

Does the Degrees of Reading Power assessment reflect the reading process? An eye-movement examination

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The modified cloze procedure demands an interruption of normal reading processes.

A weighty task for most high school and college reading specialists is accurate placement testing. While we want to be certain that all students who need support in reading get it, we are also well aware that misplacement has serious consequences. However, if we are reading specialists for whom Smith's (1994) conclusion that "comprehension cannot be measured" (p. 53) rings uncomfortably true, then accurately assessing reading ability is the educational equivalent of tilting at windmills. But tilt we must, because not only do we need to place students in appropriate reading classes, but often we must also provide some objective indication of our students' progress in reading as evidence that they are prepared to meet the next set of academic demands. Ideally, we might also hope that our assessment instruments could give us insight on the strengths and needs of our students—not just their percentile rank among peers, which tells us little more than that they are struggling in some unknown way. This sort of insight would help us develop more beneficial instructional approaches.

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Although we suspect that all commercial reading assessments are imperfect measures of a process as complex as reading, our mission is to select one that most closely resembles our theoretical understandings of what reading is. However, even that is difficult. Excellent reviews of reading assessments on the market today, such as Flippo and Schumm (2000), fall short of perfection in that they evaluate if the test measures what it claims, rather than what it should be measuring. While our instincts as experienced readers and teachers can be a

key evaluative tool in determining whether an assessment provides us with a theoretically congruent evaluation of our students' reading, often we are too inexperienced with test construction, statistical analyses, norm referencing, and reliability to feel comfortable relying upon something as unscientific as our intuition. We are left to base our choice of assessment tool on the promotional claims made by the test's publisher. In this study, we use readers' eye movements to examine a crucial claim about a popular reading assessment, the Degrees of Reading Power (DRP), made by its publisher, Touchstone Applied Science Associates (TASA Literacy).

The purpose of this article is to investigate the reading process as it pertains to readers taking

the DRP assessment. This process is examined through analyses of readers' eye movements—an analytic tool that adds a new layer of insight on what happens to students' reading when they take a placement or exit exam such as the DRP. While most reading specialists are aware of the existence of eye-movement research in the reading field, to many educators such research unfortunately connotes a word-centered view of reading in which the subject "reads" words flashed on a tachistoscope, or experiments where text is altered in some fashion and authentic context is ignored. In fact, that may be an accurate characterization of much eye-movement research that has taken place since the 1960s. However, the science of eye-movement tracking is more than a century old, and techniques in use during the early part of the 20th century show a focus on readers reading authentic, complete texts for meaning, with generalizations being drawn from readers' eye-movement behavior over the course of an entire text, instead of a word or two (e.g., Buswell, 1922; Huey, 1968/1908).

In addition, several recent studies show a return to using eye movements to study readers' responses to entire texts (Duckett, 2001; Freeman, 2001; Paulson, 2000, 2002), and that is our focus here. Instead of looking at the eye tracker as a way to measure subject response to presentations of a single word or sentence, we view the eye tracker as a "tape recorder for the eyes"—an unobtrusive recording device that provides a real-time window on the reading process.

Using eye-movement recording as a data source, we examined students' reading while they were taking the DRP for the simple reason that, of the commercially available testing programs, it is the only test that is claimed to "measure the reading comprehension *process*" (emphasis added) (TASA Literacy Information, 2002; <http://www.tasaliteracy.com/drp.htm>). A test that actually "measures the reading comprehension process" could reveal how a reader comprehended a text, instead of merely whether the reader comprehended the text. Such a test would provide us

with invaluable insights about the reading strategies a reader does or does not bring to the text—in other words, his or her strengths and needs, which would allow us to provide useful instruction that marshals these strengths and addresses the areas in which a student struggles.

The modified cloze setup of the DRP is intended to reflect and measure the process of reading, as opposed to the product of reading, which is often measured by comprehension questions at the end of a passage (e.g., the Nelson-Denny Reading Test). This claim is a strong selling point of the DRP because many college reading programs are searching for assessment measures that can provide insight on a student's reading process (Valeri-Gold, Olson, & Deming, 1991). Our aim in designing this study was to use eye-movement tracking to explore the ways in which students' reading process during the DRP might, or might not, resemble the reading process at work in their reading of other materials so that we might evaluate the claims made by the publishers of the DRP.

Description of the Degrees of Reading Power reading assessment

Detailed descriptions of the DRP can be found in Flippo, Hanes, and Cashen, 1991; in Flippo and Schumm, 2000; and from Touchstone Applied Science Associates (TASA) at its website, mentioned previously. The version used at the secondary and postsecondary level is a modified cloze test consisting of 10 passages with seven blanks in each 325-word passage. To the right of each blank there are five words from which the student chooses the one that best completes the cloze. Figure 1 contains an excerpt from TASA's promotional material (http://www.tasaliteracy.com/prod_fr.htm) that illustrates the format of the DRP (reprinted with permission of Touchstone Applied Science Associates).

The student must understand the text—or at least the sentences preceding, following, and in

Figure 1
Example of DRP passage

Bridges are built to allow a continuous flow of highway and railway traffic across water lying in their paths. But engineers cannot forget that river traffic, too, is essential to our economy. The role of 1 is important. To keep these vessels moving freely, bridges are built high enough, when possible, to let them pass underneath. Sometimes, however, channels must accommodate very tall ships. It may be uneconomical to build a tall enough bridge. The 2 would be too high. To save money, engineers build movable bridges.

- | | | |
|---|----------------|-----------|
| 1 | (a) wind | (b) boats |
| | (c) weight | (d) wires |
| | (e) experience | |
| 2 | (a) levels | (b) cost |
| | (c) standards | (d) waves |
| | (e) deck | |

Note. Reproduced by permission of the publisher. DRP® and Degrees of Reading Power® are registered trademarks of Touchstone Applied Science Associates (TASA).

which the blank appears—in order to choose the best answer. Burrill (1987) explained,

DRP test items are embedded directly in the passages and answered while the student is reading. Since the embedded item is content-neutral, and since all adoptions are semantically and syntactically correct in the sentence when read out of context, getting the correct answer is clearly a function of having read and understood the surrounding text. Although the definition of reading comprehension assessed by the DRP tests is narrowly defined as the process of comprehending the surface meaning while you read, the tradeoff is that one can be very sure background knowledge and other extra-language abilities are not confounding the comprehension measure. (pp. 69–70)

While we can argue that “background knowledge” and “extra-language” abilities are important aspects of the reading process, they do confound standardized assessments that, for the purpose of comparing a student’s reading ability to that of his or her peers in order to establish generalizable benchmarks, must level the playing field by eliminating these factors. However, because of the DRP publisher’s claims, what we should be left with, in spite of these surgical strikes, is an assurance that “the purpose of the DRP is to measure the process of reading” (Flippo & Schumm, 2000, p. 437).

However, in previous studies, it has been suggested that “cloze reading is not like ordinary reading” (Ashby-Davis, 1985, p. 587), and that cloze-type assessments “certainly altered reported reading processes” (Powell, 1988, p. 165). As the DRP is a modified cloze, it may fall prey to some of these criticisms and has, in fact, been criticized for a lack of transferability of its assessment scores to reading authentic texts in the real world (see Carver, 1985; Price & Schwabacher, 1993). Because the primary strength of the DRP is its claim to test the reading process, and previous studies have found that similar assessments alter reading processes, this study will examine whether the DRP does indeed reflect actual reading processes.

Eye-tracking apparatus

Because eye movements have been shown to be an effective tool for understanding the process of normal silent reading (Rayner & Pollatsek, 1989) this study analyzed the eye-movement records of readers taking a portion of the DRP, as well as when they read other texts. An Applied Science Laboratories Model 504 Eye-Tracker was used to record eye movements. Because the Model 504 uses remote optics technology, no part of the eye tracker needs to touch the reader; this system is

unobtrusive, and readers are able to ignore the apparatus. The eye tracker records eye position by measuring pupil and corneal reflections with an infrared reflection source and is accurate to within half a degree of vision angle. The eye-movement data are captured and produced as a series of x and y coordinates, which analysis software superimposes on a bitmap image of the text that was read. Fixation order and duration are available, that is, where the reader looked and for how long the reader looked there. In addition, the eye-tracking system produces a small, gray, rectangular cursor, which reflects the reader's eye position while reading and is superimposed on a monitor (not viewed by the reader) that displays the text during the reading. The cursor, and its real-time position on the text, is viewed on a monitor and captured on videotape.

Procedure

The study examines the eye movements of 10 readers, including African American and European American women and men, who were undergraduate students (mean age 19) at a large university in the United States and volunteered their participation. All were effective readers with vision correctable to 20/20 and no learning disabilities. Before reading the texts that were analyzed for this investigation, the participants read practice materials, including DRP practice test items, designed to alleviate any trepidation or nervousness they might have felt. They then read three passages from the same DRP test. Passage 1 and Passage 2 are DRP passages that had the cloze blanks filled in with the appropriate answer; that is, these passages appeared to be unaltered, normal text. Passages 1 and 2 can be thought of as baseline passages. In contrast, Passage 3 is a passage from the DRP that retained the cloze blanks and choices for each blank, as it appears in the test itself. Because text passages in the DRP get more difficult as the student progresses through the test, the baseline passages were chosen because one precedes Passage 3 and one is subsequent to Passage 3 in the actual DRP. Thus,

differences in eye movements between the baseline passages and the target passage are not attributable to a difference in text ease or difficulty. Readers read Passages 1 and 2 silently, then retold the texts as a measure of comprehension. Next, the DRP exam procedures and instructions were explained to them, and they tried a practice item before reading Passage 3 silently and choosing their best answer for each cloze item, just as they would when taking the DRP. Table 1 illustrates the texts in the order they were read.

Results

Studying the movement of a person's eyes while he or she is reading provides researchers with a window on the perceptual and comprehension processes that take place during reading. For example, readers fixate or pause for longer periods on unfamiliar, technical, or ambiguous words that cause them processing problems (Just & Carpenter, 1987). The opposite is also true; Rayner and Well (1996) demonstrated that predictable words are fixated for shorter periods than words that are not predictable in that context. In addition, readers return to parts of the text that are important, as well as those that failed to confirm their expectations. Because readers' eye movements indicate parts of the text they are attending to, researchers have used the eyes' movements to infer reading processes. As Just and Carpenter explained, a reader's eye movements and fixations are an indication of current cognitive processes:

The time that a reader spends on various parts of a text and the places where he fixates or rereads the text are excellent indices of the ongoing psychological processes. The time a reader spends on a word or phrase can indicate when a process occurs and how its duration is influenced by characteristics of the text, the reader, and the task. (p. 5)

In short, the location and duration of readers' eye fixations are indicators of areas of the text being attended to, with multiple fixations or

Table 1
Texts read

DRP baseline excerpt 1:	DRP baseline excerpt 2:	DRP test excerpt:
Altered this excerpt from the DRP to no longer be a cloze text; appeared to readers to be normal passage.	Altered this excerpt from the DRP to no longer be a cloze text; appeared to readers to be normal passage.	This excerpt from the DRP appeared verbatim; students completed cloze test as if actually taking the DRP.
Appears in the actual DRP <i>prior</i> to the DRP test excerpt (and is thus a "less difficult" text).	Appears in the actual DRP <i>subsequent</i> to the DRP test excerpt (and is thus a "more difficult" text).	Appears in the actual DRP between the two baseline passages.
Readers read silently, then retold passage to researcher as comprehension check.	Readers read silently, then retold passage to researcher as comprehension check.	Readers read and completed excerpt from the DRP.

regressions and long durations being associated with difficulties in comprehension. Researchers generally use several common measures of eye movements when comparing readers and readings: the percentage of words fixated, the duration of the fixations, and the percentage of fixations that are regressions. Generally about three fourths of the words in a given text are fixated, with durations averaging around 300 msec. Regressions usually make up 10–15% of all fixations. As an example of an eye-movement record well within "normal" range of eye-movement measures, one of the baseline passages is provided in Figure 2. The eye movements of one of the readers is overlaid on top of the text; each dot represents a fixation, and the lines between each dot indicate the order of the fixations (i.e., the movement of the eyes). The words and letters of the text have been obscured because, with the exception of the excerpt from DRP promotional materials, TASA Literacy denied permission to reprint passages from the DRP texts we used.

This example is typical of how the readers read the two baseline passages overall; readers fixated on an average of 72% of the words, the average duration of each fixation was 335 msec, and 13% of their fixations were regressions. As one

would expect, these figures are all well within normal range for adult readers; the eye-movement pattern looks efficient and effective. While eye movements alone cannot definitively determine whether or not comprehension has taken place, the absence of certain inefficient and ineffective eye-movement patterns is an indicator that there were no obvious areas of difficulty for the reader. Patterns such as several contiguous series of regressions, multiple fixations on a single word, or long durations on a word signal tentativeness or difficulty with that portion of the text (Rayner & Pollatsek, 1989). Other patterns can indicate "error recovery"—the process of revisiting and rereading a miscomprehended area (see Carpenter & Daneman, 1981; Fletcher, 1991; Frazier & Rayner, 1982, for examples of these patterns).

Figure 3 is the same reader's eye movements while taking a section of the DRP. Because of the numerous fixation points superimposed and the necessity to obscure the words for publication, it may be difficult to ascertain where the cloze blanks in the paragraph are located; in general they are directly across from the first choice in each group of choices. Note the drastic change from the passage in Figure 2, which has no cloze

structure, to this passage, which uses the DRP's modified cloze setup.

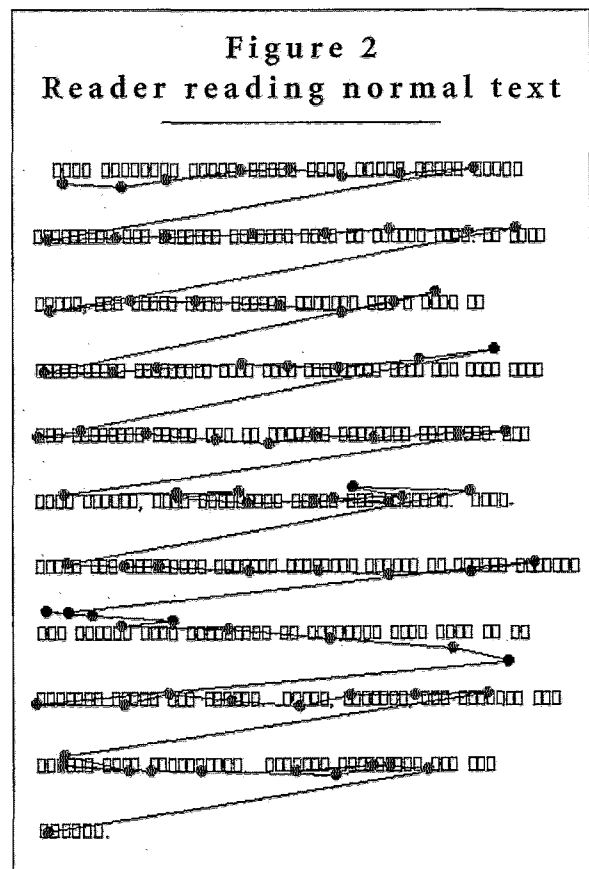
The difference between the two eye-movement records is striking. While this reader's eye movements indicated an efficient, controlled process of meaning construction while reading the no-cloze baseline passage, the same reader demonstrates an entirely different visual approach when taking the DRP in Figure 3. The DRP illustration has a frenetic, almost random appearing manifestation of eye movements. Gone is the smooth, logical progression through the text from Figure 2, replaced, instead, by a pattern that at best looks like a frantic word search.

A comparison of the eye movements made on the baseline passages with those made on the DRP excerpt shows some similarities (see Table 2).

The average duration of fixations is also very similar between the baseline passages and the DRP excerpt—an indication that there are no observable differences in the level of vocabulary difficulty in one or the other types of text. In addition, this similarity indicates that there isn't an obvious disparity between the texts in terms of places where readers feel compelled to spend large amounts of time where, for example, the syntax might be awkward. Thus, it is not the word choice or grammatical construction that separates these texts, which makes sense because they came from the same source.

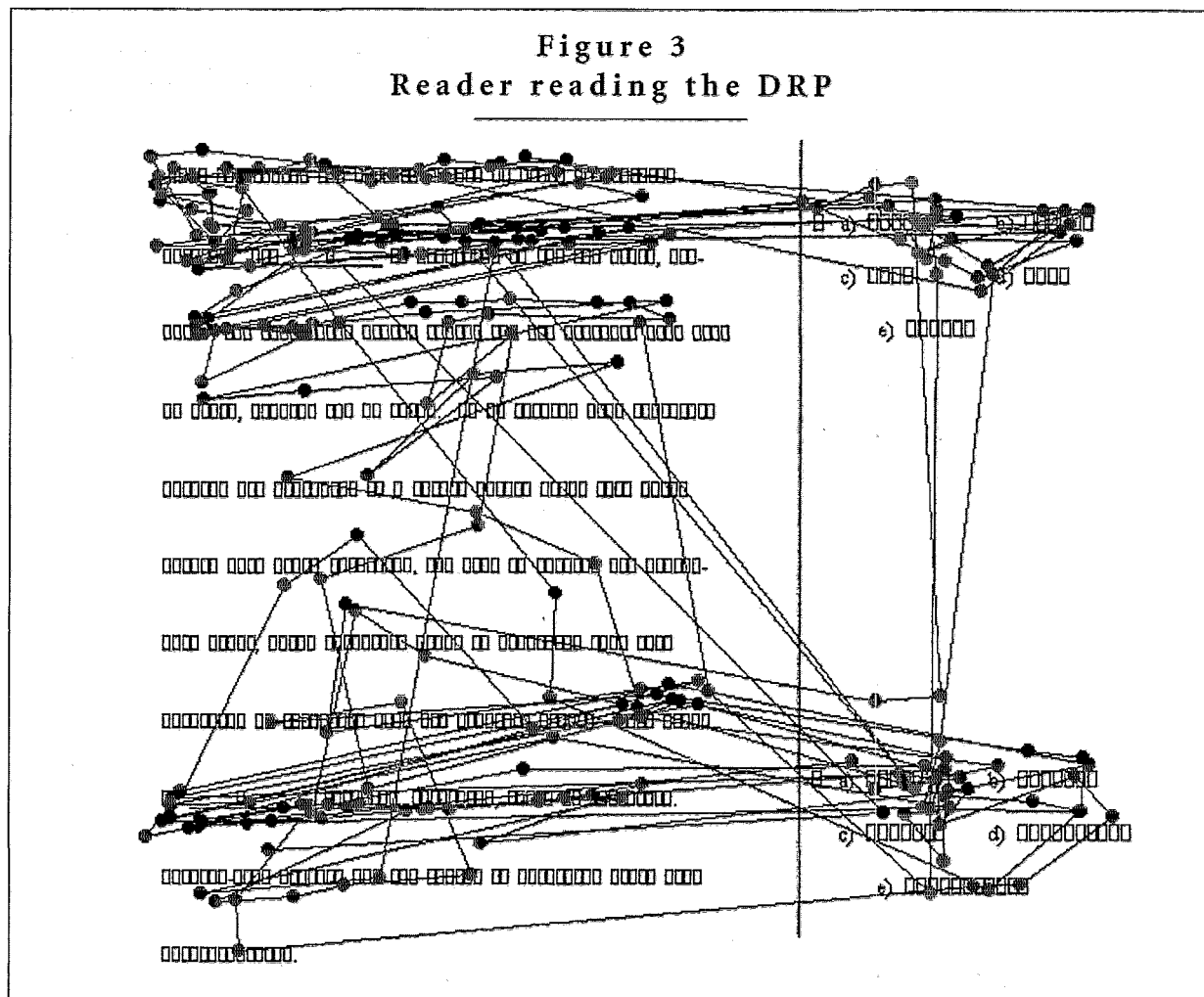
The percentage of words fixated can be deceptive, however. While both types of texts had a similar percentage of words fixated, an inspection of Figure 3 demonstrates one reason why the DRP excerpt did not have a higher percentage of words fixated: Several readers skipped entire portions of the paragraph that were not located near the blank. A clear example of this follows in Figure 4; with the exception of a few eye movements, this reader looked only at that area near the blank in question.

As Figure 4 illustrates, one way that the overall percentage of words fixated remains "normal" in the DRP excerpts is by the reader focus-



ing only on the sentence that holds the cloze blank. Several readers in this study skipped down to the text area immediately surrounding the cloze blank at least once and decided not to read either the text preceding or following that area. Because the participants in this study received the instructions printed in the DRP test booklets, in addition to practicing similar practice items, we may assume that they responded to the test as would students in other DRP testing situations. In other words, this may be a test-taking strategy that students employ consciously. Indeed, had instructors (present company included) simply asked students how they approached the DRP, we might have realized some of the differences between the way readers approach modified cloze text like the DRP and normal text. Nevertheless, the eye-movement record shows quite clearly that, at least in some instances, readers approached the DRP from a generic test-taking strategy standpoint.

Figure 3
Reader reading the DRP



The third raw measure of reading efficiency, regressions, shows a dramatic difference between the baseline and DRP excerpts. Regressions are eye movements that go from right to left—"backwards" in English texts—and usually make up about 12–15% of the eye movements in a given text. A higher number of regressions usually indicates a tentativeness or lack of comprehension during reading (Evans, 1997; Paulson, 2000; Rayner & Pollatsek, 1989). A comparison of regressions between the two unclozed, baseline passages and the DRP excerpt indicates that the average percentage of regressions was 12% for the baseline passage and 30% for the DRP excerpt.

While the average percentage of regressions made while reading the baseline passages was

12% (standard deviation 3.78), over 30% (standard deviation 4.08) of the fixations made while reading the DRP excerpt were regressions. This difference is significant ($t = -9.7232$). While students' readings of the baseline passages were untroubled, something about the DRP passage, or their reading of it, caused them to more than double their number of regressions.

The degree of saccade arc—a measurement of the angle of difference between fixations—is an important measure. In typical reading conditions, readers usually make small movements with their eyes, with the largest movement being either from the end of one line to the beginning of the next or from the bottom of one page to the top of the next. The average saccade degree for

Table 2
Eye movement measures

	Baseline passages	DRP excerpt
Average percentage of words fixated	72%	74%
Average duration of fixations	335 msec	328 msec
Average percentage of regressions	12%	30%

readers reading the baseline passages was 2.88 degrees (standard deviation .355), which is within normal ranges. The average saccade degree for readers taking the DRP was higher; 3.66 degrees (standard deviation .245), which is a significant difference ($t = -5.3737$). An average saccade degree this high is an indication of large distances—both horizontal and vertical—between eye fixations, which is more indicative of a search pattern than a reading process.

A close look at basic eye-movement measures of the reading process shows important differences in how readers navigate a traditional text and how they deal with taking the DRP test. However, dealing in descriptive statistics should not obscure the intuitive misgivings that we, as educators, may have when, after seeing what a “normal” eye-movement reading looks like (Figure 2), we see an eye-movement record from a student taking the DRP—like Figure 5. Figure 5 suggests that DRP eye movements look nothing like the reading process.

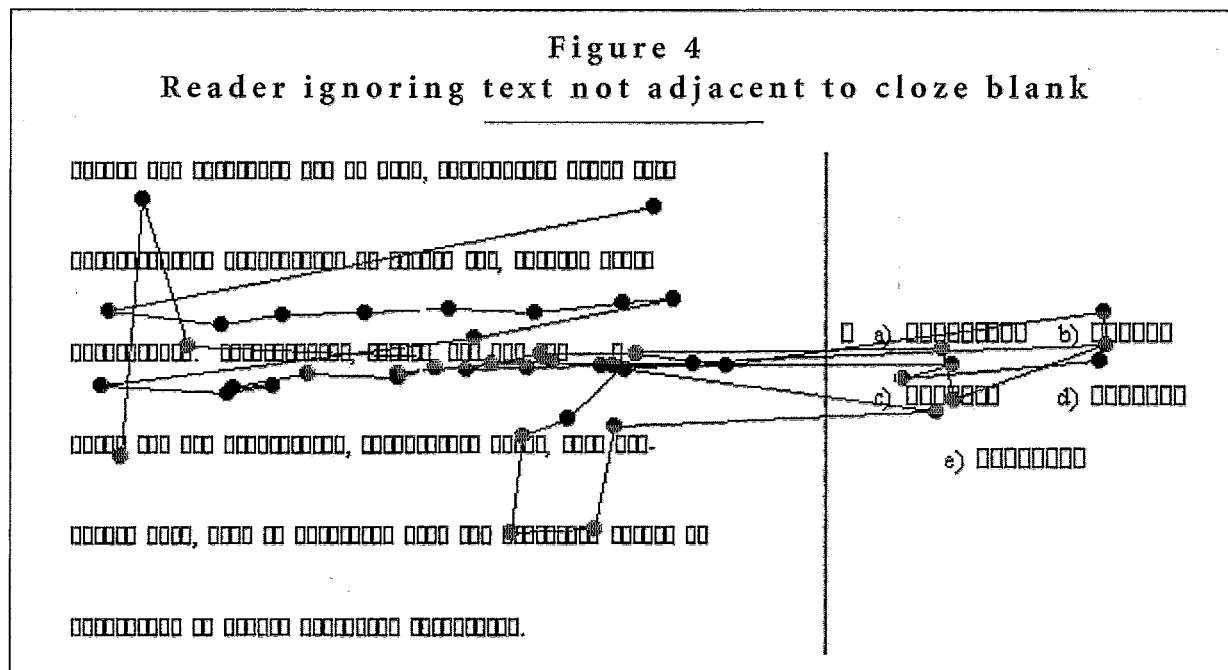
The eye movements have a frenzied quality, as if the reader were not quite sure where to search for information that would help in choosing the correct answer. Notice that while there is a convergence on the area of the cloze blank and answer choices, fixations from many of the eye movements jump from line to line, sometimes traversing several lines in one jump. This pattern does not suggest a normal, or even effective, reading process and is at odds with the process revealed by the reader’s eye-movement pattern on the baseline texts. Overall, the eye-movement

records produced during this study suggest a Degrees of Reading Power reading process radically different from the process exhibited during the reading of unaltered (“normal”) text.

Implications

Those charged with adopting reading tests want standardized, mass assessments that measure reading in a way that is congruent with their theoretical beliefs about reading. Multiple-choice assessments, such as the Nelson-Denny, are designed to measure students’ inferential reading ability. However, the artificiality of these sorts of tests raises red flags about just how discerning these instruments actually are. The DRP’s distinguishing feature and claimed advantage is that it measures the reading comprehension process. This assertion allows TASA Literacy to support central tenets of its program; for example, that “the DRP scale...was developed to make comparisons to authentic tasks and texts” (TASA Literacy, 2002, http://www.tasaliteracy.com/faq_fr.htm). This claim, while difficult to evaluate because the reading process takes place within the head of the reader, deserves considerable scrutiny, given that both placement and exit evaluations are expensive, high-stakes propositions.

The DRP’s score reporting procedures do not provide any specific information about the process-oriented reading strategies a student employed (e.g., what a right or a wrong answer might suggest about the student’s ability to make use of semantic, syntactic, or graphophonemic



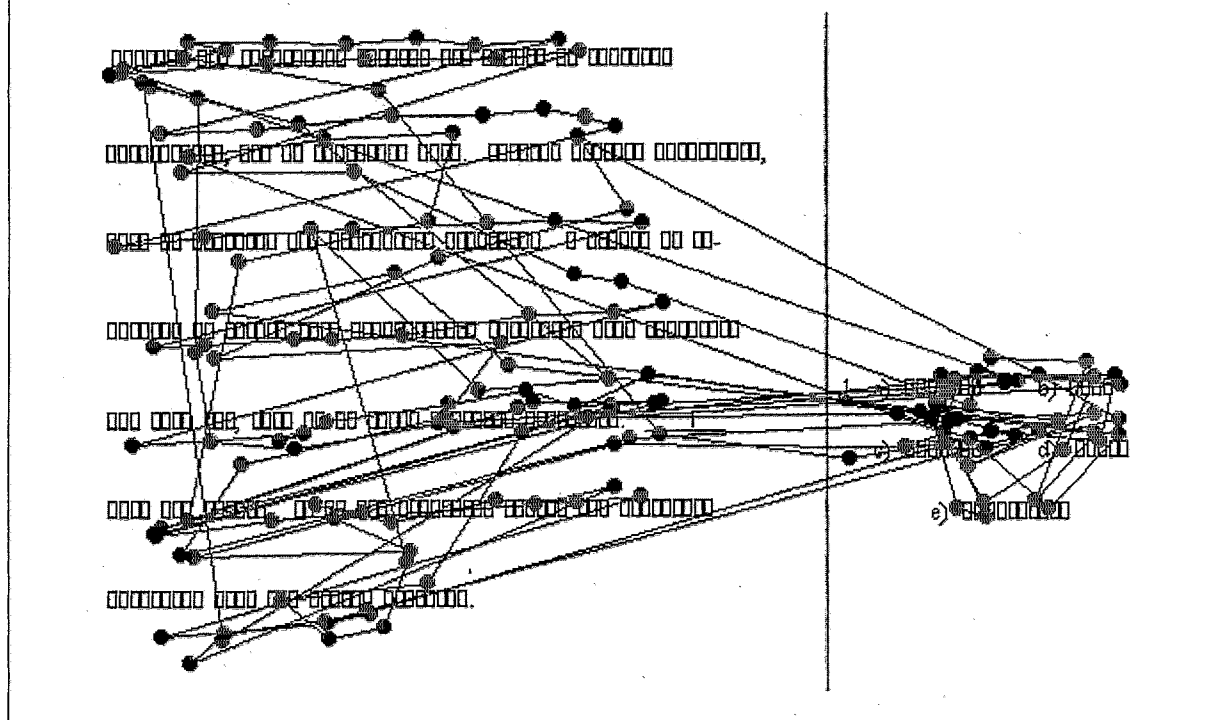
cues). Instead, instructors or institutions are furnished with the number and percentage of correct answers a student has provided and in some cases other normative information. These data offer no more information or insight about a student's reading comprehension process than do other commercially available standardized assessments. Institutions have had to take it on faith that the DRP actually is a "measure of the reading comprehension process." Again, this is a crucial selling point for the DRP.

However, eye-movement research, coupled with retelling procedures, provides us with a look inside students' heads as they read, which gives us the opportunity to justify, or not, our faith-based adoptions of the DRP. The results of this study suggest that the eye movements of students taking the DRP do not in any way correspond to those of their reading of the unclozed, baseline passages which, for all these passages may lack in aesthetic appeal, resemble much of the reading college and high school students are asked to complete. The DRP modified cloze process itself, which demands an interruption in the normal flow of reading by demanding regressions from the margins back to the text as well as possibly

signaling students to use their "test-taking" rather than reading strategies, are wholly inconsistent with the "reading comprehension process" as it normally occurs. The DRP may indicate that students are likely to struggle with their school-based reading—as measured by any mass rather than individual and contextualized assessment—but what commercial reading assessment cannot legitimately make that claim?

Our conclusion is that the DRP is not an accurate measure, or even a modest approximation of, the reading comprehension process. The DRP doubtlessly measures something, but it may not be reading, and it certainly is not the reading comprehension process—in fact this test appears to cause readers to radically alter their reading processes simply to complete the assessment successfully. However, rather than write off the DRP, reading professionals might want to lobby TASA Literacy to redevelop it as a diagnostic test that provides specific feedback on whether students' cloze choices suggest their ability to use semantic, syntactic, or graphophonemic cues or strategies—key elements of the reading process—as they make sense of text in the context, admittedly and unavoidably artificial, of completing cloze

Figure 5
Reader's eye movements reading the DRP



passages. What we might get is a mass assessment that draws, in broad strokes, portraits of our students as strategic readers. We still would not have a measure of the reading comprehension process, but growing numbers of us believe that finding a paper-and-pencil test that can do that simply may not be possible in the first place.

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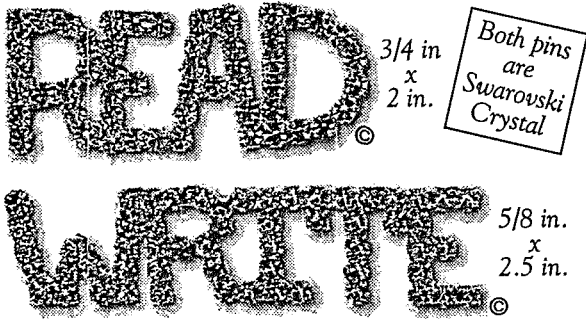
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