0.28)	0.37 (0.27)	0.41 (0.25)

Summary of Results

The results presented here suggest that GOs may indeed increase sensitivity to text structure. Students in this study who read a cause/effect GO after reading its corresponding linear text passage achieved significantly higher scores on structure-related comprehension questions than those who simply re-read the passage. More specifically, students who viewed GOs were able to correctly identify a greater number of causes and effects in each passage in comparison to students who re-read each passage. In addition, students who read the GOs recollected a

significantly greater number of structure elements (i.e. causes and effects) on the recall measure as compared to students in the control condition. The results also suggest that the relative complexity of a causal structure, as well as the familiarity of the content, may influence structure sensitivity and comprehension.

Chapter V

DISCUSSION

The purpose of the present study was to investigate the relationships between three factors in accounting for expository reading comprehension skill in typically developing second-graders: (1) the presence or absence of a graphic organizer (GO), (2) the relative difficulty of a cause/effect text structure, and (3) the familiarity of content in text. These factors were examined in relation to their effects on the text structure sensitivity and comprehension and recall of second grade students. Comprehension questions and free oral recalls were used to explore these effects; these measures assessed understanding and memory of both structure and non-structure elements of test passages.

Graphic Organizers: Structure and Non-Structure Comprehension Questions

Of the various research questions addressed in this study, perhaps the most fundamental question is whether the act of reading a simple GO can improve young readers' sensitivity to the structure of text. As discussed previously, text structure serves as the framework upon which ideas are connected; for novice readers, the ability to access such a framework may be especially beneficial given the relative inexperience these readers may have with both the reading process and the information presented in text (Williams, 2005). A GO may provide such access by explicitly delineating the relationships between concepts in text.

Using GOs When Answering Structure Comprehension Questions

Student performance on the structure comprehension questions measure of the present study suggests that GOs improved second-graders' sensitivity to causal text structure. Students who read a cause/effect GO after reading its corresponding linear passage achieved significantly higher scores on structure comprehension questions than those who simply re-read the passage. The differences between groups on this measure were striking: overall, students who read a GO answered approximately 80% of the comprehension questions correctly, while students who re-read the text correctly answered less than 40% of the questions.

The significant interactions found for this measure further emphasize the differences in performance between these groups. Students in the control condition who read only the linear text demonstrated a decline in performance when reading the more complex one cause-multiple effects passages. In contrast, students who read GOs did not experience such a decline; these students achieved comparable results when reading either one cause-one effect passages or one cause-multiple effects passages. A similar pattern was found when examining the organizer/content familiarity interaction: namely, the scores of students who re-read the linear passages declined when passages contained unfamiliar content. Students who read GOs maintained a relatively high level of performance when reading familiar and unfamiliar passages. These results indicate that GOs may improve young readers' understanding of both simple and complex causal relationships in texts, including texts that describe concepts which readers have not previously encountered.

The disparity in structure question performance between students in the control and GO conditions may have occurred for a number of reasons. First, it is possible the students in the control condition may have simply forgotten the causal relationships in the text due to distance

between causal concepts. If true, this effect should have consequently been more pronounced in the one cause-multiple effects condition, as the effect elements in these passages were listed progressively further from the cause. Such an effect was indeed observed, as demonstrated by the relatively low performance of students in the control condition who read the more complex one cause-multiple effects texts. Researchers have speculated that this distance between text structure elements leads to breakdowns in structure sensitivity and comprehension, likely due to constraints on working memory (Larkin & Simon, 1987; Linderholm, et al., 2000; Robinson, 1998). As students progressed through text, particularly in the one cause-main effects condition, it may have become more difficult for them to recall the initial main cause, or even to recognize that each of the effects was somehow related to that cause. The GOs reduced conceptual distance by visually and spatially connecting causes and effects. Therefore, students who viewed the GOs may not have been subject to the same memory or processing constraints.

Another related explanation may also account for the differences in scores between the control and GO conditions. The visual nature of the GOs, in addition to eliminating conceptual distance, may have served to attract attention to the structure of the text. To examine this possibility further, it is important to consider the testing circumstances in the present study. When answering comprehension questions, students had the passages (or GOs) available for reference at all times during the task. The questions themselves did not require inferences; rather, the answers were explicitly stated within the text. Why, then, did students in the control condition (but not the GO condition) experience difficulty when answering the structure comprehension questions, given that the text could be accessed at any time?

Other research with primary-grade students suggests that this finding may not be unusual. In discussing the strategies young students use to answer comprehension questions, Calkins,

Montgomery, and Santman (1999) state that "many children are much more likely to turn to their own memories or experiences than to the hard-to-understand text for their answers" (para. 2). Results of a study by Nicholson and Imlach (1981) support this view. In this study, students who were asked to answer cause/effect questions after reading narrative stories did not reliably turn to the text (a behavior termed a *lookback*) to answer the questions, even when the causal structure was highly explicit. Instead, students often gave answers based on what they believed was plausible, even when the text explicitly stated otherwise. Brandão and Oakhill (2005) also studied the reading lookback behavior of primary grade students who were asked to answer comprehension questions. Although these students did occasionally use textual information to answer the questions, they, too, often ignored the text and instead formulated answers based on their prior knowledge of the text topic. Studies comparing lookback behavior among younger and older readers have generally found that younger readers are less likely than older readers to refer to text when answering questions or looking for forgotten information (e.g. Garner & Alexander, 1982; Garner & Reis, 1981; Hare, 1981). Similarly, Garner and Reis (1981) demonstrated that students with poor comprehension ability look back to text with less frequency than students who are highly skilled in comprehension. Moreover, they found that only the oldest students with the best overall comprehension skills demonstrated enough metacognitive awareness to "know when they didn't know."

Interestingly, Winograd and colleagues (1984) posited that lookback behavior, as a metacognitive strategy, may have some relation to a reader's text structure sensitivity:

> We can speculate, then, that one of the factors that may lead to the ineffective use of lookbacks is poor readers' difficulty in organizing the elements in a text into a coherent structure. Without such a coherent structure to guide the search for the correct information, poor comprehenders may be more easily distracted by irrelevant information. (p. 9).

In the present study, the structure comprehension questions explicitly required second grade students to find elements of the cause/effect structure. Given the young age of these students, it seems likely that they, too, experienced difficulty in mentally organizing the elements of the text into a coherent cause/effect structure. Without a support strategy to highlight this structure, and without having learned to identify structure independently, students in the control condition may have simply avoided looking back to the text for reference.

Conversely, the visual and spatial nature of the GOs may have encouraged students in the GO condition to look back to the text for content and structure information. Work by Alvermann (1988) supports this notion; in fact, the graphic organizers used by Alvermann were designed for the specific purpose of inducing students to look back at the text when answering comprehension questions. In this study, Alvermann studied the comprehension performance and lookback behavior of tenth-grade students with either low or high standardized comprehension scores. Students in a control group read standard social studies passages, while students in the treatment group additionally read structure-aligned GOs. As in the present study, students in both groups were allowed to refer to their materials when answering comprehension questions. Alvermann found that students who were low comprehenders achieved higher scores and looked back at the text more often when using the GOs.

To further understand how GOs may influence the lookback behavior and structure sensitivity of young readers, future researchers may wish to replicate the present study while recording text lookbacks. Such a study might also include an additional support strategy, such as a bulleted outline, to help determine which features of a graphic textual support prove most useful for early readers.

GOs and Non-Structure Comprehension Questions

There were no significant differences in scores on questions not related to the text's structure (non-structure comprehension questions). On this measure, students in the control group and the GO group performed equally well. Other studies of structure sensitivity have shown similar results for questions of this type (Armbruster, et al., 1987; Lauer, 2002; Pollini, 2009; Williams, et al., 2007).

Although the design of the GOs in this study visually highlighted the cause/effect relationships in the text, the non-structure details were also available to students in the GO condition when answering comprehension questions. Thus, the design of these GOs did not prevent students in the GO condition from accessing the information provided in the non-structure details of the passages. This is an important consideration, since these sorts of non-structure sentences in expository text sometimes contain relevant or interesting facts related to the topic, some of which teachers may wish their students to learn.

Graphic Organizers: Recall of Structure and Non-Structure Elements

In textbooks and professional development materials, prospective and practicing teachers are urged to use GOs as a means to improve recall of textual information (Banikowski, 1999; Drapeau, 2008; Housel, 2008; Temple, Ogle, Crawford, & Freppon, 2011; Vacca, et al. 2012). In examining the current body of GO research involving reading comprehension, the National Reading Panel (2000) found evidence to support this recommendation, noting that "the main effect of graphic organizers appears to be on the improvement of the reader's memory for the content that has been read" (p. 45).

Indeed, much of the empirical GO research involving recall has shown that GOs tend to facilitate text recollection. For example, the early GO study by Alvermann (1981) demonstrated that tenth grade students could more accurately remember descriptive text both immediately and after a delay period of one week, provided the students read a GO after reading a passage. Similarly, sixth-graders who learned to construct GOs in a training program by Berkowitz (1986) demonstrated superior immediate and delayed recall of expository text as compared to students who answered study questions or re-read text. However, these and other GO studies (e.g. Alvermann & Boothby, 1986; Ritchie & Volkl, 2000; Robinson & Schraw, 1994), have almost exclusively focused on students in the later school years and beyond.

The results of the present study suggest that GOs may also facilitate retention amongst young, novice readers. Although levels of recall among all groups were rather low, differences emerged between students who re-read the linear text and students who read a supporting GO. Students who read a GO recalled a greater proportion of the elements that formed the passages' causal structure. Moreover, this improvement in recall persisted even when students read the more complex one cause-multiple effects passages.

Graphic organizers may facilitate memory for a number of reasons, but some have posited that one of the most salient of these reasons relates to text structure. According to the "internal connections" theory (Kiewra, et al., 1998; Robinson, 1998), readers who view structure-based GOs are better able to recall concepts in text because the GOs display the connections between these concepts. Later, as readers recall one concept, they are led to remember another related concept by recalling the visual links in a GO. The results of the present study provide some support for this view, particularly since students in the GO condition

demonstrated significantly higher levels of recall for the causal structure (but not the non-structure elements) of the passages.

Further Comments Regarding GOs

In sum, the results of this study indicate that GOs may assist students by increasing structure sensitivity as well as recall of structural elements. Each GO used in the study contained content that was identical to that in the standard linear passage; the only difference between a passage and its GO was the visual and spatial arrangement of the causal structure. Thus, it is likely that it was this visual/spatial display that served to increase both awareness and memory for the cause/effect text structure.

The findings of the present study also lend credence to earlier recommendations regarding the design of GOs; namely, that a well-designed organizer should closely reflect the discourse structure of the text upon which it is based (Griffin & Tulbert, 1995; Jiang & Grabe, 2007). Unlike earlier GO studies in which the GOs did not mirror the text's structure (e.g. Bean, Singer, Sorter, & Frazee, 1986; Simmons, Griffin, & Kameenui, 1988) the organizers in the present study explicitly illustrated the exact cause/effect macrostructures of the sample texts. This transparent representation of the causal relationships in the GOs may have assisted students as they searched for the necessary information to answer the structure questions. To understand further the facilitative effects of structured GOs as compared to unstructured GOs, future researchers may wish to replicate the present study with an additional GO group in which students view GOs that do not closely parallel the text's structure.

It should be noted that the effect sizes for the graphic organizer factor in the structure comprehension questions measure (Cohen's $d = 2.36$) and structure recall measure (Cohen's d

= 1.57) were higher than those found in other studies utilizing GOs. Horton, et al. (1993), for example, found a mean effect size of 0.59 for teacher-prepared concept maps; the GO study by Griffin, Simmons, and Kameenui (1991) found a similar effect size (0.54). However, other researchers have cautioned against comparing effect sizes among GO studies, primarily due to difference in GO designs. In a meta-analysis of GO research, Kim, Vaughn, Wanzek, and Wei (2004) found that effect sizes ranged from 0.50 to 1.69. They, along with others, have suggested that higher effect sizes may emerge when structure-based GOs are used, as compared to less- or non-structured GOs such as lists or information webs. The effect size for the GO factor in a study by DiCecco and Gleason (2002), for instance, was a relatively high 0.97; students in this study utilized GOs which reflected the structural relationships between concepts in text. To determine whether the effect sizes found in the present study are representative of structured GO use, particularly among early readers, additional GO research with structure-based organizers is needed.

Level of Structure Complexity: Structure and Non-Structure Comprehension Questions

Level of Structure Complexity and Structure Comprehension Questions

Analysis of performance on the structure questions task revealed a significant main effect for level of cause/effect complexity. Students who read the one cause-one effect passages achieved significantly higher scores than students who read the one cause-multiple effects passages. The content of both passage types was essentially the same; however, the one cause-one effect passages included sentences in which a cause was directly followed by a corresponding effect. In contrast, the more complex one cause-multiple effects passage contained

one primary cause followed by four corresponding effects, three of which did not directly follow the cause. This one cause-multiple effects passage thus introduced semantic distance between the cause and its effects.

The results of this study support the findings of earlier work with cause/effect text, in which it was shown that semantic distance may prevent students from identifying the overall organization of a more complex cause-effect structure (Linderholm, et al., 2000; St. George, Mannes, & Hoffman, 1997). These earlier studies focused exclusively on older readers and longer passages; the present study suggests that younger readers experience difficulty with complex causal structures even in relatively short passages, particularly when a support strategy is not provided.

Level of Structure Complexity and Non-Structure Comprehension Questions

As anticipated, there was no significant effect of level of structure complexity on non-structure comprehension question performance. The non-structure sentences were essentially the same at both the one cause-one effect and one cause-multiple effects levels; thus, this factor should not have influenced results in any way.

Level of Structure Complexity: Recall of Structure and Non-Structure Elements

The level of structure complexity in the texts did not appear to influence recall of either structure or non-structure elements. It was expected that recall would decline somewhat when students read the one cause-multiple effects passages; however, this trend was not seen in the data. The present study explored only two levels of structure complexity. Additional studies with

other variants of causal structure (e.g. multiple causes and one effect, or causal chains) would provide a broader picture of the influence this factor may have on recall.

Content Familiarity: Structure and Non-Structure Comprehension Questions

When presented with expository text, students are typically expected to learn the content of that text. Much of this content may be unfamiliar, particularly when the purpose of the expository text is to teach new academic concepts. However, comprehending unfamiliar content has proven a formidable task even among older or more experienced readers (Best, Floyd, & McNamara, 2008; Caillies, Denhiere, & Jhean-Larose, 1999; Linderholm et al., 2000; Reutzel & Cooter, 2012). Among very young readers, familiarity with content may play an even larger role (Dole, Valencia, Greer, & Wardrop, 1991; Pearson, Hansen, & Gordon, 1979). Content familiarity and text structure may be closely interconnected factors. To learn unfamiliar content, a reader must be able to understand the relationships between concepts; text structure may provide the key to such learning.

Within the present study, familiarity with content significantly influenced performance on both the structure and non-structure comprehension questions. Students achieved higher scores when answering structure- and non-structure-based questions about familiar content (e.g., a hot day outside) than they did when answering similar questions about unfamiliar content (e.g., the properties of steel). These results support earlier work demonstrating that familiarity with content improves text comprehension among younger and older readers alike (Best, Floyd, & McNamara, 2008; Caillies, Denhiere, & Jhean-Larose, 1999; Chiesi, Spilich, & Voss, 1979; O'Reilly & McNamara, 2001; Pearson, Hansen, & Gordon, 1979).

Examined together, the relative effect sizes for each type of question may offer additional, though indirect, insight into the relationship between content familiarity and text structure. As noted previously, some evidence suggests that the effects of content familiarity on comprehension may be influenced by text structure. The nature of this relationship remains unclear; some speculate that an interaction between these factors, if it exists, may be task-dependent (Armand, 2001; Boscolo & Maxon, 2003; Pollini, 2009; Roller, 1990) and may vary according to reading ability (McGee, 1982; Meyer, Brandt, & Bluth, 1980) and age (Armand, 2001; Englert & Hiebert, 1984; Hiebert, Englert, & Brennan, 1983).

The results of the current study suggest the existence of such a familiarity/structure interaction, even among very young readers. Although students demonstrated improved scores with structure questions about familiar content, the effect size for this measure was relatively small (Cohen's $d = 0.16$). In contrast, the effect size for content familiarity was larger (Cohen's $d = 0.77$) for the non-structure comprehension questions. Perhaps this discrepancy is due to some level of implicit text structure sensitivity, which then allowed students to compensate somewhat for their relative lack of prior knowledge for the passage topics. When answering questions about sentences that did not relate to the text's structure, this compensatory mechanism was removed, which may explain students' greater difficulty in answering non-structure questions about unfamiliar content as compared to familiar content.

This pattern of results closely fits Roller's (1990) predicted relationship between content familiarity and text structure. She, too, speculated that structural cues in text may assist readers in comprehending unfamiliar text, since the structure renders the relationships between unfamiliar concepts more explicit and thus provides a scaffold for understanding. Conversely, the structural cues may be superfluous when text concepts are highly familiar, since readers are

already familiar with how those concepts interconnect. A small number of studies involving text structure strategy instruction (Taylor & Beach, 1984) and text manipulation (Birkmire, 1985; Post & Voss, 1981, as cited in Voss & Bisanz, 1985) have provided empirical evidence in support of this interpretation of the structure/familiarity interaction; the results on the comprehension question measure of the present study are somewhat aligned with these earlier findings. To explore this possible interaction further, subsequent researchers may wish to examine the effects of comparable familiar and unfamiliar passages that are either entirely structured (e.g. each sentence or proposition contributes to the causal structure) or entirely unstructured (e.g. each sentence contains relevant content but does not fit within an overall causal structure).

Content Familiarity: Recall of Structure and Non-Structure Elements

A different pattern of results was found on the recall measure of the present study. When recalling the structural elements of a passage, students demonstrated greater difficulty with unfamiliar content. There was no difference in performance when recalling non-structure elements for either familiar or unfamiliar content passages. Given this, it appears that the structure of the text did not facilitate recall in such a way as to compensate for readers' lack of experience with the unfamiliar content.

Such findings, which appear to refute Roller's (1990) hypothesis, may simply reflect the greater cognitive demands posed by the recall task as compared to the comprehension questions. Taylor and Samuels (1983) stress that elementary-level readers frequently struggle to remember concepts in text, particularly if a passage is expository rather than narrative. Moreover, these

difficulties in recall may be directly tied to explicit, rather than implicit, awareness of text structure. Aulls (1975) found that sixth-graders recalled a greater proportion of text elements when passages were well-structured; however, this increase in recall only occurred when students read text with familiar content. When students read passages with unfamiliar topics, there were no differences in performance between students who read structured and unstructured text. Examining this phenomenon at a more general level, Taylor and Samuels (1983) found that sixth-grade students who demonstrated awareness of text structure were able to recall a greater number of concepts in expository text, presumably because they used the structure as a retrieval aid. However, less than a third of this sample demonstrated awareness of structure.

Among those in the primary grades, the percentage of students possessing explicit awareness of text structure is likely even smaller; the percentage of readers who are aware of structure *and* use it as a recall aid may be smaller still (Goldman & Rakestraw, 2000; Williams, 2005). Therefore, it is probable that most students at this age may experience very low levels of expository text recall overall, and may find it especially difficult to remember unfamiliar relationships between unfamiliar concepts. Indeed, even those students in the present study who viewed the GOs outlining the text structure, and who subsequently recalled greater numbers of structural elements as compared to students who re-read the text, still experienced a decline in performance when recalling structure elements of the unfamiliar texts.

Further Comments Regarding Text Structure/Content Familiarity Interaction

It is possible that the disparate patterns of results on the comprehension questions and recall measures may also be due to the differing natures of each respective task. If text structure and content familiarity do in fact interact, and text structure sensitivity can compensate for a lack

of familiarity with content, then it may have been the case that the structure comprehension questions themselves provided cues to the structure; these cues may have assisted students somewhat when reading unfamiliar material. Indeed, past research has suggested that comprehension questions encourage students to attend to important information in text and build connections between text concepts (Callendar & McDaniel, 2007; Peverly & Wood, 2001; Williams, et al., 2007). In contrast to the structure comprehension questions, the non-structure questions did not refer to the overall causal structure; similarly, the free recall measure did not provide explicit signals to text structure. On these measures, students tended to fare worse when reading unfamiliar text. Future researchers may wish to further examine this possibility, perhaps by comparing performance on tasks with a more diverse range of cognitive demands. Such research, when combined with the present study, would also support earlier assertions that the text structure/familiarity interaction is task-dependent (Armand, 2001; Roller, 1990).

Limitations and Further Research

The generalizability of the results presented here is limited by a number of factors. First, the sample only included readers in the second grade. Research designs utilizing participants from multiple age groups, such as those used in Danner (1976) and Taylor (1980), would allow researchers and educators to better understand how structure sensitivity develops throughout the school years, as well as determine whether GOs improve sensitivity and comprehension even as readers mature. In addition, it is important to consider the characteristics of the population sampled in this study. These second-grade students attended school in a middle-income district and were reported to be reading at or above grade level (informal teacher reports were supported

by student scores on the Gates-MacGinitie comprehension subtest). Nearly all of the participants were also reported to be native speakers of English. Prior research suggests that graphic organizers may be particularly useful for students who fit other parameters, including those who attend schools in low-income districts (Bellanca, 2007; Hall, Sabey, and McClellan, 2005), who have been diagnosed with learning disabilities (Gajria, Jitendra, Sood, & Sacks, 2007; Horton, Lovitt, & Bergerud, 1990; Kim, Vaughn, Wanzek, & Wei, 2004), and/or who are learning to read text in a non-native language (Jiang & Grabe, 2007; Liu, Chen, & Chang, 2010; Tang, 1992). Few have investigated, however, how very young readers in these populations may benefit from the use of graphic organizers in reading instruction; more work is needed in this area.

The materials used in this study were designed for our specific research questions. This, too, limits the generalizations that may be drawn. For example, cause/effect text structure was chosen as the focus of the current investigation due to its complex nature and the distinct challenges it poses toward comprehension. However, expository text encompasses a wide range of structure patterns beyond cause and effect (e.g. description, sequence, compare/contrast, and problem/solution) and many texts incorporate several structures simultaneously. It is still uncertain whether graphic organizers can improve a young reader's awareness of these other structures or combinations of structures. We may speculate that a GO may be less effective (or unnecessary) for "simpler" structures such as sequencing, but there is little research now available to answer this essential question. Additional studies are needed to compare the effects of GOs across texts with other structure types and combinations.

Along the same lines, the passages used in the present research were created expressly for the purpose of exploring our research questions, such that they do not represent "authentic" text such as that found in textbooks or trade books. A follow-up study using authentic text would

advance our understanding of the present findings and allow educators to determine whether GOs may be easily implemented with texts that are already used in the classroom. Similarly, additional standardized measures of comprehension gains would assist researchers in determining whether the superior structural awareness demonstrated by students in the GO condition is in fact limited to the experimenter-designed materials used in the present study.

By examining content familiarity as a factor in this study, we inevitably limited our ability to replicate this exact study with other populations. That is, the familiar content used in these passages (e.g. a new puppy) may not be familiar to students elsewhere. Similarly, the unfamiliar content (e.g. the lack of an atmosphere on the moon) may in fact be familiar to students who attend schools in which these subjects are studied as part of the curriculum. To address this issue, future investigators should carefully examine not only the curricula which participants study, but also participant interests, current events, and the environment in which these students live. New passages following the same general template may then be created to better suit a new sample of students.

Students' previous experience with GOs is another important consideration. Although GOs are now a standard part of most elementary curricula (Baxendell, 2003; Bellanca, 2007), their use may differ from district to district and classroom to classroom, meaning that students may possess varying levels of exposure to GOs. Furthermore, as was noted in the present study, students may have worked extensively with some types of GOs but not others. Due to district policy and sample limitations in the present study, we were unable to formally examine students' previous work with structure- and non-structure based GOs. Replication studies which included a measure of previous GO knowledge would allow researchers to further isolate the effects of text structure-based GOs.

Finally, it is important to consider the potential novelty effect introduced through the use of GOs. As Friedman (1979) notes, humans often process novel objects and items more deeply than familiar objects; this difference in processing due to novelty has been observed in cognitive neuroscience studies as well (Kishiyama, Yonelinas, & Lazzara, 2004; Ranganath & Rainer, 2003). Given this phenomenon, it is possible that the superior structure awareness and recall demonstrated by students who read GOs within the present study may have simply been due to the novelty of the GO format. If novelty alone accounted for the positive effects of GOs, however, it seems likely that performance on the non-structure measures (comprehension questions and recall) would have been concomitantly higher among students who read the organizers, as both structure and non-structure elements were presented on each GO page. Such a trend in the data was not seen, suggesting that the GOs provided support above and beyond any latent novelty effects. Moreover, it should be acknowledged that the students in the present study used graphic organizers on a near-daily basis as part of the standard curriculum. Thus, the novelty of the GOs used in our materials may not have been as great as it would have if students had never before seen a GO. To further address this concern, additional studies should be conducted in which GOs are compared to other novel formats that vary from standard linear forms. Alternatively, GOs may presented first to all groups as part of an instructional period, such that any novelty associated with the organizers would diminish or disappear prior to the administration of comprehension and recall measures.

Implications for Instruction

Reading comprehension instruction is a complex process, one that may be further complicated when it includes challenging expository text with unfamiliar content and structures. Teachers often find expository comprehension instruction especially difficult with very young readers, who are typically encountering these new concepts and patterns for the first time (Reutzel & Cooter, 2012; Williams et al, 2005; Williams et al. 2007). The results of the work presented here suggest that graphic organizers may offer an inexpensive and easily implemented approach toward teaching a difficult text structure. Moreover, these results support the possibility that GOs may be used even with minimal student or teacher training.

Previous researchers have emphasized the need for explicit and/or extensive training in the use of GOs (e.g. Griffin, Malone, & Kameenui, 1995; Jiang & Grabe, 2007; Lenz, Alley, & Schumaker, 1987; O'Donnell, Dansereau, & Hall, 2002). None of the students in the present study, however, were provided with any prior information or training regarding the GO materials. That is, students were not informed that the text inside the GOs contained causes and effects, that the arrow graphics indicated causal direction, or that the text at the top of each page included the detail sentences not relevant to the causal macrostructure. At no point in time were students told how to use the GOs in order to locate or recall structure information. That students who viewed GOs subsequently demonstrated significantly higher structure sensitivity and recall of structure elements suggests that these students gained awareness of the overall text structure without direction from another source (e.g. a teacher or a training session). Nonetheless, it is important to acknowledge that the GOs and texts used in this study were relatively simple and designed to support understanding of one specific text structure among very young readers.

Thus, if an instructor's goal is to highlight the underlying structure of a simple cause/effect text, simply providing an adjunct GO may be sufficient. Longer or more complicated texts, however, may necessitate some training in the use of GOs.

Other researchers have also posited that students must take part in the creation of a graphic organizer in order for that organizer to improve comprehension and recall. For example, Berkowitz (1986) asserted that the act of reading a pre-constructed GO would not facilitate recall of structure elements. She and others (Alvermann, 1981; Hall, Bailey, & Tillman, 1997; Katayama & Robinson, 2000) contend that improvements in recall and comprehension only occur when students construct GOs themselves, perhaps because the act of constructing an organizer encourages students to process the structure of the text more deeply. In contrast, others have argued that students should be provided with organizers that have been created by an author or teacher, as such organizers represent expert knowledge and are designed to focus attention on relevant concepts and relationships (Hall, Hall, & Saling, 1999; O'Donnell, Dansereau, & Hall, 2002; Stull & Mayer, 2007).

Student performance in the current study supports the latter position. Students in the GO condition did not take part in the creation of the organizers; rather, they viewed the GOs as the information inside the organizers was read aloud. Although they were "passive" participants in a technical sense, these students still demonstrated markedly greater structure sensitivity and structure recall as compared to students who re-read the text. This is an especially important finding for very young readers, as writing ability can vary widely in the early grades. This study suggests that teachers may provide a ready-made GO and thus preclude the need for student writing, while still assisting students in understanding challenging causal text.

Graphic organizers may also serve as an effective vehicle for presenting young students with more complex structures. Students in the GO group of this study demonstrated improved sensitivity and recall for causal structure at both levels of complexity, without a significant decline in performance for the more complex text. This suggests that GOs support comprehension for both simple and relatively complicated text, thus allowing teachers and textbook writers to more effectively introduce young readers to a wider range of causal structures. Similarly, GOs appear to support structure sensitivity and recall for both familiar and unfamiliar text. Since all students experienced a decline in recall of structure elements for unfamiliar text, however, educators may wish to initiate instruction with familiar content while students are first learning about causal structures.

Concluding Remarks

In reviewing the processes involved in comprehending cause/effect text, McCrudden, Schraw, and Lehman (2009) found that readers must perform a number of complex tasks in order to fully understand what they are reading. To comprehend even the most basic cause/effect text, a reader must "(1) identify the events in a causal sequence, (2) infer the relationships between individual causal antecedents and causal effects, and (3) integrate the series of cause-effect relationships into a holistic causal sequence" (p.66). Each of these tasks has proven difficult for the most adept adult readers (Armand, 2001; McCrudden, Schraw, Lehman, & Poliquin, 2007). For very young readers with far less reading experience, cause/effect texts pose a still greater comprehension challenge.

A great deal of the expository content taught in school, chiefly in the fields of science and history, involves intricate causal relationships (Ciardiello, 2002; Clement & Yanowitz, 2003). Frequently this material is presented through written media, such as magazine articles, excerpts from the Internet, trade books, and textbooks (Temple, Ogle, Crawford, & Freppon, 2011). It is thus of vital importance that teachers, along with the curriculum materials they use in the classroom, guide the comprehension of cause/effect texts as early as possible, ideally beginning in the primary grades. Such guidance will likely encourage students to not only "read the lines" in their texts, but also to read between and beyond the lines to the point at which deep understanding, learning, and application of the material may be achieved.

As we have seen, graphic organizers may offer a simple, efficient, and low-cost method of improving the comprehension of cause/effect texts. A well-designed graphic organizer, one that explicitly displays the causal relationships between important concepts in text, has the potential to assist students in recognizing and understanding the macrostructure of that text. Younger readers, who tend to have less familiarity with both expository content and its constituent structures, may especially benefit from this type of reading scaffold. All told, the results of this study, and others like it, support the use of structured GOs in the primary-grade classroom, and may assist teachers, writers, and other practitioners who seek to utilize this promising approach toward supporting children's understanding of expository text structure.

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Appendix A

Passages

One Cause-One Effect Passages

Comprehension Questions Measure

Passage A1 (familiar content):

The children made a mess during their party in the classroom. The classroom was a big mess, so the teacher could not find her papers. The papers were about the new school play. The children had dropped things on the floor, so they tripped when they walked. There was a chair for the teacher near the door. The tables were dirty, so the children could not work at them. Each table was big enough for five children. There was trash all over the classroom, so the children had to clean for a long time.

Passage B1 (familiar content):

Many things happened on a summer day last week. It was a very hot day, so all of the children went swimming in the lake. The lake was across the street from the town library. The children were hungry so they bought some ice cream at the store. Jen had chocolate ice cream with candy on top. Marco wanted to read instead of swim, so he went into the library. Marco found a book about snakes and turtles. The sun was very bright so many children sat in the shade.

Passage C1 (unfamiliar content):

There is no atmosphere on the moon. There are no gases on the moon, so there is no air to breathe. The moon is made of three layers. There are no clouds on the moon, so you can always see the stars from the ground. The ground is covered with dust. The moon does not have a blanket of air to keep it warm, so the moon gets very cold at night. The moon takes one month to circle around the Earth. There is no weather on the moon, so it never rains.

Passage D1 (unfamiliar content):

Things that are made out of steel are very hard and strong. Steel is very strong, so people use it to make parts of houses. Telephone wires are put inside the walls of houses. Big animals like elephants need strong fences, so those fences are made from steel. A good fence can last for 100 years or more. Bridges carry heavy cars and trucks, so they are made using steel cables. Steel is made out of iron and carbon. Some machines lift and move heavy things, so they are made from steel parts.

Recall Measure

Passage E1 (familiar content):

The town built a new, bigger playground for the school. The new playground was very big, so there was room for all the children to play together. The slides were built near the north of the school. The playground had a new field, so there was more space for playing ball games. The new swings were red and green. There was space left over, so the children planted a school garden. The second grade grew carrot plants. There were many seats outside, so the teachers had lots of room to sit.

Passage F1 (familiar content):

Many things happened when Maria bought a new puppy. Maria bought a new puppy, so she felt very excited and happy. The puppy had brown fur with white spots. The puppy needed lots of supplies, so Maria had to go to the pet store. She bought a soft dog bed made out of cotton. The puppy needed exercise, so Maria walked the puppy after school. They walked to the big dog park near the supermarket. The puppy got sick, so Maria had to find a veterinarian to take care of him.

Passage G1 (unfamiliar content):

Almost all kinds of birds have a high metabolic rate. Birds use up their food energy very fast, so they must eat all the time to keep living. A duck is a bird that likes to eat plants. Using food energy makes heat, so birds are always warm. Most baby birds have soft feathers called down. Birds have lots of energy, so they can move very fast. A bird called a falcon can fly over 120 miles an hour. Eating food helps birds make strong wings, so birds can fly long distances.

Passage H1 (unfamiliar content):

The tundra is the coldest, driest place in the world. The tundra is very cold and dry, so the ground there is too frozen for trees to grow. There is a tundra in Alaska. The tundra weather is very cold, so only a few animals are able to live there. One tundra animal is the gray wolf. Tundra grass is always dry, so grass fires start often. There was a big tundra fire three years ago. It almost never rains on the tundra, so there is not much water to drink there.

One Cause-Multiple Effects Passages

Comprehension Questions Measure

Passage A2 (familiar content):

The children made a mess during their party in the classroom. The classroom was a big mess, so the teacher could not find her papers. The papers were all about the new school play. The children tripped on the things that were dropped on the floor. There was a big chair for the teacher near the door. The tables were too dirty for the children to work on them. Each table was big enough for five children. The children and the teacher had to clean for a long time.

Passage B2 (familiar content):

Many things happened on a hot summer day last week. It was a very hot day, so all of the children went swimming in the big lake. The lake was right across the street from the town library. The children bought some ice cream to cool off. Jen had chocolate ice cream with candy on top. Marco went into the cool library where there was air conditioning. Marco found a good book about snakes and turtles. Many children sat in the shade of the tall trees by the lake.

Passage C2 (unfamiliar content):

There is no atmosphere on the moon. There are no gases or clouds at all on the moon, so there is no air to breathe. The moon is made up of three layers. You can always see the stars from the moon's ground. The ground on the moon is covered with two inches of dust. The moon always gets very cold at night without a blanket of air to keep it warm. The moon takes about one month to circle around the Earth. It never rains on the moon.

Passage D2 (unfamiliar content):

Things that are made out of steel are very hard and strong. Steel is very strong, so people use it to make parts of houses. Telephone wires are put inside of the walls of houses. Fences to hold in strong animals like elephants are made from steel. A good fence can last for 100 years or more. Bridges that carry heavy cars and trucks are made using steel cables and beams. Steel is made out of iron and carbon. Machines that lift and move heavy things are made of steel.

Recall Measure

Passage E2 (familiar content):

The town built a new, bigger playground for the school. The new playground was very big, so there was room for all the children to play together after lunch. The slides were built near the north end of the school. There was much more space for playing ball games. The new playground swings were red and green. There was even enough space for a school garden on the playground. The second grade children grew carrot plants. The teachers had lots of room to sit while they watched the children.

Passage F2 (familiar content):

Many things happened when Maria bought a new puppy. Maria bought a new puppy, so she felt very excited and happy. The puppy had long brown fur with white spots. Maria had to go to the store and buy lots of dog supplies. She bought a soft dog bed made out of cotton. She had a new chore of walking the puppy after school. They walked to the big dog park near the supermarket. Maria had to find a veterinarian to take care of the puppy when he got sick.

Passage G2 (unfamiliar content):

Almost all kinds of birds have a high metabolic rate. Birds use their food energy very fast, so they must eat all of the time to keep living. A duck is a bird that likes to eat plants and fish. A bird's body is always very warm from using food energy. Most baby birds have lots of soft warm feathers called down. Birds can move their bodies fast. A special bird called a falcon can fly over 120 miles an hour. Birds have lots of energy to fly long distances.

Passage H2 (unfamiliar content):

The tundra is the coldest, driest place in the world. The tundra is very cold and dry, so the ground there is too dry and frozen for trees to grow. There is a big tundra in Alaska. Only a few animals are able to live in such cold, dry tundra weather. One kind of animal that lives on the tundra is the gray wolf. Fires start often on the dry tundra grass. There was a big fire in Alaska three years ago. There is not much water to drink on the tundra.

Appendix B

Content Survey for Teachers

Instructions: After reading each passage, please tell me whether you think this topic is familiar or unfamiliar for young readers (approximately 6 to 8 years of age).

After reading the two passages in the passage pairs, I will also ask you to rate the similarity of the content in each passage. By content, I mean the factual information given in the text. Please mark your responses directly on this form using the checkboxes.

PASSAGE PAIR #1

PASSAGE A:

Almost all kinds of birds have a high metabolic rate. Birds use their food energy very fast, so they must eat all of the time to keep living. A duck is a bird that likes to eat plants and fish. A bird's body is always very warm from using food energy. Most baby birds have lots of soft warm feathers called down. Birds can move their bodies fast. A special bird called a falcon can fly over 120 miles an hour. Birds have lots of energy to fly long distances.

How familiar is this content for primary-grade students? (Please check only one.):

Not familiar at all	Somewhat Familiar	Very familiar
☐	☐	☐

PASSAGE B:

Almost all kinds of birds have a high metabolic rate. Birds use up their food energy very fast, so they must eat all the time to keep living. A duck is a bird that likes to eat plants. Using food energy makes heat, so birds are always warm. Most baby birds have soft feathers called down. Birds have lots of energy, so they can move very fast. A bird called a falcon can fly over 120 miles an hour. Eating food helps birds make strong wings, so birds can fly long distances.

How familiar is this content for primary-grade students? (Please check only one.):

Not familiar at all	Somewhat Familiar	Very familiar
☐	☐	☐

Now compare Passage A with Passage B. How similar is this content?

Not similar at all	Somewhat similar	Almost identical
☐	☐	☐

Appendix C

Readability Summary

One Cause-One Effect Passages

Paragraph	**# of sentences**	**Word Count**	**Spache Readability**
Passage A1 (Big Mess/one cause-one effect)	8	94	2.95
Passage B1 (Hot Day/one cause-one effect)	8	90	2.90
Passage C1 (Moon/one cause-one effect)	8	93	2.94
Passage D1 (Steel/one cause-one effect)	8	93	2.94
Passage E1 (Playground/one cause-one effect)	8	91	2.91
Passage F1 (Puppy/one cause-one effect)	8	91	2.91
Passage G1 (Metabolism/one cause-one effect)	8	92	2.92
Passage H1 (Tundra/one cause-one effect)	8	92	2.92
Means: Familiar Passages	8	91.50	2.92
Means: Unfamiliar Passages	8	92.50	2.93
Means: One Cause-One Effect Passages	8	92.0	2.92

One Cause-Multiple Effects Passages

Paragraph	# of sentences	Word Count	Spache Readability
Passage A2 (Big Mess/one cause-multiple effects)	8	89	2.79
Passage B2 (Hot Day/one cause-multiple effects)	8	89	2.98
Passage C2 (Moon/one cause-multiple effects)	8	89	2.98
Passage D2 (Steel/one cause-multiple effects)	8	90	2.90
Passage E2 (Playground/one cause-multiple effects)	8	89	2.89
Passage F2 (Puppy/one cause-multiple effects)	8	90	2.90
Passage G2 (Metabolism/one cause-multiple effects)	8	90	2.90
Passage H2 (Tundra/one cause-multiple effects)	8	92	2.92
Means: Familiar Passages	8	89.25	2.89
Means: Unfamiliar Passages	8	90.25	2.93
Means: One Cause-One Effect Passages	8	89.75	2.91

Appendix D

Sample Structure and Non-Structure Comprehension Questions for One Cause-One Effect and One Cause-Multiple Effects Passages

One Cause-One Effect Passage

Many things happened on a summer day last week. It was a very hot day, so all of the children went swimming in the lake. The lake was across the street from the town library. The children were hungry so they bought some ice cream at the store. Jen had chocolate ice cream with candy on top. Marco wanted to read instead of swim, so he went into the library. Marco found a book about snakes and turtles. The sun was very bright so many children sat in the shade.

Structure Questions:

1. Why did the children go swimming in the lake? [cause question]
2. Why did the children buy ice cream? [cause question]
3. What happened because Marco wanted to read instead of swim? [effect question]
4. What happened because the sun was very bright? [effect question]

Non-Structure Questions:

1. Where was the lake?
2. What kind of ice cream did Jen have?
3. What was Marco's book about?

One Cause-Multiple Effects Passage

Many things happened on a hot summer day last week. It was a very hot day, so all of the children went swimming in the big lake. The lake was right across the street from the town library. The children bought some ice cream to cool off. Jen had chocolate ice cream with candy on top. Marco went into the cool library where there was air conditioning. Marco found a good book about snakes and turtles. Many children sat in the shade of the tall trees by the lake.

Structure Questions:

1. Why did many children sit in the shade of the tall trees? [cause question]
2. What happened because it was a very hot day? [effects question: 4 possible effects]

Non-Structure Questions:

1. Where was the lake?
2. What kind of ice cream did Jen have?
3. What was Marco's book about?

Appendix E

Scoring Guidelines: Comprehension Questions

Scoring Guidelines for One Cause – One Effect Level Comprehension Questions

<u>"BIG MESS" PASSAGE (A1)</u>

The children made a mess during their party in the classroom. The classroom was a big mess, so the teacher could not find her papers. The papers were about the new school play. The children had dropped things on the floor, so they tripped when they walked. There was a chair for the teacher near the door. The tables were dirty, so the children could not work at them. Each table was big enough for five children. There was trash all over the classroom, so the children had to clean for a long time.

<u>STRUCTURE COMPREHENSION QUESTIONS</u>:

1. What happened because the classroom was a big mess? [effect]

Correct response (1 pt.): The teacher/She could not find her papers.

2. What happened because the children dropped things on the floor? [effect]

Correct response (1 pt.): They/The children tripped [when they walked].

3. Why couldn't the children work at the tables? [cause]

Correct response (1 pt.): [Because] the tables were dirty.

4. Why did the children have to clean for a long time? [cause]

Correct response (1 pt.): [Because] there was trash [garbage, a mess] [all] over the classroom.

<u>NON-STRUCTURE COMPREHENSION QUESTIONS</u>:

1. What were the teacher's papers about?

Correct response (1 pt.): The [new, school] play.

2. Where was the teacher's chair?

Correct response (1 pt.): [There was a chair for the teacher] near the door.

3. How many children could sit at one table?

Correct response (1 pt.): Five [children]/Each table was big enough for five children.

"HOT DAY" PASSAGE (B1)

Many things happened on a summer day last week. It was a very hot day, so all of the children went swimming in the lake. The lake was across the street from the town library. The children were hungry, so they bought some ice cream at the store. Jen had chocolate ice cream with candy on top. Marco wanted to read instead of swim, so he went into the library. Marco found a book about snakes and turtles. The sun was very bright so many children sat in the shade.

STRUCTURE COMPREHENSION QUESTIONS:

1. Why did the children go swimming in the lake? [cause]

Correct response (1 pt.): [Because] it was a [very] hot day.

2. Why did the children buy ice cream? [cause]

Correct response (1 pt.): [Because] they/the children were hungry.

3. What happened because Marco wanted to read instead of swim? [effect]

Correct response (1 pt.): He/Marco went into/to the library.

4. What happened because the sun was very bright? [effect]

Correct response (1 pt.): [Many] children/They sat in the shade.

NON-STRUCTURE COMPREHENSION QUESTIONS:

1. Where was the lake?

Correct response (1 pt.): [It was] Across the street from [near] the [town] library.

2. What kind of ice cream did Jen have?

Correct response (1 pt.): Chocolate [ice cream, with candy on top].

3. What was Marco's book about?

Correct response (1 pt.): Marco's book/It [was about] snakes and turtles.

MOON PASSAGE (C1)

There is no atmosphere on the moon. There are no gases on the moon, so there is no air to breathe. The moon is made of three layers. There are no clouds on the moon, so you can always see the stars from the ground. The ground is covered with dust. The moon does not have a blanket of air to keep it warm, so the moon gets very cold at night. The moon takes one month to circle around the Earth. There is no weather on the moon, so it never rains.

STRUCTURE COMPREHENSION QUESTIONS:

1. Why isn't there any air to breathe on the moon? [cause]

Correct response (1 pt.): [Because] there are no gases [on the moon].

2. Why are you always able to see the stars from the moon's ground [cause]

Correct response (1 pt.): [Because] there are no clouds [on the moon].

3. What happens because the moon doesn't have a blanket of air to keep it warm? [effect]

Correct response (1 pt.): The moon [it] gets very cold [at night].

4. What happens because there is no weather on the moon? [effect]

Correct response (1 pt.): It never rains/It doesn't rain [on the moon].

NON-STRUCTURE COMPREHENSION QUESTIONS:

1. How many layers is the moon made of?

Correct response (1 pt.): Three; [The moon is made of] three layers.

2. What covers the moon's ground?

Correct response (1 pt.): Dust; The ground is covered in/with dust.

3. How long does it take for the moon to circle around the Earth?

Correct response (1 pt.): One month; The moon/It takes one month to circle around the Earth.

STEEL PASSAGE (D1)

Things that are made out of steel are very hard and strong. Steel is very strong, so people use it to make parts of houses. Telephone wires are put inside the walls of houses. Big animals like elephants need strong fences, so those fences are made from steel. A good fence can last for 100 years or more. Bridges carry heavy cars and trucks, so they are made using steel cables. Steel is made out of iron and carbon. Some machines lift and move heavy things, so they are made from steel parts.

STRUCTURE COMPREHENSION QUESTIONS:

1. Why do people use steel to make parts of houses? [cause]

Correct response (1 pt.): [Because] it [steel] is [very] strong.

2. Why are elephant fences made from steel? [cause]

Correct response (1 pt.): [Because] big animals [like]/ Elephants need strong fences; [Elephants are strong and need strong fences].

3. What happens because bridges must carry heavy cars and trucks? [effect]

Correct response (1 pt.): Bridges/ They are made using [from] steel cables.

4. What happens because some machines must lift heavy things? [effect]

Correct response (1 pt.): They/Machines are made from [using] steel parts.

NON-STRUCTURE COMPREHENSION QUESTIONS:

1. What kind of wires is put inside the walls of houses?

Correct response (1 pt.): Telephone [wires].

2. How long does a good fence last?

Correct response (1 pt.): 100 years or more; over 100 years; more than 100 years; 100 years.

3. What is steel made out of?

Correct response (1 pt.): Iron and carbon.

Scoring Guide for 1cMe Level Questions

BIG MESS PASSAGE (A2)

The children made a mess during their party in the classroom. The classroom was a big mess, so the teacher could not find her papers. The papers were all about the new school play. The children tripped on the things that were dropped on the floor. There was a big chair for the teacher near the door. The tables were too dirty for the children to work on them. Each table was big enough for five children. The children and the teacher had to clean for a long time.

STRUCTURE COMPREHENSION QUESTIONS:

CAUSE QUESTION: Why were the tables too dirty for the children to work on them?

Correct response (1 pt.): The classroom was a big mess.

EFFECT QUESTION: What happened because the classroom was a big mess?

Correct responses (1 pt. EACH):

a) **The teacher/She could not find her papers.**

b) **The children tripped [on the things that were dropped on the floor].**

c) **The tables were too dirty for the children to work on them.**

d) **The children and the teacher/They had to clean for a long time.**

NON-STRUCTURE COMPREHENSION QUESTIONS:

1. What were the teacher's papers about?

Correct response (1 pt.): The [new] school play.

2. Where was the teacher's chair?

Correct response (1 pt.): Near/By the door.

3. How many children could sit at one table?

Correct response (1 pt.): Five; Five children could sit at one table.

HOT DAY PASSAGE (B2)

Many things happened on a hot summer day last week. It was a very hot day, so all of the children went swimming in the big lake. The lake was right across the street from the town library. The children bought some ice cream to cool off. Jen had chocolate ice cream with candy on top. Marco went into the cool library where there was air conditioning. Marco found a good book about snakes and turtles. Many children sat in the shade of the tall trees by the lake.

STRUCTURE COMPREHENSION QUESTIONS:

CAUSE QUESTION: Why did many children sit in the shade of the tall trees?

Correct response (1 pt.): It was a [very] hot day.

EFFECTS QUESTION: What happened because it was a very hot day?

Correct responses (1 pt. EACH):

a) **All of the children went swimming in the big lake.**

b) **The children bought some ice cream to cool off.**

c) **Marco went into the cool library where there was air conditioning.**

d) **Many children sat in the shade of the tall trees by the lake.**

***NON-STRUCTURE COMPREHENSION QUESTIONS*:**

1. Where was the lake?

Correct response (1 pt.): [Right] across [the street] from the [town] library.

2. What kind of ice cream did Jen have?

Correct response (1 pt.): [Jen/She had] chocolate [ice cream with candy on top].

3. What was Marco's book about?

Correct response (1 pt.): Snakes and turtles.

MOON PASSAGE (C2)

There is no atmosphere on the moon. There are no gases or clouds at all on the moon, so there is no air to breathe. The moon is made up of three layers. You can always see the stars from the moon's ground. The ground on the moon is covered with two inches of dust. The moon always gets very cold at night without a blanket of air to keep it warm. The moon takes about one month to circle around the Earth. It never rains on the moon.

STRUCTURE COMPREHENSION QUESTIONS:

CAUSE QUESTION: Why doesn't it rain on the moon?

Correct response (1 pt.): There are no gases or clouds [at all] [on the moon].

EFFECTS QUESTION: What happens because there are no gases or clouds at all on the moon?

Correct responses (1 pt. EACH):

a) **There is no air to breathe.**

b) **You can always see the stars from the moon's ground.**

c) **The moon always gets very cold at night without a blanket of air to keep it warm.**

d) **It never rains on the moon.**

NON-STRUCTURE COMPREHENSION QUESTIONS:

1. How many layers is the moon made of?

Correct response (1 pt.): Three [layers].

2. What covers the ground on the moon?

Correct response (1 pt.): [Two inches of] dust.

3. How long does it take for the moon to circle around the Earth?

Correct response (1 pt.): [About] one month.

STEEL PASSAGE (D2)

Things that are made out of steel are very hard and strong. Steel is very strong, so people use it to make parts of houses. Telephone wires are put inside of the walls of houses. Fences to hold in strong animals like elephants are made from steel. A good fence can last for 100 years or more. Bridges that carry heavy cars and trucks are made using steel cables and beams. Steel is made out of iron and carbon. Machines that lift and move heavy things are made of steel.

STRUCTURE COMPREHENSION QUESTIONS:

CAUSE QUESTION: Why are fences for animals like elephants made from steel?

Correct response (1 pt.): [Because] Steel/It is very strong.

EFFECTS QUESTION: What happens because steel is very strong?

Correct responses (1 pt. EACH):

a) **People use it/steel to make parts of houses.**

b) **Fences to hold in strong animals [like elephants] are made from steel.**

c) **Bridges that carry heavy cars and trucks are made using steel cables and beams.**

d) **Machines that lift and move heavy things are made of steel.**

NON-STRUCTURE COMPREHENSION QUESTIONS:

1. What kind of wires are put inside of the walls of houses?

Correct response (1 pt.): Telephone wires; Telephone wires are put inside of the walls of houses.

2. What happens because bridges must carry heavy cars and trucks?

Correct response (1 pt.): Bridges [they] are made using [from] steel cables.

3. What is steel made out of?

Correct response (1 pt.): Iron and carbon.

Appendix F

Scoring Guidelines: Recall

Scoring Guide for One Cause – One Effect Level Recall

<u>"Playground" PASSAGE (E1)</u>

The town built a new, bigger playground for the school. The new playground was very big, so there was room for all the children to play together. The slides were built near the north of the school. The playground had a new field, so there was more space for playing ball games. The new swings were red and green. There was space left over, so the children planted a school garden. The second grade grew carrot plants. There were many seats outside, so the teachers had lots of room to sit.

<u>STRUCTURE ELEMENTS (1 pt. each; may be recalled in reverse order or individually, but must include entire element)</u>:

Note: Information in brackets not required for a score of "correct."

Cause Elements:

- The new playground was [very] big.
- The playground had a new field.
- There was space left over.
- There were many seats outside.

Effect Elements:

- There was room for [all] the children to play together.
- There was more space for playing ball [games].
- The children planted a [school] garden.
- The teachers had [lots of] room to sit.

<u>NON-STRUCTURE ELEMENTS (1 pt. each; may be recalled in any order; must include entire element)</u>:

- The slides were built near the north of the school.
- The [new] swings were red and green.
- The second grade grew carrots/carrot plants.

“New Puppy” PASSAGE (F1)

Many things happened when Maria bought a new puppy. Maria bought a new puppy, so she felt very excited and happy. The puppy had brown fur with white spots. The puppy needed lots of supplies, so Maria had to go to the pet store. She bought a soft dog bed made out of cotton. The puppy needed exercise, so Maria walked the puppy after school. They walked to the big dog park near the supermarket. The puppy got sick, so Maria had to find a veterinarian to take care of him.

STRUCTURE ELEMENTS (1 pt. each; may be recalled in reverse order or individually, but must include entire element):

Cause Elements:

- Maria bought a new puppy.
- The puppy needed [lots of] supplies.
- The puppy needed exercise.
- The puppy got sick.

Effect Elements:

- She felt [very] excited and happy.
- Maria had to go to the pet store.
- Maria walked the puppy [after school].
- Maria had to find a veterinarian to take care of him.

NON-STRUCTURE ELEMENTS (1 pt. each; may be recalled in any order; must include entire element):

- The puppy had brown fur with white spots.
- She bought a [soft] dog bed [made out of cotton].
- The walked to the [big] dog park near the supermarket.

“Bird Metabolism” PASSAGE (G1)

Almost all kinds of birds have a high metabolic rate. Birds use up their food energy very fast, so they must eat all the time to keep living. A duck is a bird that likes to eat plants. Using food energy makes heat, so birds are always warm. Most baby birds have soft feathers called down. Birds have lots of energy, so they can move very fast. A bird called a falcon can fly over 120 miles an hour. Eating food helps birds make strong wings, so birds can fly long distances.

STRUCTURE ELEMENTS (1 pt. each; may be recalled in reverse order or individually, but must include entire element):

Cause Elements:

- Birds use up their [food] energy [very] fast.
- Using [food] energy makes heat.
- Birds have lots of energy.
- Eating food helps birds make strong wings.

Effect Elements:

- They/birds must eat all the time to keep living.
- Birds are always warm.
- They/birds can move very fast.
- Birds can fly long distances.

NON-STRUCTURE ELEMENTS (1 pt. each; may be recalled in any order; must include entire element):

- A duck is a bird that likes to eat plants/Ducks like to eat plants/Ducks eat plants.
- [Most] baby birds have [soft] feathers called down.
- A bird called a falcon/Falcons can fly over 120 miles an hour.

“The Tundra” PASSAGE (H1)

The tundra is the coldest, driest place in the world. The tundra is very cold and dry, so the ground there is too frozen for trees to grow. There is a tundra in Alaska. The tundra weather is very cold, so only a few animals are able to live there. One tundra animal is the gray wolf. Tundra grass is always dry, so grass fires start often. There was a big tundra fire three years ago. It almost never rains on the tundra, so there is not much water to drink there.

STRUCTURE ELEMENTS (1 pt. each; may be recalled in reverse order or individually, but must include entire element):

Cause Elements:

- The tundra is [very] cold and dry.
- [The] [tundra] weather is very cold.
- Tundra grass/The grass is always dry.
- It [almost] never rains on the tundra.

Effect Elements:

- The ground there is [too] frozen for trees to grow.
- Only a few animals are able to/can live there.
- Grass fires start often.
- There is not much water to drink [there].

NON-STRUCTURE ELEMENTS (1 pt. each; may be recalled in any order; must include entire element):

- There is a tundra in Alaska.
- One tundra animal is the gray wolf.
- There was a [big] tundra fire [three years ago].

Scoring Guide for One Cause – Multiple Effects Level Recall

"Playground" PASSAGE (E2)

The town built a new, bigger playground for the school. The new playground was very big, so there was room for all the children to play together after lunch. The slides were built near the north end of the school. There was much more space for playing ball games. The new playground swings were red and green. There was even enough space for a school garden on the playground. The second grade children grew carrot plants. The teachers had lots of room to sit while they watched the children.

STRUCTURE ELEMENTS (1 pt. each; may be recalled in reverse order or individually, but must include entire element):

Cause Element (single cause):

- The new playground was [very] big.

Effect Elements:

- There was room for [all] the children to play together [after lunch].
- There was [much] more space for playing ball [games].
- There was [even] enough space for a [school] garden.
- The teachers had [lots of] room to sit [while they watched the children].

NON-STRUCTURE ELEMENTS (1 pt. each; may be recalled in any order; must include entire element):

- The slides were built near the north end of the school.
- The [new] [playground] swings were red and green.
- The second grade [children] grew carrots/carrot plants.

“New Puppy” PASSAGE (F2)

Many things happened when Maria bought a new puppy. Maria bought a new puppy, so she felt very excited and happy. The puppy had long brown fur with white spots. Maria had to go to the store and buy lots of dog supplies. She bought a soft dog bed made out of cotton. She had a new chore of walking the puppy after school. They walked to the big dog park near the supermarket. Maria had to find a veterinarian to take care of the puppy when he got sick.

STRUCTURE ELEMENTS (1 pt. each; may be recalled in reverse order or individually, but must include entire element):

Cause Element (single cause):

- Maria bought a new puppy.

Effect Elements:

- She/Maria felt [very] excited and happy.
- Maria had to go to the store and buy [lots of] dog supplies; Maria had to buy dog supplies.
- She/Maria had a new chore of walking the puppy [after school]; She/Maria had to walk the puppy [after school]
- Maria/She had to find a veterinarian [to take care of the puppy when he got sick].

NON-STRUCTURE ELEMENTS (1 pt. each; may be recalled in any order; must include entire element):

- The puppy had [long] brown fur with white spots.
- She bought a [soft] dog bed [made out of cotton].
- The walked to the [big] dog park near the supermarket.

“Bird Metabolism” PASSAGE (G2)

Almost all kinds of birds have a high metabolic rate. Birds use their food energy very fast, so they must eat all of the time to keep living. A duck is a bird that likes to eat plants and fish. A bird's body is always very warm from using food energy. Most baby birds have lots of soft warm feathers called down. Birds can move their bodies fast. A special bird called a falcon can fly over 120 miles an hour. Birds have lots of energy to fly long distances.

STRUCTURE ELEMENTS (1 pt. each; may be recalled in reverse order or individually, but must include entire element):

Cause Element (single cause):

- Birds use their food energy [very] fast.

Effect Elements:

- They/birds [must] eat all [of] the time to keep living.
- A bird’s body is [always very] warm from using food energy.
- Birds can move [their bodies] fast.
- Birds have lots of/a lot of energy to fly long/big/huge/distances.

NON-STRUCTURE ELEMENTS (1 pt. each; may be recalled in any order; must include entire element):

- A duck is a bird that likes to eat plants and fish/Ducks eat plants and fish.
- [Most] baby birds have [lots of] soft warm feathers called down.
- A special bird called a falcon can fly over 120 miles an hour.

“The Tundra” PASSAGE (H2)

The tundra is the coldest, driest place in the world. The tundra is very cold and dry, so the ground there is too dry and frozen for trees to grow. There is a big tundra in Alaska. Only a few animals are able to live in such cold, dry tundra weather. One kind of animal that lives on the tundra is the gray wolf. Fires start often on the dry tundra grass. There was a big fire in Alaska three years ago. There is not much water to drink on the tundra.

STRUCTURE ELEMENTS (1 pt. each; may be recalled in reverse order or individually, but must include entire element):

Cause Element (single cause):

- The tundra is very cold and dry.

Effect Elements:

- The ground [there/on the tundra] is too dry and frozen for trees to grow.
- Only a few animals are able to live in such cold, dry tundra weather.
- Fires start often on the dry tundra grass.
- There is not much water to drink on the tundra.

NON-STRUCTURE ELEMENTS (1 pt. each; may be recalled in any order; must include entire element):

- There is a [big] tundra in Alaska.
- One kind of animal [that lives on the tundra] is the gray wolf.
- There was a [big] fire in Alaska [three year ago].

Appendix G

Analyses for Year 1 (2010) and Year 2 (2011)

Structure Comprehension Questions

Year 1 (n = 28):

Means and Standard Deviations for Proportion of Correct Structure Question Responses

	One cause-one effect Means (SD)		**One cause-multiple effects Means (SD)**	
Graphic Organizer	Familiar Content	Unfamiliar Content	Familiar Content	Unfamiliar Content
GO Present	0.82 (0.19)	0.79 (0.17)	0.74 (0.21)	0.83 (0.14)
GO Absent	0.54 (0.19)	0.46 (0.35)	0.30 (0.12)	0.16 (0.08)

There was a significant main effect for graphic organizers, $F(1,24) = 47.83$, $p < .001$, as well as for level of structure complexity, $F(1, 24) = 5.40$, $p < .05$. Content familiarity did not emerge as a significant factor, $F(1, 24) = 1.03$, $p > .05$.

The interaction between graphic organizer condition and level of structure complexity was marginally significant, $F(1,24) = 4.15$, $p = .053$. The interactions between GO condition and content familiarity approached but did not reach significance, $F(1,24) = 2.66$, $p > .05$. The interactions between structure complexity and familiarity was not significant, $F(1,24) = 0.10$, $p > .05$, nor was the interaction between all three factors, $F(1,24) = 1.42$, $p > .05$.

Year 2 (n =52):

Means and Standard Deviations for Proportion of Correct Structure Question Responses

	One cause-one effect Means (SD)		**One cause-multiple effects Means (SD)**	
Graphic Organizer	Familiar Content	Unfamiliar Content	Familiar Content	Unfamiliar Content
GO Present	0.77 (0.14)	0.72 (0.21)	0.84 (0.24)	0.84 (0.24)
GO Absent	0.48 (0.23)	0.36 (0.23)	0.25 (0.17)	0.21 (0.15)

A significant main effect was found for GO condition, $F(1,48) = 87.93$, $p < .001$ as well as for content familiarity, $F(1,48) = 4.91$, $p < .05$. Level of structure complexity did not reach significance, $F(1,48) = 0.82$, $p > .05$.

An interaction between GO condition and level of structure complexity was found to be significant, $F(1,48) = 8.10$, $p < .05$. Interactions were not significant between GO condition and content familiarity, $F(1,48) = 1.27$, level of structure complexity and familiarity, $F(1,48) = 1.36$, or between all three factors, $F(1,48) = 0.14$.

Non-Structure Comprehension Questions

Year 1 (n = 28):

Means and Standard Deviations for Proportion of Correct Non-Structure Question Responses

	One cause-one effect Means (SD)		**One cause-multiple effects Means (SD)**	
Graphic Organizer	Familiar Content	Unfamiliar Content	Familiar Content	Unfamiliar Content
GO Present	0.90 (0.13)	0.71 (0.25)	0.83 (0.10)	0.64 (0.24)
GO Absent	0.86 (0.31)	0.71 (0.21)	0.74 (0.13)	0.57 (0.29)

A significant main effect was found for content familiarity on this measure, $F(1,24) = 12.01$, $p < .05$. Main effects were not significant for GO condition, $F(1,24) = 0.65$, $p > .05$ or level of structure complexity, $F(1,24) = 2.38$, $p > .05$.

There were no significant interactions between GO condition and level of structure complexity, $F(1,24) = 0.20$, GO condition and content familiarity, $F(1,24) = 0.12$, level of structure complexity and content familiarity, $F(1,24) = 0.01$, or between all three factors, $F(1,24) = 0.01$.

Year 2 (n = 52):

Means and Standard Deviations for Proportion of Correct Non-Structure Question Responses

	One cause-one effect Means (SD)		**One cause-multiple effects Means (SD)**	
Graphic Organizer	Familiar Content	Unfamiliar Content	Familiar Content	Unfamiliar Content
GO Present	0.77 (0.24)	0.56 (0.33)	0.90 (0.16)	0.77 (0.19)
GO Absent	0.79 (0.21)	0.62 (0.26)	0.79 (0.14)	0.65 (0.21)

As in Year 1, a significant main effect was found in Year 2 for content familiarity on non-structure comprehension questions, $F(1,48) = 24.21$, $p < .01$. Main effects were insignificant for both GO condition, $F(1,48) = 0.46$ and level of structure complexity, $F(1,48) = 3.16$.

In addition, all interactions were insignificant, including those between GO condition and level of structure complexity, $F(1,48) = 2.0$, GO condition and content familiarity, $F(1,48) = 0.01$, level of structure complexity and content familiarity, $F(1,48) = 0.75$, and all three factors, $F(1,48) = 0.08$.

Recall of Structure Elements

Year 1 (n = 28):

Means and Standard Deviations for Proportion of Correctly Recalled Structure Elements

	One cause-one effect Means (SD)		**One cause-multiple effects Means (SD)**	
Graphic Organizer	Familiar Content	Unfamiliar Content	Familiar Content	Unfamiliar Content
GO Present	0.52 (0.14)	0.38 (0.14)	0.49 (0.16)	0.37 (0.11)
GO Absent	0.35 (0.19)	0.21 (0.11)	0.27 (0.16)	0.13 (0.11)

A main effect for GO condition was found, $F(1,24) = 18.82$, $p < .001$. Additionally, a significant effect was found for content familiarity, $F(1,24) = 25.29$, $p < .01$. There was no significant effect of structure complexity on recall of structure elements, $F(1,24) = 1.14$.

Contrary to the hypotheses, there were no significant interactions for GO condition and level of cause/effect complexity, $F(1,24) = 0.34$, GO condition and content familiarity, $F(1,24) = 0.12$, or content familiarity and level of structure difficulty, $F(1,24 = 0.03$. Similarly, the interaction among all three factors was not significant, $F(1,24) = 0.03$.

Year 2 (n = 52):

Means and Standard Deviations for Proportion of Correct Structure Question Responses

	One cause-one effect Means (SD)		**One cause-multiple effects Means (SD)**	
Graphic Organizer	Familiar Content	Unfamiliar Content	Familiar Content	Unfamiliar Content
GO Present	0.54 (0.20)	0.37 (0.20)	0.62 (0.15)	0.42 (0.18)
GO Absent	0.32 (0.17)	0.17 (0.11)	0.35 (0.16)	0.18 (0.17)

Significant main effects were found for GO condition, $F(1,48) = 29.58$, $p < .001$ and content familiarity, $F(1,48) = 72.84$, $p < .001$. As in Year 1, there was no significant effect of structure complexity on recall of structure elements, $F(1,48) = 1.03$.

No interactions were found for GO condition and level of cause/effect complexity, $F(1,48) = 0.21$, GO condition and content familiarity, $F(1,48) = 0.27$, or content familiarity and level of structure difficulty, $F(1,48) = 0.18$. In addition, the interaction among all three factors was not significant, $F(1,48) = 0.002$.

Recall of Non-Structure Elements

Year 1 (n = 28):

Means and Standard Deviations for Proportion of Correctly Recalled Non-Structure Elements

	One cause-one effect Means (SD)		**One cause-multiple effects Means (SD)**	
Graphic Organizer	Familiar Content	Unfamiliar Content	Familiar Content	Unfamiliar Content
GO Present	0.50 (0.29)	0.55 (0.16)	0.22 (0.12)	0.33 (0.29)
GO Absent	0.36 (0.31)	0.45 (0.36)	0.43 (0.31)	0.38 (0.29)

Recall of non-structure elements was equivalent across all conditions. There were no significant main effects for GO condition, $F(1,24)=.003$, level of cause/effect structure complexity, $F(1,24)=1.80$, or content familiarity, $F(1,24) = .90$.

In addition, there were no significant interactions for GO condition and level of structure complexity, $F(1,24) = 1.90$, GO condition and content familiarity, $F(1,24) = .26$, level of structure complexity and content familiarity, $F(1,24) = .11$, or all three factors, $F(1,24) = .87$.

Year 2 (n = 52):

Means and Standard Deviations for Proportion of Correctly Recalled Non-Structure Elements

	One cause-one effect Means (SD)		**One cause-multiple effects Means (SD)**	
Graphic Organizer	Familiar Content	Unfamiliar Content	Familiar Content	Unfamiliar Content
GO Present	0.30 (0.24)	0.35 (0.20)	0.38 (0.25)	0.40 (0.28)
GO Absent	0.45 (0.31)	0.29 (0.23)	0.33 (0.25)	0.42 (0.24)

Main effects were not significant for GO condition, $F(1,48) = 0.10$, level of structure complexity, $F(1,48) = 0.39$, or content familiarity, $F(1,48) = 0.00$.

Nearly all interactions between factors were insignificant: between GO condition and structure complexity, $F(1,48) = 0.27$, GO condition and content familiarity, $F(1,48) = 0.92$, structure complexity and content familiarity, $F(1,48) = 2.37$. The interaction between all three factors approached significance, $F(1,48) = 4.48$.