Envisioning Story: The Eye Movements of Beginning Readers

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ABSTRACT

Miscue analysis and eye movement analysis are used to explore the reading process of first-grade beginning readers as they use pictures and print in a picture book designed for instructional purposes. Eye movement miscue analysis (EMMA) is also used as a tool to gain insights into the reading strategies of the beginning readers in this study. Miscue analysis provides a psycholinguistic analysis of unexpected oral responses in the oral text that readers produce. Eye movement analysis provides an analysis of the visual fixations of readers in the pictures and the print. Both forms of analysis are used to examine the relationship between the oral and visual aspects of the reading process.

This article focuses on first-grade beginning readers' use of pictures and print as they read. Patterns of eye movements relative to picture use, print use, and the relationships between the two media are described, analyzed, and compared.

Major findings include that beginning readers are aware that reading is a complex process of making meaning from print and pictures; they exhibit many of the same reading strategies as older, more experienced readers; and they sample pictures in ways that are purposeful and know where to look for useful information.

It is the first day of the school year and Luke, a first-grader, is reading a Sunshine Series book by Cutting and Cutting entitled *Are You a Ladybug?* (1988). Before Luke begins, he tells me that he really doesn't know how to read because he doesn't know all the words. With encouragement, he agrees to try. He encounters several challenges and handles them in various ways. Sometimes he pauses, looks at the pictures, goes back to the print, and sounds out the first letter of the next word. Other times, he goes back and seems to be studying the picture. For each difficult word that he encounters, Luke eventually makes an attempt. Often his attempt matches multiple sources of information including the graphophonic information that he has accessed, his current syntactic under-standings, his semantic knowledge, his understandings of the picture, and his background knowledge and life experience about story and picture books.

Luke's various attempts to solve difficult words offer a view into his reading process, demonstrating how readers draw upon various sources of information in order to make a reading attempt. Many assessment tools are available to measure how students use all of these sources of information with the exception of pictures. The lack of available evidence about children's use of pictures to read is somewhat surprising, given that children who are emerging into literacy appear to make extensive use of the information provided in illustrations to help them read. In fact, Adams (1990) noted that there is virtually no available information on how beginning readers constructively use pictures to read.

Authors and illustrators of children's literature intentionally create pictures and texts that achieve a wedding of two sign systems: words and illustrations. According to Kiefer (1995), Barbara Cooney, a well-known Caldecott award winner,

> likened the picture book to a string of pearls. She suggested that the pearls represent the illustrations, and the string represents the printed text. The string is an object of beauty on its own, but the necklace can-not exist without the string. Although in picture books a verbal text should certainly be beautiful and bring pleasure in and of itself, Cooney's analogy supports the idea of the interdependence of pictures and text in the unique art object that is a picture book. (p. 6)

Together the subtle weave of words and pictures allow both to tell one seamless tale (Scieszka, 1998). We also know that children are aware of this weaving of pictures and print into one story by their own writing and conversa-tions about pictures and print (Hubbard, 1989; Yaden, Smolkin, & Conlon, 1989).

In this paper, I report the findings of a study that examines whether and how children use pictures in their reading attempts. In addition to collecting

data on students' oral reading behaviors, I also collected data on their eye movements while reading aloud. Combined, these two data sources provide a deeper understanding of what children are noticing and using while they read. Not only does such a study take us beyond surface observations of oral reading behaviors, it also provides a deeper understanding of the reading process in terms of what children are noticing and using as they read.

LITERATURE REVIEW

Most research regarding print and pictures in early reading falls into two categories: (a) word identification and pictures and (b) comprehension and pictures. Studies involving word identification and pictures generally focus on finding out whether or not pictures are beneficial in the teaching of sight words (Samuels, 1977; Singer, 1980; Willows, 1978a; Willows, 1978b). The second set of studies involves older proficient readers reading complete illustrated texts to determine the effects of pictures on comprehension. Vernon's studies (1953, 1958) typify such research in that the focus is one of determining the effects of the treatment of including pictures in a text on reading comprehension (Holmes, 1987; Koenke, 1968, 1980; Koenke & Otto, 1969; Weintraub, 1960, 1966).

Denburg's (1976) study falls outside these two broad categories in that she examines first-grade readers' use of pictures in reading complete texts. Her study suggests that pictures have a positive influence on reading (when defined as word identification) and that beginning readers do use pictures and print together when reading; however, the study does not provide detailed information about how beginning readers use both pictures and print as they read.

During the early 1920s, Buswell (1922) conducted eye movement studies involving first-grade beginning readers. His study explored readers' eye movements relative to the texts, two methods of instruction (word analysis focused and meaning focused), and differing pathways toward a mature reading attitude. He found that while readers exhibited different eye movements related to the method of instruction experienced, these eye movements were not significant (better or worse) if considered in relation to the ultimate goal of mature reading habits.

This study extends the body of research on eye movements and reading by examining the data provided when participants read aloud. I used miscue analysis (Goodman, 1967) to collect and analyze the oral readings of participants in my study. Miscue analysis provides a window on the reading process and the knowledge and strategies that readers employ as they read.

METHOD

Participants

Data were collected from 10 first-grade beginning readers with data from six readers ultimately proving usable. Cory, Esmeralda, Javier, Kimberly, Mac, and Rashaun attended both public and private schools. Esmeralda and Mac were Spanish-English bilingual and biliterate. The six readers represented three ethnic ancestries—Hispanic American, African-American, and European-American—as well as diverse socioeconomic groups.

Data Collection

I intentionally used a text designed for instructional use in schools that a first-grade beginning reader might be able to read without support but one which would elicit some miscues in the reading. After experimenting with several texts, I selected *I Saw a Dinosaur,* a Literacy 2000 Stage 2 Set D book published by Rigby, written by Joy Cowley (1988), and illustrated by Phillip Webb.

I collected three sets of data for each reader. The primary set was in the form of the oral reading with the eye movement data. There were two secondary sets of data: a modified Burke Reading Interview and retellings, which were used to uncover readers' conceptualizations of reading and to confirm their comprehension of the stories that they read. The retellings are a standard component in any miscue analysis. The data were collected using an ASL model 5000 eye-tracking machine, a computer to record oral data, and an audiocassette recorder to collect back-up and additional oral data.

Analyses

Paulson (2000) used eye movement research in conjunction with miscue analysis to create a hybrid form of analysis that he has called EMMA (eye movement miscue analysis). EMMA uses both miscue analysis and eye movement to examine the relationship between eye movements and miscues that readers produce as they read in order to reveal the complex relationships between where the eye has been directed by the brain and what the voice is producing as an oral text.

I performed three levels of analysis: miscue analysis of the reading, eye movement analysis of the reading, and EMMA of the reading. A total of 1,308 eye fixations on print were analyzed. Again, eye movement and EMMA are the focus of this article.

Findings

First-grade beginning readers in this study fixated (or looked at) print, pictures,

and other areas as they read the complete text. They fixated print more frequently than pictures. On average, 55% of the fixations were in print and 36% of the fixations were in pictures. The remaining 9% of fixations were in other areas outside the print and picture fields.

In terms of fixation duration (time spent fixating) of these three areas, the readers devoted 73% of their time viewing print, 21% of their time on pictures, and 6% on other areas outside the print and picture fields. All readers had average fixation durations in print that were greater than their overall average fixation durations of the three categories combined (print, pictures, and other). Rayner has replicated this finding in a recent print-picture study with adult readers viewing magazine advertisements, in which he reports that subjects spent 67%, 73%, 72%, and 77% of their time reading the text (Rayner, personal communication, 2001).

All readers had average fixation durations in pictures that were less than their average fixation durations of the three categories combined (print, pictures, and other). All readers had average fixation durations in print that were almost double their average fixation durations in pictures.

None of the readers fixated every word in the text; readers' nonfixation rate varied from 9% to 34% of the words in the text. Figure 1 illustrates where Rashaun fixated and did not fixate as he read page 6. The lines between the
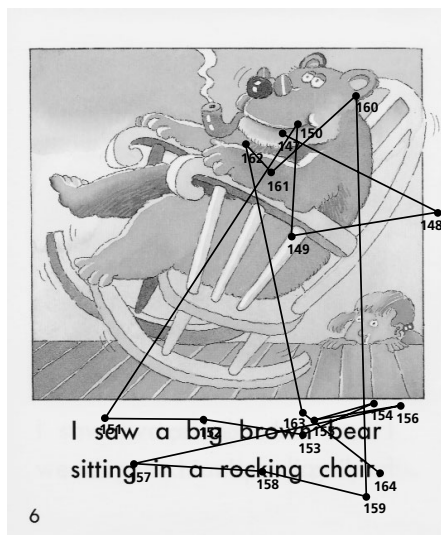
Figure 1. Eye Movements Showing Fixations and Saccades

dots represent saccades, (eye movements between fixations) during which no useful graphic information is transmitted to the brain. Previous eye movement research has substantiated the occurrence of nonfixations during reading (Just & Carpenter, 1987; Paulson, 2000; Rayner, 1997).

Like Paulson's (2000) readers, the first-grade readers in this study did not always fixate words serially from word to word, left to right. As they read, readers engaged in regressive eye movements within print or transitioned from print to pictures and then back to print. They also engaged in fixations that shifted vertically from line to line and diagonally across the print field. Readers did not always fixate words for the same amount of time. They did not always fixate at the center of words, horizontally or vertically. There was a low incidence of fixations that fell between lines of print, between words, and in the blank margins of the page.

All readers spent less than 1.5 seconds in fixating pictures prior to entering print. For monolingual speakers, this amount of picture-viewing time prior to entering print was even further reduced to less than .5 second.

Bilingual readers in this study fixated pictures and print more frequently and for longer periods of time than their monolingual counterparts. Bilingual readers' average fixation times were longer than those of monolingual readers. These findings regarding bilingual readers are not new eye movement research. Cattell (1886) found that second-language readers took more time to read texts. Almost a century later, Oller and Tullius (1973) further substantiated this finding. Although bilingual readers fixated pictures and print more frequently and for longer periods of time, their fixation durations were proportionally similar (in terms of percentages) to monolingual readers.

Among all readers, 20% transitioned from pictures back to print by moving to a word prior, 45% by moving to the same word, 26% by moving to a word beyond, and 9% by moving to other areas outside word boundaries.

On average, regressive eye movements (eye movements which move backwards in the text) accounted for 14% of all eye movements. Regressions within sentences (moving backward across word boundaries within a sentence) accounted for 52% of all regressive eye movements, while regressions within words (moving backward within word boundaries) accounted for 46% of all regressive eye movements.

As Table 1 illustrates, in instances of words with multiple occurrences, readers fixated the same word (in this example, the word *a*) in different contexts for different durations (amounts of time). In some contexts they did not fixate the word at all.

When sampling pictures, readers devoted a majority of their time (fixation duration: 90%) and fixations (number of fixations: 89%) sampling major components such as characters and objects within the pictures.

The first-grade beginning readers in this study were more likely to not fix-

Table 1. Total Fixation Durations (in Seconds) on the Word *A*
in Multiple Contexts

Word	Page	Cory	Esmeralda	Javier	Kimberly	Mac	Rashaun	Average
a	2	0.85	1.16	0	0	1.07	0	0.51
a	3	0	0.53	8.99	0.71	0.94	0	1.86
a	5	1.33	0.31	0	0	1.36	0	0.50
a1	6	0	2.59	0	0.52	0.58	0	0.61
a2	6	0.46	0	0	0.95	0.9	0	0.38
a	7	0.56	1.56	0	0.73	0	0	0.55
a	8	0.48	4.31	2.33	1.57	1.93	0.18	1.52
Total Duration		3.68	10.46	11.32	4.48	6.78	.18	6.02
Average		.52	1.49	1.61	.64	.95	.02	.86

ate function words than content words. On average for all readers, 82% of non-fixated words were function words. This is a common finding within eye movement research. Paulson (2000) found that his readers fixated 79% of the content words and just 46% of the function words. Just and Carpenter (1984) found that 74% of content words were fixated, while only 40% of function words were fixated.

Readers were also more likely to transition from print to pictures at content words. On average, 91% of all transitions from print to pictures were from content words.

EMMA analyses involved examining readers' oral miscues relative to eye fixations within the eye-voice span across the reading of the complete text. Eye-voice span refers to the phenomenon that readers' eye fixations are generally ahead of their voice as they read. EMMA analyses revealed that first-grade beginning readers in this study engaged in picture sampling prior to producing a miscue 86% of the time. Readers sampled from pictures prior to omissions 91% of the time. All readers fixated miscued words well beyond their personal average fixation duration prior to miscue production 94% of the time. Paulson (2000) reports similar findings. In cases where miscues were corrected, post-miscue fixations on the same word occurred 100% of the time. Readers also engaged in regressive eye movements, transitioned to pictures, or both, 100% of the time when miscues were corrected.

In cases where readers produced oral repetitions, regressive eye movements

or picture sampling, or both, preceded the oral repetition. During oral pauses, readers engaged in fixations of extended durations or multiple fixations. In most cases, these extended fixations or multiple fixations included picture sampling. During oral pauses, all readers were active in terms of eye movement, indicating equal brain activity. The data analyses related to oral pauses and eye movements show clearly that although readers' voices may be inactive, their eyes are not. Since eye movement is brain-directed, this can only mean that both readers' eyes and brains are active during oral pauses. When teachers interrupt readers during oral pauses, they interrupt readers' thought processes toward independently making sense of the information that they are sampling from print and pictures as they read.

Discussion

The readers in this study apparently sampled both pictures and print in ways that were strategic and systematic in order to orally construct a text that made sense. They demonstrated awareness of the systematic nature of their actions. They used pictures and print in ways to construct meaning that transmediated (Leland & Harste, 1994) both media.

The readers employed a variety of reading strategies for making sense of the text as they read. They used their knowledge of oral language, their knowledge of written language, information from the printed text, and information from the personal text that they were constructing as they read.

As they read, the readers made decisions about where useful information would be located. These decisions were based on information that the text offered and on the evolving text that the reader was constructing.

In relation to picture and print use, readers spent more time sampling print than pictures; however, this is not to imply that the pictures were without value. Readers sampled from pictures in ways that appeared to be purposeful and systematic. Their sampling of pictures relative to print suggests that they were well aware of the relationships between pictures and print and how to effectively access those relationships. In sampling pictures and print, they devoted the majority of their time to the major meaning carriers in both media. In pictures, they sampled from the major components (characters and objects) which were key sources for information regarding who and what were central to the story as well as the actions between characters and objects. Thus, the sampling of major components in pictures provided the reader with information regarding nouns, adjectives, and verbs. Within print, readers knew enough to sample more frequently from content words (nouns, adjective, adverbs, and verbs) because these words are the major meaning carriers in print. Readers' systematic transitioning from content words to major components in pictures indicated that they were well aware of the fact that content words in print and

major components in pictures are related in terms of informational value.

Readers were less likely to fixate function words. As readers progressed throughout the text, they learned more about how the text was constructed. As a result, they were able to make more informed predictions about what was coming next and where valuable information would be located in the print. They arrived at places in the text where constraints of the text and their knowledge of English were so strong that they were able to confidently predict function words, making it unnecessary to fixate those words in order to produce them orally.

The sampling of pictures and print played key roles in correction strategies. Readers regressed and refixated the miscued word and generally resampled the picture. Their knowledge of the relationship between content words and major components in pictures proved informative in the correction process. They seemed to know where they would find useful information in order to confirm or disconfirm the text that they were producing and where to get cues to textual constraints in building meaning.

Reading is a constructive process. The first-grade beginning readers in this study used the same reading processes as adult readers, but perhaps because they were less experienced, the readers in this study sampled the pictures and print more frequently than older, more experienced readers.

Implications

Educators need to be aware that pictures do not constitute a distraction in the reading of picture books. Practices such as covering the illustrations to force readers to focus on print only create a further fracturing of the reading experience and makes reading more difficult.

The fact that readers in this study (and proficient adult readers) do not fixate every word as they read implies that reading is not a word-by-word identification process. If instruction focuses on having readers fixate every word in print, the reading process will be influenced in ways that run contrary to what proficient readers do when reading. Instructional practices that demand that readers look at every word (or every letter) will slow down the reading process, making comprehension more difficult.

Educators need to realize that when readers miscue, it is not because they have not thoroughly examined the word on which the miscue occurs. The data from this study and Paulson (2000) show that miscues occur only after readers have thoroughly examined the text and rejected what it offers because it does not fit with the syntactic, semantic, or pragmatic knowledge that the reader brings to the text.

Proficient readers are sometimes characterized by their ability to identify words in any context in an equal amount of time. By this definition, good read-

ers are accurate automatic word identifiers; however, the data from this study strongly refute this idea. Instead, the data show that readers make contextually influenced adjustments to the time devoted to viewing words based on the printed text and the oral text that they are producing as they read. There are instances in which the reader's oral text and the printed text conjoin and the reader predicts words without ever fixating them. Likewise, there are instances in which the reader's oral text and the printed text strongly diverge. The data in this study show that at such points, readers exhaustively examined the print and picture resources offered and consciously rejected what does not make sense or fit with the oral text that they were producing. In both cases, the contextual and textual constraints conjoined to support the dynamic emergence of text.

EMMA analyses found that the readers in this study exhibited the phenomenon of eye-voice span that has been historically reported in eye movement research. The concept of eye-voice span calls into question instructional practices that ask readers to match oral text to print. If flexible eye-voice span is the mark of proficient readers, then is it effective to ask readers to match voice to print? If so, under what conditions is this practice effective, for what purposes, and for how long? Additionally, teachers need to realize that the concept of eye-voice span challenges the idea that when readers' voices are producing an oral text, the point of oral production and the location of the eye in collecting information are not synonymous.

The data from this study also indicate that when readers pause in oral reading, they are sampling picture and print resources to make sense of the text. Traditionally, educators have been encouraged to consider oral pauses as a sign of readers' inactivity and a plea for help. However, the data from this study suggests this may not be the case. Instead of interrupting readers' thought processes during oral pauses, educators might wait to see what readers decide to do or to acknowledge that readers are working and then ask them what they want to do. An oral pause is a strategic learning opportunity in which readers integrate information from the three cuing systems in order to make sense of pictures and print. These are the moments at which readers make decisions regarding strategies that they can employ to make meaning. If educators interrupt to tell them the word, they may be taking away an important strategic learning opportunity.

The data in this study support a transactive socio-psycholinguistic model of reading (Goodman, 1996) because the model accounts for and explains reasons for readers' performances in this study including nonfixated words, words with multiple occurrences with varied fixation times ranging from zero to 8.99 seconds, textual influences on readers' production of miscues in one context and not another on words with multiple occurrences, regressions across large linguistic units, and readers' extended fixation times on words prior to miscue production.

Limitations

The study is limited in terms of the number of informants involved; however, it serves as a baseline study to which subsequent reading research may add.

The length of the text (55 running words) is an issue because miscue analysis generally works with texts that are longer than 250 words in length. Research (Menosky, 1987) has shown that the quality of miscues changes substantially after the first 250 words; however, I intentionally chose a short text because I wanted to achieve a match with the kind of text commonly used in the classroom. While this text is generally used for instruction, it does not come from basals, which are more frequently used in classrooms than the kind of material that *I Saw a Dinosaur* represents. A contrastive study, therefore, involving trade books and instructional texts might prove informative and beneficial.

The study is also limited by the small number of miscues produced by readers in this study. Miscue analysis researchers generally agree that at least 25 miscues are needed in order to be able to gain insight into the reader's miscue patterns and reading strategies. Across all readers in this study, a total of 53 miscues were analyzed, and a total of 2,347 eye fixations were examined and analyzed. Although there were 55 running words in the text, not all words were fixated with equal frequency. At times words were not fixated at all; at other times, words were multiply fixated, resulting in more than one fixation per word.

Finally, analyses within this study involved the use of traditional eye movement research in which eye fixations were ascribed to words and within word boundaries. Technically speaking, eye fixations do not always fall neatly within word boundaries. At times the graphic information that falls within the foveal field (the area of greatest visual acuity) falls across word boundaries or across boundaries of lines of print. Therefore, the traditional use of word boundaries in ascribing the location of fixations is an additional limitation of this study. The phenomenon of ascribing fixations to words and ignoring beyond word boundary or multiple word boundary fixations has not been challenged within eye movement research. The idea of arbitrarily forcing eye movements to fit within word boundaries distorts the data—to what degree, eye movement researchers will not know until we begin to examine and compare fixations based on foveal boundaries and fixations arbitrarily ascribed at word boundaries.

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