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ARE ORAL READING WORD OMISSIONS AND SUBSTITUTIONS CAUSED BY CARELESS EYE MOVEMENTS?

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Many readers and reading theorists alike hold a "common sense" intuition that omissions and substitutions made while reading orally are caused by the reader failing to see the omitted or substituted word, or looking at it for too short a time. In this study the eye movements of college age readers were recorded while they read aloud and then analyzed to see if there is a causal relationship between "careless" eye movements and oral reading omissions and substitutions. Results indicate that, contrary to conventional wisdom, most omitted and substituted words are visually examined, and examined thoroughly, prior to being orally omitted or substituted. These findings are discussed in a context that views reading as a perceptual, interactive, and constructive process.

Miscues are unexpected responses to the text that readers produce when reading a text aloud. Miscue researchers agree that specific miscues are produced for a host of psycholinguistic reasons that involve cues from semantic, syntactic, graphic, or pragmatic aspects of the text (Goodman & Goodman, 1994). For example, in the following excerpt from a reading done by a male college undergraduate, the word *with* is omitted, indicated by the word being circled; *the* is repeated, indicated by the symbol ® and the word being underlined; and the reader's word *trotting* is substituted for the text word *tottering*, indicated by the reader's word appearing above the text item in Figure 1.

A miscue analysis explanation would include the awkward syntactic construction of the lengthy prepositional phrase that, instead of following the verb *fell* as a reader might expect, is instead found at the beginning of the subordinate clause after *when*. The reader's assignment of syntax predicts a prepositional phrase fol-

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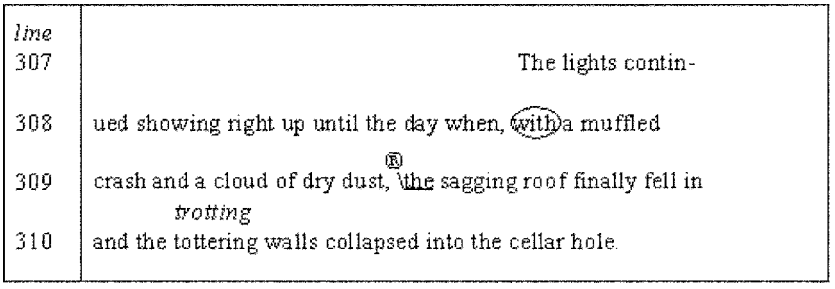

FIGURE 1. Omission of *with*.

lowing *fell*, as an "independent clause + subordinate WH-clause" syntax, beginning with a noun phrase (*a muffled crash*).

In addition to these psycholinguistic explanations, however, many readers and reading researchers intuitively believe that visual factors also play a role in explaining how miscues are made possible, and some believe that visual factors alone explain miscues. For example, Marek (1996) describes one of her adult student's views on why she makes oral reading errors as literally not seeing some words:

> In response to the question "Why do you think you made the miscue?" Marlene frequently stated that she was "trying to rush through," or that she was "skipping words." (p. 75)

This view is not limited to readers; reading researchers imbue visual processes with similar explanatory power. For example, Smith (1994) explains miscues in general as the byproducts of a focus on meaning that allows the surface level of language a certain amount of carelessness:

> The prior use of meaning ensures that when individual words must be identified, for example, in order to read aloud, a minimum of visual information will be used. And as a consequence, mistakes will occur (p. 154).

While an early eye-movement study (Fairbanks, 1937) done before the formalization of miscue analysis procedures did not find support for oral-reading miscues being caused by a lack of visual input, this view is nevertheless not uncommon and has intuitive appeal, and provides the purpose of this study: to examine where

readers look while they produce two common types of miscues—substitutions and omissions—in order to investigate whether those miscues have visual explanations.

Background

Miscue Analysis

Miscue data collection procedures are important as they are designed to mimic, as much as possible, an authentic reading experience for the reader; a whole text is used, and there is no task aside from retelling the story after it is read. Analysis of the miscues the reader made involves coding the linguistic systems of the text and of the reader, and the nature of miscue patterns across texts and across readers. Each miscue is examined in terms of the relationship between it and the sentence in which it is embedded and the entire text. Areas of examination include syntactic acceptability, semantic acceptability, meaning change, correction, graphic similarity, and sound similarity (Goodman, Watson, & Burke, 1987). Miscue analysis has been undertaken with readers from a variety of ages, backgrounds, and reading levels (Brown, Goodman, & Marek, 1996).

While procedures for miscue analysis are designed to be as authentic as possible, the necessity for readers to read aloud has generated criticism based on perceived differences between oral and silent reading (Leu, 1982). However, there is evidence that their similarities outweigh their differences. Goodman and Goodman (1982) state: " . . . a single process underlies all reading. The cycles, phases, and strategies of oral and silent reading are essentially the same" (p. 160). In addition, Beebe's (1980) research found that "[the data] lead to the conclusion that analysis of oral reading miscues is an effective way of inferring what kinds of miscues may occur during silent reading" (p. 335). Levin (1979) constructs a persuasive argument for the similarities of oral and silent reading that includes evidence that

> those who read well in one mode do so in the other. Comprehension is similar as is the development of the skills. Anderson and Dearborn conclude that silent and oral reading may be implicit and overt expressions, respectively, of the same underlying processes. (p. 20)

Classic eye movement research has come to similar conclusions; in 1920 Buswell found that the eye movements relative to ambiguous words were the same, which " . . . shows that eye movements in both oral and silent reading are largely controlled by the recognition of meaning" (in Levin, 1979, p. 31). In addition, Anderson and Swanson (1937) compared the eye movements of readers reading orally and silently and found that the difference in eye movements between oral and silent reading is one of degree, not kind: "Correlations between each measure of eye-movements in silent reading and the same measure in oral reading were uniformly positive and rather high for all groups" (p. 68). For these reasons, oral reading, while superficially different than silent reading, is considered here as proceeding from the same central reading process and able to generate reliable inferences about silent reading. Perhaps even more important than the validity of miscue analysis, however, is the fact that miscues do indeed happen—and this study is an attempt to understand whether miscues have a visual explanation.

Eye Movements

Eye movements were not always considered a source of information regarding the reading process; it wasn't until 1879 that University of Paris Professor Emile Javal observed that a reader's eyes do not sweep smoothly across print but make a series of short pauses, or fixations, at different places until reaching the end of a line, when they move to the beginning of the next line in a smooth, unbroken fashion (Huey, 1908). This observation gave birth to a question that is still researched today, involving the amount of information the eye can process with each fixation. This question became even more important as Dodge's (1900) conclusion that readers see nothing while the eye is actually in motion began to be empirically replicated (e.g., Wolverton & Zola, 1983); researchers now understand that the only text information available to readers is presented during the fixations.

From physiological studies of the eye several basic facts about how the eye is able to process information are understood. There are three regions of viewing information the eye has access to during a fixation: the foveal, parafoveal, and peripheral regions. The

foveal region is the area of the visual field that is in focus, and includes two degrees of visual angle around the point of fixation, where one degree is equal to about three to four letters (six to eight letters are thus in focus). The parafoveal region extends about 15–20 letters, and the peripheral region includes everything in the visual field beyond the parafoveal region. Objects presented outside of the foveal region experience a marked drop in acuity; words presented to locations further from the fovea are more difficult to identify (Rayner & Sereno, 1994). These are, of course, *physical* limitations of the eyes' ability to present visual information to the brain; of interest to reading researchers and theorists is the *perceptual* process of what the brain makes of the visual information from the eyes. These perceptual processes are inferred from two main types of data provided by eye-movement recording: where the eye stops and for how long it stops there.

Evidence from eye-movement studies in the early part of the twentieth century demonstrated that many words in a text are not fixated. Fisher and Shebilske (1985) report that ". . . in the 17 records published by Judd and Buswell (1922) we have found that less than two-thirds of the words were fixated in eight of the records and no more than three-fourths in any of those remaining" (p. 149). Figures from these early studies may seem to run counter to intuition; in fact, the idea that every word in a text must be fixated in order for the text to be read has been expressed by some reading theorists. For example, Adams (1990, p. 100) asks, "Do skilled readers skip over any significant number of words in meaningful text? Not really. Normal adult readers fixate most words of a text, regardless of its difficulty." Similarly, Liberman and Liberman (1992, p. 352) state that "the elegant studies of eye movements during reading by Rayner and his associates have shown conclusively that good readers read every word." However, the above statements fail to be supported by early as well as recent eye movement research. Rayner (1997 p. 319) states that " . . . at least 20% to 30% of the words in text are skipped altogether (i.e., do not receive a fixation) . . . " Just and Carpenter (1987, p. 37) concur, finding that " . . . about 68% of the words [in the study] are fixated" and Hogaboam's (1983, p. 315) research supports these figures: "In fact, in the present study about 40% of the words were skipped. . . . " While the discrepancy between some theorists' syntheses and actual eye movement research results is puzzling, the important fact

is that in normal reading, approximately 60–80 percent of the words in a given text are fixated.

However, since the failure of a word to receive a fixation or otherwise move into foveal focus means that it is not physiologically possible to process its individual letters, the question is raised: how can readers fail to fixate words and still feel as if they are reading? Just and Carpenter (1987) explain that readers perceive the words that eye movement studies show are not fixated:

> Some of the words that are not fixated directly are still processed to some extent. The evidence for this claim is that certain words are more likely to be skipped than others. If readers did not process the skipped words, then all words would be equally likely to be skipped. . . . Readers were more likely to skip three letter function words (such as *the, and*) than three letter content words (such as *ant, run*). . . . This selectivity implies that readers had more information about those words than just their length, even though the words were not fixated. (p. 39)

Readers are thus able to receive some text-level information from the parafoveal region, even though the parafovea does not provide sharp focus. Several studies have demonstrated that this information is reliant on readers' predictions and inference. For example, McClelland and O'Regan's (1981) results show that the speed and ease with which readers could name a target word from a parafoveal preview is dependent upon the reader's expectations: " . . . a priori expectations and context greatly increase the benefit subjects gain from a preview of a word in parafoveal vision" (p. 634). They assert that " . . . our experiments have clarified one point: The ability to derive benefit from the preview we receive of upcoming words in parafoveal vision depends on a prepared mind" (p. 643). That is, readers are able to make use of text information that they have not fixated on but which they have predicted. In addition, Fisher and Shebilske (1985) state:

> More specifically, the present results support the generality of the hypothesis that expectations based on contextual constraints can interact with parafoveal information to determine the guidance of fixations. (p. 154)

In other words, predictions from context are used by the brain to direct the eye where and whether to fixate or not. Other research-

ers concur; for example, Rayner and Well (1996) effectively confirm findings of other eye movement studies that show that

> . . . highly constrained target words are skipped (i.e., not directly fixated) more frequently than unconstrained words . . . (and) when target words are fixated, fixation time is shorter on constrained than unconstrained words." (p. 504)

The researchers conclude that "predictability of a word (or the amount of contextual constraint for that word) . . . will affect both fixation time and word skipping" (Rayner & Well, 1996, p. 507). That is, readers' predictions allow them to skip (to not fixate) certain upcoming words. In doing so they use some parafoveal information about the words. Not all researchers agree with this conclusion; studies by Zola (in McConkie & Zola, 1981) and Hyona (1993) both questioned the usefulness of context in parafoveal processing. However, both Zola and Hyona's studies have been criticized as being flawed; see Ehrlich and Rayner, 1981, Rayner and Pollatsek, 1989, pp. 223–224, and Rayner and Well, 1996, for a critique of the studies.

The amount of time readers spend on individual words is an important measure as moment-to-moment processing of the text influences when readers move their eyes (Rayner & Well, 1996); the time readers spend on a word is a measure of the ease or difficulty they experience with that portion of the text. As with the above percentage of words that are fixated, the idea that readers spend different amounts of time on different words may not have intuitive appeal; in fact, some reading theorists deny that readers spend less time on predictable text, which implies that word fixation times must be stable. For example, Adams (1990) asks

> Even if skilled readers look at every word, they might not process every word in equal detail. Do skilled readers sample the visual features of predictable text less thoroughly? No. Regardless of semantic, syntactic, or orthographic predictability, the eye seems to process individual letters. (p. 101)

Similarly, Stanovich (1992) states:

> Furthermore, the study of the processing of visual information within a fixation has indicated that the visual array is rather completely processed during each fixation. It appears that visual features are not minimally

> sampled in order to confirm "hypotheses," but instead are rather exhaustively processed, even when the word is highly predictable. (p. 7)

However, the assertions about eye movement fixation durations made in the Adams and Stanovich's syntheses above are not supported by eye movement studies. For example, in their 1996 study mentioned above, Rayner and Well demonstrated that " . . . as far as fixation times of words are concerned, words that are unconstrained by context are fixated longer than words that are moderately to highly constrained" (507). Similarly, Reichle, Pollatsek, Fisher, and Rayner, (1998) stated that

> reading is a more interactive process, and there may be many situations in which a word will not be predictable in the absence of any information but quite predictable given minimal information such as approximate word length and the first letter. (p. 153)

In general, eye movements are useful in reading research because readers' eye movements indicate the part of the text to which they are attending (Just & Carpenter, 1987), providing a window to perceptual and comprehension processes during reading. More in-depth reviews of eye movement research can be found in Paulson and Goodman, 1999, and Rayner 1997, 1998.

Eye Movement Miscue Analysis

The combination of eye movement records and oral reading records has been termed eye movement miscue analysis (EMMA) in several recent dissertations (Duckett, 2001; Freeman, 2001; Paulson, 2000). Just and Carpenter (1984) recommend supplementing eye movement recording with another measure to " . . . indicate more about what has been comprehended" (p. 154); miscue analysis provides that comprehension measure. The usefulness of looking at both eye movements and miscues is based on the assumption that they each provide information the other cannot; both verbal and visual data are available to provide information about a reading. As an example of the information available through EMMA, Figure 2 reintroduces the miscues shown at the beginning of this article, with the reader's eye movements added. In this example the reader omits a preposition that demonstrates his prediction of the syntax.

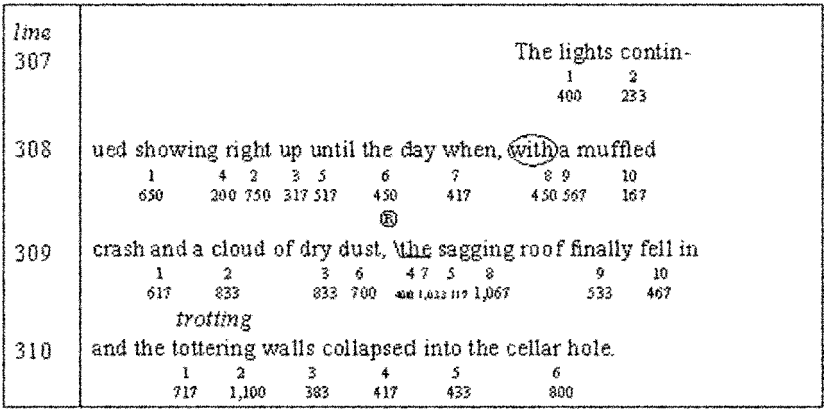

FIGURE 2. Eye movements: omission of *with*.

In this and all eye movement overlays, the top number signifies the position of the fixation on the word directly above it as well as the order of fixations (these numbers start over at 1 on each subsequent line). The bottom, three-digit number indicates the duration of the fixation in milliseconds (msec). Thus, in line 308, the first fixation is on the *h* of *showing*, the second on the *gh* of *right*, the third on the *p* of *up*, and the fourth is a regression back near the *r* of *right*. In this passage, as was pointed out at the beginning of this article, a lengthy prepositional phrase has been moved by the author from the verb *fell* to the beginning of the subordinate clause after *when*. Assignment of syntax predicts the verb but not this unexpected interruption of the syntactic flow—the sentence might have been more predictable if the prepositional phrase followed *fell*. Note that the reader fixates on *with* for 450 msec, then on *a* for 567 msec and *muffled* for 167 msec, at which time he has subconsciously rejected the information he found in the text in favor of the independent clause + subordinate WH-clause syntax, beginning with a noun phrase (*a muffled crash*) he had predicted. When he reaches the end of the noun phrase, he repeats *the*, possibly as a place holder while he gathers more text information, and then fixates *the sagging* for over 2.5 seconds before moving on. It is at this point that it becomes obvious that the sentence as he read it is not syntactically acceptable; thus he has probably disconfirmed his prediction, but makes no explicit correction of his omission of *with*.

As this example demonstrates, the analysis of the conjunction of eye movements and the oral reading record can provide copious information about how a reader navigates a text. However, a thorough EMMA exploration of the readings collected in this study is beyond the scope of this article, as is a detailed description of the theoretical foundation of the combination of eye movements and miscue analysis. Instead, the focus here is specifically whether or not careless eye movements, such as failing to fixate a word or fixating for an abnormally short time, play a part in the production of oral substitutions and omissions.

Equipment, Participants, and Method

Applied Science Laboratories 4000SU and Model 504 eye trackers were used to record eye movements, which record pupil and corneal reflections with an infrared reflection source and are accurate to within one degree. In addition, the 4000SU utilizes a head tracker, and the Model 504 uses a remote pan-tilt camera, both of which negated the need for a chin rest or bite bar. The eye-movement data was captured and produced as a series of x, y coordinates. A video camera simultaneously recorded a cursor that reflects eye-position superimposed on the text and the readers' oral reading.

The eye movements of 15 readers, 11 male and 4 female university undergraduate students who volunteered for the study, were used in this study. All were effective readers with vision correctable to 20/20. In addition to practice materials designed to alleviate any trepidation or nervousness they might have felt, the participants read aloud *Waterford Ghost's Revenge* (Colby, 1973), a 471 word "true" ghost story. This text was chosen because as a fictional narrative it is a common style of writing, and is short enough so it may be read, retold, and discussed in a short (half-hour) period of time. After reading the story aloud, each participant retold the story to insure that basic levels of comprehension were met.

The purpose of this study is to present a view of the behavior of these readers' eyes relative to the oral reading omissions and substitutions they made. Specifically, whether readers fixated for such a short time that perception was hindered or failed completely to fixate substituted and omitted words were examined.

Results

Overall Measures

In general, the results from an analysis of the eye movement data that follow are typical of normal, adult reading. An average of 67.36 percent (sd = 6.25 percent) of the words in the texts were fixated in this study. This percentage of fixations is consistent with the same measure found in early and contemporary eye movement studies. Although, on average, almost one third of the words in the texts in this study were not fixated, the readers reported no comprehension problems and were all able to give complete and inclusive retellings of the readings. The average duration of each fixation across readers was 371.13 msec (sd = 61.28 msec), and 16.19% (sd = 5.66 percent) of fixations were regressions.

Since a lack of visual information, the oft-suspected cause of some oral reading miscues, manifests itself in eye movements as either failing to fixate a word or fixating for insufficient duration, instances of fixation percentages or fixation durations relative to substitutions and omissions that were lower than the averages reported above could hold explanatory power. Results specific to substitutions and omissions follow, each with an example to illustrate the miscue/eye movement relationship, a brief narrative describing the results, and a discussion section. In the results for both substitutions and omissions, the eye movements that are reported took place before the miscue in question was produced, not after. Eye movements made after a miscue is produced could conceivably be part of a correction strategy as opposed to a cause of the miscue, and it is the latter phenomenon of interest in this article.

Eye Movements Relative to Substitutions

In the following example, the reader substituted *unusable* for *usable*, probably predicting a continuation of the idea of a "run down house" presented at the beginning of the sentence in Figure 3.

The reader fixated 60 percent of the words in the sentence, and little is remarkable about his eye movements before and after his miscue—there are no regressions, and aside from the fixations on

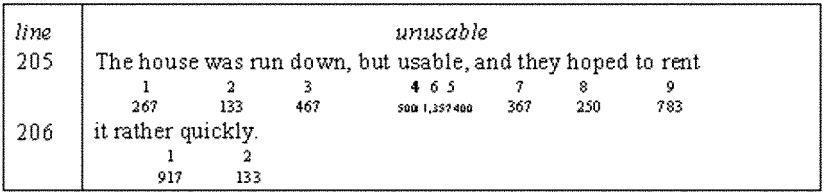

FIGURE 3. Substitution of *unusable*.

rent and *rather*, the fixation durations are near his average. The word *usable*, however, received three fixations, including an intraword regression, and a gaze duration of 2,257 msec. In this instance the reader hesitated very briefly after reading aloud *down*, made the three fixations on *usable*, then said *but unusable*. It is tempting to think of the intraword regression as an implicit, non-verbal correction of the miscue, but the reader made all the fixations on the word *before* verbalizing it—it can't be a correction when there's nothing yet to correct. So this reader actually fixated on the substituted word, and fixated for a long time—a phenomenon not unique to this reader.

Differences between the percentage of words fixated in general and the percentage of substituted words fixated were not significant ($t = -1.2496$); in fact, instead of substituted words *failing* to be fixated, in these readings they tended to be *more* likely to be fixated than the other words in the text. While 67.36 percent of all words in the text were fixated, 75.24 percent (sd = 23.61 percent) of the substituted words were directly fixated. In other words, most words that were substituted were looked at before the oral substitution was produced. Note that these fixations on substituted words refer to the first time the miscued words are encountered—not to regressions or any other fixations that take place subsequent to a fixation after the word as part of a correction strategy. So in these readings, most words that were substituted were actually looked at by the readers.

While it is important that the words that were orally substituted were looked at by the readers, equally important is the amount of time the readers spent on those words; a smaller fixation duration on substituted words might not have provided the reader with enough time to accurately perceive the word. This was not the case; differences between the duration of fixations on substituted

words and the duration of all fixations in the text were not significant ($t = -1.4211$). In fact, the mean duration of the fixations associated with substitutions was 462.76 msec (sd = 242.09), and, in contrast, the mean duration of all the fixations throughout the readings was 371.13 msec (sd = 61.28). Thus the average duration of fixations associated with substituted words, instead of being shorter than other words in the text, tended to be almost 25 percent longer than the average duration of all fixations in these readings. Not only does this suggest that oral reading substitutions were not caused by a too-brief glance, but that these readers tended to look at them for a longer period of time than non-substituted words.

Eye Movements Relative to Omissions

In Figure 4, the reader omits the word *that.*

The word *that* does not function as a necessary semantic or syntactic unit in this sentence. The reader fixated *that*, then, not satisfied with the syntactic construction, omitted the word in his parallel text and continued the rest of the sentence verbatim. Note also that the word *the* is not fixated, but it is verbalized. The fixation on the omitted word in this example is not atypical of other omissions in this study.

The reader's fixations brought the omitted word into foveal focus as a direct fixation, a pattern that was repeated for over half of the omitted words in the text; readers fixated 59.57 percent, (sd = 37.73) of the words they orally omitted. As with the figures given for substitutions in foveal focus, these fixations on omitted words refer to the first time the miscued words are encountered—not to

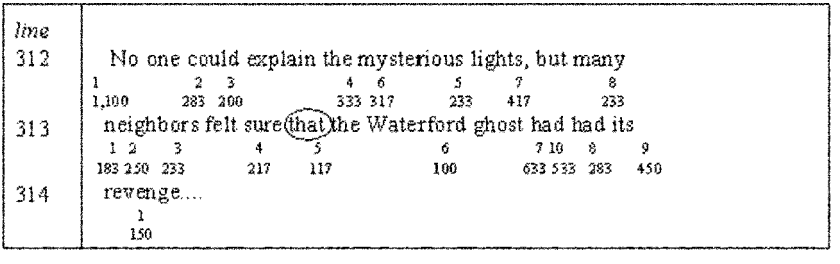

FIGURE 4. Omission of *that.*

regressions or any other fixations that take place subsequent to a fixation after the word. While the percentage of omissions that were directly fixated is lower than the percentage of all words fixated in the text, this is not a significant difference ($t = .7889$) and still amply demonstrates that a substantial portion of omitted words was fixated. In addition, if fixations that are not directly on the omitted word but are close enough to bring it into foveal focus are considered, then 95.55 percent of the words that were omitted in these readings were in sharp focus.

As with the eye movements relative to oral substitutions, the duration of the fixations on words that were omitted were examined. The above reader's fixation on *that* was relatively short, and fixating an omitted word might not be very interesting if those fixations were substantially shorter than the average fixation—it might seem as though it were only a fleeting glimpse. However, any difference in fixation duration was not found to be significant ($t = -.4699$); in fact, instead of being shorter than the average fixation, fixations on omitted words in these readings tended to be longer. Readers spent an average of 391.34 msec (sd = 154.88 msec) on the fixations relevant to omitted words, and an average of 371.13 msec on all fixations. As with substituted words, omitted words were looked at for a considerable amount of time.

Discussion

Substituted Words Are Thoroughly Examined

Traditional views of oral reading substitutions center around substitutions being caused by ". . . a careless reader . . . " (Ekwall, 1981, p. 26). Similarly, Dechant (1981) includes carelessness and reading too rapidly as causes of substitutions, as well as "failure of pupil to scan the word thoroughly enough to identify the order of the letters and to be certain that the word is a particular word and not another" (p. 333). In addition, entire studies have been constructed around the premise that substituted words are not seen "correctly." For example, Nicholson et al.'s (1979) study was designed to emulate certain miscues and assumes that when readers make oral substitutions they have not seen the correct word, and failed to see at all words that they omit. The researchers explain:

> It was assumed that in trying to understand a story, the unskilled reader is not only faced with insufficient text data (caused by failing to respond at all to certain words) but anomalous data as well (caused by responding with certain semantically inappropriate substitutions). (p. 341)

In general, the traditional explanation for the generic causes of substitutions are carelessness, reading too rapidly, and not using enough visual information. But as was pointed out above, there was no lack of visual information; any difference in the number of words fixated or the durations of those fixations was not significant. Instead, the readers directly fixated a higher percentage of substituted words than the percentage of words fixated overall. In addition, the average duration of fixations relative to substitutions was not shorter than the average duration of all fixations; in fact, the reverse tended to be true. Contrary to "common sense" explanations, substituted words in these readings are examined, and examined thoroughly. While the readers' perceptions of substituted words were that they were different, it is not because of a lack of visual acuity or visual attention.

Non-Deliberate Omissions

The omissions that these adult readers made were not made deliberately, in an effort to avoid a difficult or unknown word; rather they are non-deliberate omissions that reveal the reader's parallel, constructed text—a text that does not use that word in that specific place. The evidence for this is the fact that most of the omitted words were function words or short verbs, like *do, to, the, a, and, that,* and *of;* few would suggest that these adults, none of whom omitted lower frequency and "harder" words like *tuberculosis* and *untenantable,* were unable to read the word *the.* Goodman and Gollasch (1980) report that "often [non-deliberate] omissions involve words read correctly without hesitation at other places in the text" (p. 17). Thus it is not the word itself that the reader rejects, but its use in the specific context in which it is found.

The traditional visual explanation of the cause of non-deliberate omissions is similar to that of substitution-type miscues, that readers are careless or reading too fast. For example, Spache (1964, p. 255) states that "omissions of whole words, particularly among intermediate grade and older pupils, may indicate either exces-

sive speed or a tendency to skip over unknown words." Harris and Sipay (1980, p. 216) argue that "omissions usually are caused by carelessness or inattention." However, differences in the number of words fixated and the duration of those fixations between omitted words and all the words in the text were not significant, as noted above; readers were as likely to fixate an omitted word as they were to fixate a non-omitted word. In addition, in this study over half of the readers' omitted words were directly looked at. In the case of omissions, it is especially useful to look at not only direct fixations, but also omitted words that were only in foveal focus. The reason is that traditional explanations suggest that omitted words aren't seen at all; one example is Nicholson et al.'s (1979) study that viewed omissions as "insufficient text data" that were "caused by failing to respond *at all* to certain words" (p. 341; emphasis added). But if the omitted word was in foveal focus, then it was physiologically seen, and 95.55 percent of omissions were in foveal focus (all others were in the parafovea). Thus, in these readings it is not a default inaction of a lack of visual data that causes the reader to omit the word; rather, the omission is the reader's response to that text item.

General Discussion

Our eyes do not deliver concepts to our brain, but provide a " . . . diffuse and continual bombardment of electromagnetic radiation, minute waves of light energy that vary only in frequency, amplitude, and spatial and temporal patterning" (Smith 1994, p. 69). Another, less technical way to describe the data our eyes deliver to us is to say that "we are given tiny distorted upside-down images in the eyes...." (Gregory, 1966, p. 7). The reason we do not perceive the world upside-down, much less in terms of electromagnetic radons, is because it is the brain, not the eyes, that constructs our visual world. The eyes merely deliver raw data to the brain, while the brain decides to what it must attend. This, then, is perception—not what the eyes look at, but what the brain does with the visual information it receives. Thus, when the brain constructs perceptions, it has to decide *what* to see, a process that the familiar Necker cube[1] illustrates in Figure 5.

[1]This example is after Gregory, 1966, p. 12.

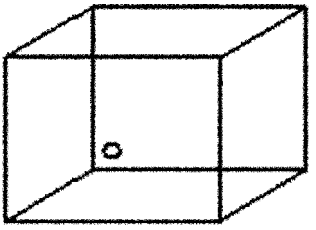

FIGURE 5. Necker cube.

While the "o" seems to alternate from the front to the back face, and vice-versa, the figure itself has not been altered, nor has the information the eye transmits to the brain. This popular optical illusion is evidence of the brain constructing different perceptions of the same visual input. This example is a microcosm of what the brain is engaged in on a continuous basis: what may be called "hypothesis checking." As Gregory (1966) argues, " . . . the senses do not give us a picture of the world directly; rather they provide evidence for checking hypotheses about what lies before us. Indeed, we may say that a perceived object *is* a hypothesis, suggested and tested by sensory data" (pp. 11–12). The Necker cube provides no clues as to which hypothesis, namely, "A. the circle is on the front face, or B. the circle is on the back face," is more acceptable, which is why we don't perceive one hypothesis as being better than the other. For the most part, however, our brains construct hypotheses about the world that allow us to settle on a perception that has meaning. In a similar way, as readers search for meaning in a text they are also engaged in a perceptual activity.

Depicting reading as a perceptual activity lends itself to understanding reading as a constructive or interactive process, where reading involves an interaction between the processing of graphic information and the readers' experiences and expectations they bring to the text (Harris & Hodges, 1995, p. 256). Goodman (1996) describes the cyclical nature of reading:

> We are constantly anticipating where a text is going, what will come next, what we will see, what structures we will encounter, and we make inferences from what we think we've seen and predicted. Our predictions are based on the information we've selected and sampled from the text, but they also guide the process of selecting and sampling. (pp. 112–113)

So what readers find when they read depends on what they think they will find, which is informed by what they actually find. Smith (1994, p. 161) states that "the way readers look for meaning is not to consider all possibilities nor to make reckless guesses about just one, but rather to predict within the most likely range of alternatives." Expectations, predictions, and hypotheses are crucial to perceptions, both of the world in general and of text.

Although in this study some substituted or omitted words were not looked at, or looked at for a below average duration, these differences were not significantly different than the fixation percentage and fixation duration averages of all words in the text. In other words, readers were as likely to fixate a word they orally substituted or omitted as they were to fixate a word they produced verbatim to the text. In fact, with the exception of the percentage of omitted words that were fixated, fixation percentages and duration averages for substituted and omitted words tended to be higher than average. Thus, the results of this study suggest that readers are likely to look directly at words they omit or substitute for an ample duration, which prompts the question: why are thoroughly examined portions of text changed during the course of constructing a parallel text?

The answer may lie in the nature of the reading process itself. As this study demonstrated, readers non-deliberately deleted or changed text items that they have fixated and thoroughly examined. This seems counter-intuitive because if a prediction does not mesh with the input, it's usually easier to change the prediction than to "change" the input. Yet in these readings most substituted and omitted text items are visually examined and then perceived differently—evidence of the interactive and constructive nature of reading. The Necker cube (Figure 5) may provide a limited analogy: as with the Necker cube, readers have the ability to change the structure of the graphic information the eye sends the brain. And just as readers try to understand the Necker cube they also try to understand text. As they disregard a version of the Necker cube, so readers disregard an element of the text. But while the Necker cube flits back and forth from one perception to another, readers' perception of the text item makes sense, satisfies their expectations, and they can move on. In this way, readers have the task of deciding, subconsciously, what aspects of the written text are to be

used and what aspects are to be disregarded, and may change the written text if it does not fit their meaning-centered predictions.

That these readers looked at the word they then omitted or substituted shows that the perceptual cycle is not being short-circuited, and suggests that readers actively examine the text and search for meaning. Readers change the text instead of changing their minds because they can—reading is not passive, but active, and constructive. The route to meaning is not in information transfer *from* text *to* reader but in a transactive construction of meaning *between* text *and* reader. It is to be expected that in the process of constructing a text there will be changes in the written text and in the reader (Rosenblatt, 1978). Portions of the text where observable changes —oral miscues—take place were fixated and examined, then changed, presumably because readers' predictions made more sense than the text item found in the written text. In making changes to the written text readers exercise their implicit authority to disregard text items that don't make sense for text items that do make sense—they allow themselves to construct a meaningful text even if it is not graphically identical to the published text.

Limitations and Implications

This study is limited by the small number of readers used, lack of variety of text genre read, and other concerns (such as purpose for reading) that were not able to be addressed. While limited, the basic premise of this article, that oral reading omissions and substitutions are looked at, finds support in data generated by Grant Fairbanks in 1937. He recorded the eye movements of college freshmen reading aloud, and combined the oral and visual records. As noted in the introduction to this article, the results of his study do not support visual explanations for the production of oral "errors" (Fairbanks' term). Fairbanks found that most words that readers orally substituted, omitted, changed, inserted, or repeated were within foveal focus, and stated that "fixation is equally precise when an error is made as when it is not" (p. 96).

In general, this article is meant to provide impetus for further exploring the idea of reading as a perceptual process. But it also has pedagogical implications—since the majority of omitted or substituted words in these readings are not only examined but

tended to be looked at for longer than average, the exhortation to the student to "slow down and look carefully at the text" loses its validity. Especially in today's educational atmosphere where even college students are targeted by commercial curriculum producers as needing "accurate and orderly seeing" visual training in order to read better (Taylor Associates, 2000, p. 16), it may be important to think of this study as further evidence that reading, as Smith (1996, p. 30) reminds us, depends on what is "behind the eyes."

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