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1

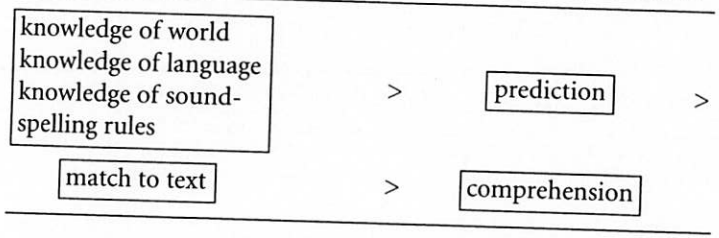
Eye Fixation Studies Do Not Disprove the Goodman-Smith Hypothesis

Trying to pinpoint meaning by studying where the eyes fixate can be like trying to study digestion by analyzing knife and fork movements.

—FRANK SMITH, *UNDERSTANDING READING*

The Goodman-Smith view of literacy development hypothesizes that literacy development and comprehension are closely related (Goodman 1982; Smith 1994), in agreement with the Input Hypothesis (Krashen 1985). Figure 1–1 illustrates the Goodman-Smith hypothesis. Before readers encounter a piece of text, they have made predictions about what they are about to read. These predictions come from their knowledge of the world, what they have read so far, and their knowledge of language, which can include knowledge of sound-spelling correspondences. They then look at the text to see if it matches what they have predicted. If the match is "close enough," the text is "understood." In other words, their prediction has been confirmed. A crucial aspect of this

Figure 1–1
The Goodman-Smith Hypothesis for Reading Comprehension



view is that readers do not have to notice every detail of the text; they only have to confirm that it is the predicted text. It is also important to note that the model does not predict that readers will be able to guess the next word of any text they happen to be reading; rather, their knowledge of the world, the text, and language helps them reduce the alternatives, which relieves them of the burden of having to note every detail of the text.

Language acquisition and literacy development can occur when the reader encounters new aspects of language in the text that he or she has not yet acquired but is developmentally "ready" to acquire; this could be new sound-spelling correspondences, new vocabulary, or new grammar.

One of the oft-repeated arguments against this view and in favor of "skill-building" approaches are reports that readers "completely sample the visual array" (Stanovich 1986), that they do not engage "in the wholesale skipping of words, nor are they markedly reducing their sampling of visual features from the words fixated" (368). This finding appears to contradict the view that fluent readers make predictions and utilize text only to confirm these predictions.

I expand here on a point already made by Smith (1994, 87): Studies showing complete sampling of text are studies in which

eye movements are monitored while subjects read. What is crucial is that in these studies, subjects are put in a situation in which intensive, detailed reading is necessary: No other strategy is possible. In eye-fixation studies, one or more of the following conditions is present:

1. In all eye-fixation studies, texts are selected by the experimenter, with no consideration of readers' interests. Many of the studies, in fact, do not even use coherent texts; subjects read individual words and sentences (e.g., Rayner and Morris 1992). When texts that are more coherent are used, they are typically irrelevant to the reader and are sometimes quite difficult.

   In Just and Carpenter (1980), for example, college students read texts selected from *Time* and *Newsweek* on scientific discoveries, technical inventions, and biological mechanisms. Just and Carpenter point out that most students were not familiar with the information contained in the passages. Here is an excerpt from one passage:

   > Flywheels are one the oldest mechanical devices known to man. Every internal combustion engine contains a small flywheel that converts the jerky motion of the pistons into the smooth flow of energy that powers the drive shaft. The greater the mass of a fly-wheel and the faster it spins, the more energy can be stored in it. But its maximum spinning speed is limited by the strength of the material it is made from. (334)

   Unless you are really interested in mechanics, the eyes don't move much. In fact, they glaze over.

   Just and Carpenter (1987) point out that their readers fixated nearly as frequently (77 percent of the content words) on a "less technical" article from *Reader's Digest*. This less technical article "described the expeditions of John Colter, an early

nineteenth-century explorer who traveled through the American West" (431–432), a passage I suspect would be of great interest to a minority of readers.

Just and Carpenter (1980) conclude from their studies that in "ordinary" reading, "almost all content words are fixated" (329), noting that this applies to narratives as well as scientific texts. They also, however, note the following:

> Of course, this is not the case when adults are given simple texts, such as children's stories; under such circumstances, these same studies show an increase to an average of two words per fixation. (330)

In other words, as reading is made less demanding, eye fixation behavior becomes more normal.

2. In all eye-fixation studies, readers are asked comprehension questions or are asked to summarize the passages after they read them; they must try to remember what they read as they read it, which is certainly abnormal behavior. This is true in all eye-fixation studies I have read.

   Subjects in Just and Carpenter (1980) were told not to "memorize," but they knew they would be asked to orally summarize the passages after they read them. In addition, they were asked "not to reread the passage or parts of it" (335). It is thus no surprise that the readers fixated on more than 80 percent of the content words in the passage.

   In Ehrlich and Rayner (1981), comprehension questions were asked either before or after reading the passage, and subjects were told that "the most important part of the experiment was to be able to answer the questions" (644). In Rayner et al. (1991), subjects were asked to read five- to eight-word sentences and then "report the sentence verbatim (or paraphrase it, although subjects tended to report the sentence verbatim)" (168). After the subject reported as much of the sentence as possible, "the experimenter recorded the subject's response and gave feedback by reciting the stimulus sentence" (168). This is strong encouragement to read carefully.[1]

3. In eye-fixation studies, readers are placed in an awkward physical position for reading, making it harder to focus on the text and meaning. As Smith (1994) has noted, in some studies subjects cannot even move their heads, because of chin rests, bite plates, or helmets (255). In addition, quite often texts are read off computer screens that allow subjects to see only one line at a time. Making the situation even more artificial, in some studies, before reading the text, readers

   > must look at an asterisk located in the upper–left hand corner of the screen (where the first word will eventually appear) and at the same time press a "ready" button. If the reader's point of regard is not within one degree of the fixation point, then the text is not displayed, and the experimenter must recalibrate. If the accuracy is adequate, then the text appears on the screen and remains there until the reader indicates that he or she has finished reading by pressing a "done" button. Then the fixation point reappears and the subject initiates presentation of the next screen as just described. (Just and Carpenter 1984, 153)[2]

To summarize: In eye fixation studies, readers are asked to read something they did not select and that may be either bland or boring but is surely irrelevant to the reader; readers are placed in a Clockwork Orange–type contraption while reading; the text is presented on a computer screen; and readers are told they have to try to remember what they are reading as they are reading it. In addition, they are sometimes told that there might be odd spelling errors in the text but they should ignore them (e.g., Zola 1984). It is hard to imagine a stranger situation.

Rayner and Pollatsek (1987) feel that "these concerns are ill founded," noting that Tinker (1939) showed that "reading rate and comprehension of subjects in a soft easy chair with a book did not differ from the reading rate obtained in the eye-movement laboratory" (24). It is true that Tinker's subjects had equal performance in rate and comprehension when reading in front of the camera and when reading without the camera. Subjects in the "normal condition" were not, however, in an easy chair, as Rayner and Pollatsek claim; rather, they were reading "at a table" (Tinker 1939, 742). In all conditions, Tinker's subjects read passages that were not self-selected (paragraphs from the Chapman-Cook Speed of Reading test), and comprehension questions were asked. Thus, Tinker only showed that photographing eye movements did not significantly alter reading speed and comprehension on tests of reading comprehension, a situation in which most people would read intensively, focusing on details. Eye-fixation studies do not tell us about fixations during ordinary reading of self-selected material that readers are interested in reading, without comprehension testing.

Despite the fact that conditions in eye-fixation studies force careful reading, the results are surprisingly consistent with the hypothesis-testing view. Ehrlich and Rayner (1981) and Zola (1984) reported that when subjects read words that were highly predictable from context, fixation duration was reduced. Ehrlich and Rayner feel, however, that their results do not support the hypothesis-testing position because in their view the hypothesis-testing position predicts no fixation at all for very predictable words; partial information from the parafovea should be enough. The hypothesis-testing view does not necessary predict zero fixation in these cases. Rather, the reader needs to note enough of the word to confirm what it is. With more predictable text, this fixation will be less thorough and take less time, but not necessarily zero time. And this is what the research shows.

Zola (1984) reported that his subjects fixated longer on words with small spelling errors, even when the words were highly predictable from context, a result that appears to conflict with the view that readers use minimum visual information. As in other studies, however, the conditions promoted very careful reading. Even so, as noted above, Zola's subjects fixated a shorter time on predictable words, which is consistent with the hypothesis-testing position.

Additional evidence that readers do not focus on every detail comes from Rayner et al. (1991). In this study, readers read text through a window that only allowed them to see a few letters at a time. Rayner et al. reported that "reading performance (rate) improved with increasing window size" (170). When the window only allowed a few letters, reading was "difficult but not impossible" (170). This result suggests that it is not necessary or desirable to focus on every letter.

Speed Readers: An Alternative Interpretation

Just, Carpenter, and Masson (1982; cited in Just and Carpenter 1987) compared fixations of normal and "speed" readers. My interpretation of their results is that dense fixations are not "normal." Just, Carpenter, and Masson reported that non–speed readers fixated on 77 percent of the content words (readers of the Colter passage from *Reader's Digest*), while speed readers only fixated on 40 percent of the content words. As usual, comprehension tests were administered, making the entire situation unnatural. Just et al. reported that normal and speed readers produced summaries of the passage of equal quality. The normal readers, however, did better on a reading comprehension test. Just et al. conclude that "the summaries are imprecise indicators of comprehension" (Just and

Carpenter 1987, 447). In my view, the summaries are more valid than the reading comprehension test: Just, Carpenter, and Masson's results actually show that speed readers do perfectly well in reading for their own purposes, but do not do especially well when reading according to someone else's agenda.

Notes

1. Brady and Moats (1998) argue that just the opposite is true, that "asking participants about the content of what they read is a realistic way to assess if they were reading normally" (9). But when readers know in advance that they will be quizzed on the content of what they are reading, or know that they will have to paraphrase what they are reading, the process is not normal: Instead of focusing on understanding the message (the route to long-term memory), readers in this condition will try to put information in short-term memory while they are reading—they will make a deliberate effort to remember, a process that disrupts comprehension (Smith 1998).

2. Brady and Moats note that this kind of situation "is not the way someone would like to sit to read for pleasure" but ask whether there is any theoretical rationale "that holding one's head still and reading off a monitor alters the cognitive requirements of reading" (9). Of course there is: Head movements are a natural part of reading, as is allowing the reader to focus on what he or she wants to focus on. Restricting subjects' gazes so they must read what and where someone else tells them to read is violating what is perhaps the most central aspect of normal reading.

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