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Studying from highlighted material : the role of color in memory for text

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**STUDYING FROM HIGHLIGHTED MATERIAL:
THE ROLE OF COLOR IN MEMORY FOR TEXT**

A Thesis

**Presented to
the Faculty of the Department of Psychology
San Jose State University**

**In Partial Fulfillment
of the Requirements for the Degree
Master of Arts**

**by
Michelle L. Gaddy
May, 1996**

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ABSTRACT

STUDYING FROM HIGHLIGHTED MATERIAL:
THE ROLE OF COLOR IN MEMORY FOR TEXT

by Michelle L. Gaddy

Authors of college textbooks sometimes use typographical cues (e.g., boldface type, italic type) to aid readers in determining which textual elements are most important to remember (Goetz & Schallert, 1987). While such cues can effectively facilitate recall of cued information (see Lorch, 1989, for a review), a popular student-generated cue, highlighting, has received minimal attention in the literature. This is despite the likelihood that college students will come into contact with used textbooks that have been highlighted by past readers. In the present study, 120 college students read a textual passage in which particular statements within the passage were either: (a) highlighted in yellow, blue, or pink, (b) underlined, or (c) left unmarked. Cued recall of the highlighted or underlined information was significantly better than recall of unmarked information, and highlighter color had no significant effect on recall. Results are discussed in terms of the study skills taught to college students.

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Studying From Highlighted Material:
The Role of Color in Memory for Text

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Footnotes

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Abstract

Authors of college textbooks sometimes use typographical cues (e.g., boldface type, italic type) to aid readers in determining which textual elements are most important to remember (Goetz & Schallert, 1987). While such cues can effectively facilitate recall of cued information (see Lorch, 1989, for a review), a popular student-generated cue, highlighting, has received minimal attention in the literature. This is despite the likelihood that college students will come into contact with used textbooks that have been highlighted by past readers. In the present study, 120 college students read a textual passage in which particular statements within the passage were either: (a) highlighted in yellow, blue, or pink, (b) underlined, or (c) left unmarked. Cued recall of the highlighted or underlined information was significantly better than recall of unmarked information, and highlighter color had no significant effect on recall. Results are discussed in terms of the study skills taught to college students.

Studying From Highlighted Material:

The Role of Color in Memory for Text

Studying from textbooks is unavoidable in the lives of college students, for a great deal of information that students must learn and master comes from college texts. In order to be successful at studying, students must be able to glean specific information from texts and then use that information to perform well on future events, such as exams. It has been observed, however, that readers often do not agree on which elements in text are most important to know in preparation for an exam (Surber, 1994). If readers are not always able to deduce on their own which textual elements are most necessary to remember, providing readers with cues that distinguish one word or phrase within text from another might assist those readers in identifying and classifying the most important ideas presented in the text (Glynn, 1978).

Typographical cues are variations in typography used by writers to distinguish particular levels of information in text. These cues commonly take the form of boldface type, italic type, capitalization, underlining, and color variation. While several studies have shown such cues to be effective in facilitating recall of cued information (Cashen & Leicht, 1970; Crouse & Idstein, 1972; Foster & Coles, 1977; Fowler & Barker, 1974; Glynn & DiVesta, 1979; Golding & Fowler, 1992; Klare, Mabry, & Gustafson, 1955; Lorch, Lorch, & Klusewitz, 1995; Nist & Hoglebe, 1987), only one of these studies (Fowler & Barker, 1974) examined the effectiveness of highlighting as a cue for directing readers' attention. This seems surprising, considering the fact that highlighting has been observed to be a study tactic used frequently by college students (Brennan, Winograd, Bridge, & Hiebert, 1986; Cioffi, 1986; Peterson, 1992; Surber, 1992, 1994; Turner, 1992; Wade & Trathen, 1989; Wade, Trathen, & Schraw, 1990).

Known also as accenting, highlighting involves using a highlighter pen to change the background color of a line of black-on-white print by simply stroking the pen over the

line. This stroking action changes the color of the line to a bright but relatively unsaturated hue, such as yellow, blue, green, or pink. Although it is not entirely clear why so few studies have failed to investigate the efficacy of this study technique, one possible explanation is that researchers are not entirely convinced that highlighting differs at all from the equally popular study strategy of underlining. Highlighting was called the equivalent of underlining by Anderson and Armbruster (1984), and Caverly and Orlando (1991), in a review of textbook study strategies, used the terms "underlining" and "highlighting" interchangeably, as if they each encompassed a single strategy. Fowler and Barker (1974) compared the facilitating effects of highlighting and underlining by having graduate students read a textual passage that contained both highlighted material and material underlined in red ink. The students recalled approximately the same amount of highlighted and underlined information. While this finding supports the notion that highlighting and underlining are "equivalent," the fact that graduate students participated in the study may also explain why equal attention was paid to both highlighted and underlined material. Typically, graduate school is characterized as a time in which students must "'wade through' a large amount of fairly difficult material" (Thomas & Rohwer, 1993, p. 260). This may lead graduate students to pay more attention to the details of a textual passage, or to employ study strategies that are distinct from the strategies used by college freshmen or sophomores. Because books that deal exclusively with study skills are frequently targeted at undergraduate students, it may be a mistake for study skills authors to assume, based on the findings of Fowler and Barker (1974), that it is not necessary to treat highlighting and underlining as separate study strategies.

It may also be a mistake to assume that the results of studies that examine the role of underlining in remembering information in text are equally applicable to the effects of highlighting. Generally speaking, most studies on underlining (Blanchard & Mikkelsen,

1987; Johnson, 1988; Klare et al., 1955; Nist & Hogrebe, 1987; Peterson, 1992; Rickards & August, 1975) have shown either neutral or positive effects of underlining on recall, but as Hartley, Bartlett, and Branthwaite (1980) have posited, it is often difficult to compare underlining studies, for the length of the material studied and the nature of the criterion task differs markedly from one underlining study to the next. This would appear to make it even more difficult to infer the effects of highlighting from underlining studies. The obvious physical distinctions between underlining and highlighting also make accounts of the "equivalence" of the two popular student-generated cues questionable. Underlining does not change the overall appearance of a line or a word, while highlighting involves a complete transformation of the background upon which a line or a word is presented. It has been thought, in fact, that underlining might actually be detrimental for readers, for underlining can fill in the space between lines of text and make the underlined parts of the text hard to read (Foster & Coles, 1977).

The fact that highlighting is used frequently by college students during the process of studying raises the relatively unexamined question of whether readers are able to learn from text that has already been highlighted by someone else. According to a study by Peterson (1992), 82% of the students surveyed reported that they always or usually highlighted when they studied. If a large majority of these students highlighted their textbooks and then sold these books back to their college bookstores, future students buying used textbooks might come into contact with material that has already been studied and highlighted by other readers. Whether previously highlighted information is attended to, and whether it is advantageous for students to attend to this information, is largely unknown, and therefore the focus of the present study.

A Past Study on Highlighting

Upon examining 200 randomly selected used textbooks for sale in a college bookstore,

Fowler and Barker (1974) observed that 92% of the sampled books contained some form of student-generated emphasizing technique, such as underlining, parentheses, brackets, or highlighting. In order to discover whether highlighting was effective as an aid for retaining instructional material, an experiment was designed in which participants were asked to read two scientific articles whose combined length was approximately 8,000 words.

The participants were randomly assigned to one of four groups: an active highlighting group, who highlighted the articles while reading them; a passive highlighting group, who read articles highlighted by the active highlighting group; an experimenter highlighted group, who read articles pre-highlighted by the experimenters; and a control group, who read articles devoid of any type of highlighting. All highlighting was done using yellow highlighters.

Participants had one hour to read and study the two articles. One week later, they returned to the site of the experiment, spent 10 minutes reviewing the same set of articles that they originally read, and took a 54-item multiple-choice test in which 18 of the items were based on the information pre-highlighted for the experimenter highlighted group. An analysis of the results of the multiple-choice test revealed that there were no significant differences among the four groups in terms of overall retention test scores, although participants in the experimenter highlighted group did significantly better on the 18 test items based on pre-highlighted information than did the control group. An analysis of the combined retention test scores of the active highlighting group and the passive highlighting group also showed that the probability of passing an item when the answer to that item had been highlighted was greater than if the answer had not been highlighted. Pairwise comparisons showed that the probability was higher for the active highlighting group, however, than for the passive highlighting group.

One criticism of the Fowler and Barker (1974) study raised by Lorch (1989) was that too much of the text content may have been highlighted. For the experimenter highlighted group, 25% of the content of the two articles was highlighted. Members of the active highlighting group highlighted anywhere from 4.2% to 32.1% of the articles, which meant that some members of the passive highlighting group were reading and studying texts in which almost one-third of the information was distinctly set apart from the rest of the text. Although cueing has been observed to be effective even when up to 46% of the content in an experimental passage is cued (Coles & Foster, 1975), it is generally advised that cues be used sparingly in text in order to avoid taxing the processing capacities of readers (Glynn, Britton, & Tillman, 1985). The findings of Lorch et al. (1995) support this notion, for they observed cued recall to be better when 5% of textual information was underlined as opposed to when 50% of such information was underlined. One focus of the present study was to attempt to show that highlighting can effectively aid in recall if used on only 5% of the information in a textual passage.

The Question of Color

An important but overlooked issue raised by the Fowler and Barker (1974) study is whether color plays a role in the effectiveness of highlighting. The rationale that Fowler and Barker provided for using yellow highlighters was that yellow was the most widely used highlighter color, and "the yellow (approximately 570 nm) is near the point of maximum spectral sensitivity for photopic vision" (p. 359). Today, highlighters come not only in yellow, but in blue, green, pink, purple, and orange. Because textbooks may be highlighted in colors other than yellow, it seems logical that the question of whether colors vary in their effectiveness as attention-guiding cues would need to be addressed.

Compared with the amount of research done on typographical cues in general, research aimed specifically at the use of color variation in text is meager, at best, quite

possibly because adding colored cues to text is a costly venture for publishers (Glynn et al., 1985). Although this additional cost may discourage authors from using color in text, color enhancement has been shown to be an effective method for increasing recall of textual material (Dwyer & Moore, 1992; Hall & Sidio-Hall, 1994; Lamberski & Dwyer, 1983). Color may also make particularly difficult reading materials, such as instruction manuals, look attractive and easy to use (Angiolillo & Roberts, 1991). When Angiolillo and Roberts asked participants to judge several instruction manuals in terms of perceived ease of use, most participants reported that color was a beneficial addition to manuals, particularly when it was used to “highlight types of information” (p. 224).

In other domains, research has focused on the issue of whether different colors have distinctive effects on individuals. Jacobs and Hustmyer (1974) found that the mean galvanic skin response of individuals seated in front of walls illuminated with red lights was higher than for individuals seated in front of walls illuminated with blue or yellow lights. In a similar experiment in which individuals were again seated in front of walls illuminated with lights, Jacobs and Suess (1975) observed that the anxiety-state scores on the State-Trait Anxiety Inventory were higher for individuals presented with red or yellow lights than for those presented with blue or green lights. Levy (1980) also observed that participants exhibited different emotional responses when asked to stare at colored panels and then complete the Profile of Mood States based upon how the colors made them feel. Bluish-violet panels were equated with sadness and fatigue, bluish-green panels aroused feeling of anger and confusion, reddish-orange panels aroused feelings of vigor, anger, and tension, and dull, dark mustard-yellow panels aroused some sad and angry feelings, but very little vigor.

More recently, the question of whether emotional responses can be affected by different colored sheets of paper has been examined. Following from the anecdotal

reports presented by Schauss (1979) that detention facilities painted pink had calming and tranquilizing influences in criminal custodial situations, while rooms painted blue produced aggression, Weller and Livingston (1988) sought to examine the effect of questionnaire color on responses to the questionnaire. Participants read three vignettes, each of which described a murder or rape, and then answered eight questions for each vignette. The questions were printed on pink, blue, or white paper. In addition, half of the questionnaires indicated that the suspect in each of the vignettes was found not guilty by a jury, while the other half indicated that the suspects were found guilty. It was observed that participants whose questionnaires were printed on pink paper were less emotionally upset by the vignettes or the verdicts than were participants whose questionnaires were printed on blue or white paper. This finding was taken as support for the “tranquilizing pink hypothesis” which was put forward by Schauss (1979). The hypothesis was later partially supported by Pellegrini, Schauss, and Miller (1981), who observed an initial decrease in the frequency of aggressive officer-arrestee encounters when the color of the walls in a county jail detention room were changed from blue to pink.

A study by Jacobs and Blandino (1992) provided further support for the effect of paper color on emotional response and mood. Participants were asked to complete the Profile of Mood States, which was printed on either yellow (or canary), blue, green, white, or red paper. Upon examining the responses of the participants, a significant effect of color was found on the fatigue-inertia scale, with participants presented with blue, green, yellow, or white paper all scoring higher than participants whose profiles were printed on red sheets.

It is clear, as Weller and Livingston (1988) have indicated, that two separate theories have emerged concerning the effects of color on perception and emotional response. One view shows warm hues (reds and pinks) to be associated with anxiety and emotional

arousal, and cool hues (blues and greens) to be associated with calmness and relaxation (Goldstein, 1942; Jacobs & Blandino, 1992; Jacobs & Hustmyer, 1974; Jacobs & Suess, 1975; Wilson, 1966). The other view holds that the warm hue of pink induces tranquillity, while the cool hue of blue induces aggression (Schauss, 1979; Weller & Livingston, 1988). Because anxiety can lead students to exhibit poor study, retrieval, and organizational skills (Benjamin, McKeachie, Lin, & Holinger, 1981), it stands to reason that if warm hues do increase anxiety levels, studying from a textual passage highlighted in pink may result in poor performance on a test of highlighted material. Studying from text highlighted in blue, on the other hand, may have a calm, relaxing effect on students, therefore allowing for better concentration, which may then lead to better test performance. Another possibility is that the reverse is true, and that students studying from text highlighted in pink become more relaxed and subsequently do better on a test of highlighted material than do students studying from text highlighted in blue.

The Present Study

In the present study, participants were asked to read a passage on energy adapted from the Lorch et al. (1995) study. For some of the participants, specific information in the text was highlighted in one of three colors: yellow, which was used by Fowler and Barker (1974), and which still appears to be the highlighter color of choice, pink, and blue. The remaining participants read text that was either free of highlighting, or that contained specific information that was underlined instead of highlighted. Based upon the findings in the aforementioned studies, two research hypotheses were constructed.

Hypothesis 1

The probability of recalling information from a textual passage will be greater if that information is highlighted or underlined than if it is not highlighted or underlined.

Hypothesis 2

If color does have an effect on emotional response and mood, as the aforementioned

color studies suggest, exposure to different colors of highlighted information will result in differential responding to a cued recall test on that information.

Method

Participants

One hundred-twenty college students participated in this study. Eighty-three of these students were recruited from the Psychology Department Subject Pool at San Jose State University, and they participated in the study in order to fulfill a course requirement. The remaining 37 students were recruited from an introductory psychology course at a local junior college, and these students also participated in order to fulfill a course requirement. All participants reported the ability to read and speak English fluently, and all reported having normal or corrected-to-normal vision. Participants who believed that they might be color-blind were discouraged from participating in the study.

Materials

The text used in the Lorch et al. (1995) study on underlining was used in the present experiment. The subject of this text is energy usage, and the text discusses problems associated with conventional energy sources and alternative energy sources. The text is approximately 2,400 words in length, and it was presented to participants in the form of an eight-page, double-spaced booklet in which the first page was a cover sheet that read "Energy Article". The article was printed in 12-point, Times New Roman type font (see Appendix B for a copy of the energy article).

In the Lorch et al. (1995) study, 28 target sentences were chosen to be underlined. Fourteen of those sentences were underlined in one version of the energy usage text (Version A), and the other 14 were underlined in a second version of the text (Version B). This created texts in which approximately 5% of the words in each text version were cued. The versions differed only in terms of the sentences that were underlined. Each target

sentence in Version A had a corresponding target sentence in Version B that was similar with respect to the type of information that it conveyed.

In the present study, the same two versions of the energy article were used. In addition to using the underlined versions of the text used by Lorch et al. (1995), several other versions of the text were constructed in which the target sentences were highlighted with Major Accent ® highlighters instead of underlined. In Appendix B, target sentences that were underlined or highlighted in Version A of the text are underlined, and target sentences that were underlined or highlighted in Version B of the text are typed in italics. For the text versions in which target sentences were underlined, underlining was done using a computer. For the text versions in which target sentences were highlighted, a highlighter pen was stroked over the sentence, resulting in a colored line, approximately 0.6 cm in width, superimposed on the target sentence. Three highlighter colors (yellow, pink, and blue) were used, and one color was used throughout a single version of the text. In all, nine different variations of the energy article were created: Version A-underlining, Version B-underlining, Version A-yellow highlights, Version B-yellow highlights, Version A-pink highlights, Version B-pink highlights, Version A-blue highlights, Version B-blue highlights, and the control condition, in which no sentences were underlined or highlighted.

Along with the energy text, participants were presented with an 18-question cued recall test that was also used in the Lorch et al. (1995) study. This test was presented in a three-page booklet in which the first page was a cover page with instructions and the next two pages presented the 18 questions along with room to write the answers (see Appendix C for a copy of the cued recall test). The answers tested memory for either single target sentences or target information and non-target information. The information conveyed in all 28 target sentences was tested across the 18 questions in the cued recall test.

Procedure

Twelve participants were randomly assigned to each of the eight experimental conditions (two versions of each of the four cue types). Twenty-four participants were assigned to the control, no cue condition. It is important to note that the number of participants was doubled in the control group since there was only one, non-cued version of the passage. Participants were tested in groups of no more than 30 individuals. Upon their arrival to the experimental setting, the experimenter seated the participants and placed copies of both the energy text and the cued recall test, face down, in front of each participant.

Once all participants were given the necessary materials, the experimenter informed them that they would be reading a seven-page article and that once they had finished reading the article, they would be answering a set of questions that would test their memories for specific information contained within the article. The participants were instructed that the test was a short-answer test. They were also told that they could read the passage at whatever pace was comfortable for them, but that once they finished reading and studying the passage, they would need to turn it over and answer the test questions, without referring back to the passage. Participants were instructed not to mark in their text booklets and not to look at the test questions until they finished reading the text.

Once the participants indicated that they understood the directions, and after the experimenter answered any questions that the participants had, the experimenter instructed the participants to turn over their text booklets and begin reading. The entire experimental session generally took no longer than one hour, although most participants finished reading in 30 to 40 min.

Results

The cued-recall tests were scored according to accurate recall of the information

contained in the 28 target statements. For each participant, one point was given for each target statement recalled. Participants did not have to recall each target statement word-for-word. They were given a point if they recalled verbatim the information contained within a target statement or if they recalled, in their own words, the main idea conveyed by a target statement. The total score for each participant could range from 0 to 28.

Two raters, each blind to experimental condition, independently scored each of the 120 cued-recall tests. The scores given by each rater were then compared. Interrater agreement was 93%, and all differences between raters were settled in conference.

The first analysis involved a comparison of the total recall scores for participants in the eight cueing conditions who read either Version A or Version B of the passage. Because the only difference between the two versions concerned the target statements that were chosen to be highlighted or underlined, a t -test was done in order to determine whether there were any content-specific recall effects. The t -test revealed no significant effect of text version on recall, $t(94) = .75$, $p > .05$.

Since text version was not significant, data were collapsed across this variable in order to compare the four cueing conditions (yellow highlights, blue highlights, pink highlights, and underlining). This was done to address both the first hypothesis, that participants would recall more cued information (i.e., highlighted or underlined target statements) than non-cued information, and the second hypothesis, that color might affect recall scores. Table 1 shows the means and standard deviations for the two types of information that were recalled by participants in each of the four conditions. Participants could recall up to 14 cued statements and up to 14 non-cued statements. Participants in all cueing conditions generally recalled approximately 4, or 29%, of the 14 cued target statements. Participants recalled an average of 2.76, or approximately 20%, of the 14 non-cued target statements. The data were analyzed using a 2 X 4 mixed factorial design in which the

within-subjects variable, text type, consisted of the levels of cued and non-cued text, and the between-subjects variable, cueing condition, consisted of the levels of yellow highlights, blue highlights, pink highlights, and underlining. There was a significant main effect of text type on recall, $F(1, 92) = 27.25, p < .001$, with participants recalling more cued than non-cued target statements. There was not a significant main effect of cueing condition on recall, $F(3, 92) = .09, p > .05$, nor was there a significant interaction between text type and cueing condition, $F(3, 92) = .08, p > .05$. Participants recalled approximately the same number of highlighted and underlined target statements, and the color of the highlighted statements did not significantly affect recall.

To compare the performance of participants in the cueing conditions with participants in the control condition, the total score for each participant was calculated. Table 2 lists the means and standard deviations of the total recall scores for each of the four cueing conditions and for the control condition. In each of the five conditions, at least one participant had a score of zero. The highest score obtained was 17 correct, and this was obtained by a participant in the control group. In the yellow highlights, blue highlights, pink highlights, and underlining groups, the highest scores were 15, 15, 15, and 16, respectively. A one-way between subjects ANOVA revealed no significant difference in total recall scores among the five groups, $F(4, 119) = 1.01, p > .05$. Across all five conditions, participants recalled approximately 7, or 25%, of the 28 target statements.

Discussion

The results of the present study clearly supported the first hypothesis. Participants who read textual passages containing highlighted or underlined cues were more likely to focus on and recall cued, as opposed to non-cued, information. Participants in the cueing conditions were not, however, able to recall more total information from the passage than participants who received no cues at all. The second hypothesis of the study was not

Table 1

Means and Standard Deviations of Cued and Non-Cued Text Recalled as a
Function of Experimental Condition

Condition	<u>n</u>	Text Type	
		Cued	Non-Cued
Yellow Highlights	24		
<u>M</u>		3.88	2.71
<u>SD</u>		2.69	1.65
Blue Highlights	24		
<u>M</u>		3.63	2.42
<u>SD</u>		2.86	2.05
Pink Highlights	24		
<u>M</u>		4.38	2.96
<u>SD</u>		2.60	2.18
Underlining	24		
<u>M</u>		4.08	2.96
<u>SD</u>		2.45	2.07

Table 2

Means and Standard Deviations of Total Recall Scores as a Function of Experimental Condition

Condition	<u>n</u>	Total Recall Scores
Yellow Highlights	24	
<u>M</u>		6.58
<u>SD</u>		3.73
Blue Highlights	24	
<u>M</u>		6.04
<u>SD</u>		4.08
Pink Highlights	24	
<u>M</u>		7.33
<u>SD</u>		4.44
Underlining	24	
<u>M</u>		7.04
<u>SD</u>		4.06
Control	24	
<u>M</u>		8.42
<u>SD</u>		5.26

supported by the results. Although it was believed that exposure to pink or blue highlighted text might affect the mood or anxiety level of the participants, the recall scores for participants in all three color conditions and in the underlining condition did not significantly differ. If color did increase anxiety or make participants more calm, these effects did not influence the ability of the participants to remember particular information contained within the passage.

There presently exists a large body of literature that supports the hypothesis that visually distinct information encountered in text will be remembered more than indistinct information (Cashen & Leicht, 1970; Crouse & Idstein, 1972; Foster & Coles, 1977; Fowler & Barker, 1974; Glynn & DiVesta, 1979; Golding & Fowler, 1992; Klare et al., 1955; Lorch et al., 1995; Nist & Hoglebe, 1987). In light of this past research, it is not surprising that participants in the present study recalled a greater proportion of cued textual information. Often, the reason that students highlight or underline their textbooks in the first place is to compensate for the lack of author-provided cues contained within the text (Glynn et al., 1985). The results obtained here indicate that when such cues are provided to a participant, they will influence the participant's perception of the importance of various information encountered during the reading process. In this study, participants were told only that they would be asked to recall specific information contained within the experimental passage, yet it appears that participants may have assumed that information that was highlighted or underlined was somehow more important to remember than similar information that was not cued. A further explanation might be that the presence of highlighting or underlining within the experimental passages somehow distracted participants from the sections of the passages that were not highlighted or underlined.

An interesting finding in the present study was that participants who read from cued passages were at no more of an advantage than participants who read from non-cued

passages. It was assumed that participants who read cued texts would focus the majority of their attention on the cued material. While these participants did recall more cued than non-cued target statements, the presence of highlighted or underlined cues within the text did not have a significant impact on total recall scores. Overall, total scores for participants in the cued conditions were not significantly different than total scores for participants in the control condition. Although this finding was not predicted, it is not entirely unexpected in light of research done by Meyer (as cited in Golding & Fowler, 1992), who found that overall recall of a text often does not improve when cues are used versus when they are not used. This suggests that students who must read and study text without the aid of attention-guiding cues may adopt study strategies that compensate for the lack of assistance that highlighted or underlined cues might provide. When cues are absent from a textual passage, students may read the passage more slowly, or they may read the passage more than once. Reading and rereading, which is regarded as the most popular passive study strategy (Blanchard & Mikkelsen, 1987), often “turns out to be equal or better than more sophisticated study techniques” (Barnett & Seefeldt, 1989, p. 351). Unfortunately, in the present study, no attempt was made to determine whether participants in the control condition employed the strategy of reading and rereading. All participants were given as much time as they needed to read and study the passage, and they were free to use any study strategy that they preferred, with the exception of the text-marking strategy. A future study might include a condition in which participants are specifically instructed to read a passage twice. Comparing a read and reread condition with cued conditions might then determine whether reading a passage twice is as effective as reading a cued passage.

According to Lorch et al. (1995), under most conditions, cues contained within a textual passage do not divert attention from non-cued information to cued information.

Several studies that have examined the role of cues in text have found that recall of non-cued statements is not affected by the presence of cues (Foster, 1979; Fowler & Barker, 1974; Golding & Fowler, 1992; Hartley et al., 1980; Hershberger & Terry, 1965; Kulhavy, 1972; Lorch et al., 1995). The results of the present study, however, indicate that attention to cued information may come at the cost of attention to non-cued information. While participants who read cued texts recalled significantly more cued than non-cued statements, they did not recall more non-cued information than participants in the control condition. Participants who read cued passages recalled an average of 2.76, or approximately 20%, of the non-cued statements contained within the passage, while participants in the control condition recalled an average of 8.42, or approximately 30%, of the non-cued statements. Although the presence of highlighting or underlining within the experimental passages served to guide the participants' attention to cued statements, the facilitatory effect of these cues led to an inhibitory effect on memory for non-cued information. This indicates that students who read and study from used textbooks that contain even a small amount of highlighting or underlining may be at a disadvantage when compared to students who purchase and read from new textbooks.

Several reasons may account for the lack of a color effect on recall scores. The most obvious reason is that the colors employed in the present study simply had no effect on the participants' abilities to extract information from the passage. The colors blue and pink, while hypothesized to induce arousing or calming effects, may instead have had very neutral effects on participants.

A second possibility is that the colors blue and pink may only have arousing or calming effects in situations in which individuals are exposed to relatively large amounts of these colors. Studies that have found color effects have exposed participants to walls illuminated with lights (Jacobs & Hustmyer, 1974; Jacobs & Suess, 1975), whole rooms

painted pink or blue (Pellegrini et al., 1981; Schauss, 1979), or colored sheets of paper (Jacobs & Blandino, 1992; Weller & Livingston, 1988). In the present study, participants in the color conditions read passages in which only a small portion of each page of the passage contained color. Participants may have been more affected by color had they been asked to read passages in which much more than 5% of the content was highlighted.

Another possibility concerns the criterion task used in the present study. It is possible that exposure to the colors blue or pink will have arousing or calming effects on individuals only in situations that may be anxiety-provoking to begin with. Here, participants were not graded on their performance on the cued-recall tests. Instead, they were given course credit simply for participating in the study. This may have led the participants to feel less anxious than they might have felt had their course grade been dependent on their performance. Students who must study from highlighted text in preparation for an exam that will count for a large portion of their course grade may be much more affected by the color of the highlighted material.

A final possibility is that color preference may determine the effect that various colors will have on individuals. Studying from a passage highlighted in blue or pink may be helpful for students who like those colors, but would students who have a strong preference for the color blue be at a disadvantage if they had to study from a textbook highlighted in pink? The participants in the present study were not asked about color preferences, and if, as a group, they did have distinct preferences, these preferences did not appear to influence performance on the criterion task. However, past research on color preference has consistently shown the color blue to be a favorite among adults, followed closely by the color red (Eysenck, 1941; Frank, 1976; Meerum-Terwogt & Hoeksma, 1995). Based on these findings, and on the fact that used textbooks may be highlighted in one of several colors, it would appear worthwhile to examine the impact of

color preference on a student's ability to recall information highlighted in a non-preferred color.

The probability that used textbooks will be highlighted or marked in any number of ways leads to another issue. In the present study, participants read passages in which only 5% of the content was highlighted or underlined. It is very likely that used textbooks will contain significantly more marks than the number presented to participants here, primarily because students may highlight or underline too much while studying (Joffe, 1982; Lenier & Maker, 1985; Policastro, 1975; Starke, 1990). When Peterson (1992) asked undergraduate students about their highlighting habits, 77% of these students indicated that they highlighted over 20% of their textbooks, and 83% indicated that they highlighted as they read through a section of text for the first time. Lorch et al. (1995) indicated that cues are only beneficial to readers when they are used selectively; when too much of a passage is cued, readers supposedly do not use the cues. It may be tempting, however, for students who buy used textbooks to put off studying for an exam until the last minute, reasoning that they can always quickly review the marks left behind by the previous owners of the books. Students may make the mistake of assuming that the previous owners of these books were good students who highlighted or underlined all of the material that might appear on an exam. Students may also refrain from making any of their own marks in a used textbook, for they might believe that adding additional marks would only confuse them during the process of reviewing for an exam. In these cases, it is clear that studying from used textbooks can be problematic.

To solve the potential problems associated with used textbooks, Deese and Deese (1994) offer a quick solution to students. Basically, students are advised to avoid purchasing used books, primarily because seeing another student's marks can be a "handicap" that "is far too serious to be worth the amount of money you save by buying a

used book” (p. 50). While it might be advantageous for a student to study from a new textbook, it is not always possible for students to buy new books. Students are often on tight budgets in college, and many times, used books are much cheaper than new books. Students also sometimes put off purchasing their books until well after the start of their classes. When students purchase their textbooks late, they may find that all of the newer books have already been purchased. In this case, students would have no choice but to buy used textbooks.

Instead of advising students to avoid used textbooks, it may be more advantageous for researchers to take a closer look at the text-marking techniques that are being taught to students in the first place. If students do not learn to mark their books appropriately and then sell these books back to their college bookstore, other students may eventually purchase and study from these poorly-marked books. Although most study skills books contain a fair amount of information on text-marking techniques (Heinrichs & LaBranche, 1986; Radencich & Schumm, 1984), the particular approaches that authors advocate are often quite different. For example, there is little consensus concerning the exact amount of material that students should highlight. Some authors advise students not to mark at all in their textbooks (Barrass, 1984), while others advise students to mark no more than 20% of a book (Lenier & Maker, 1985), or to mark up to one-third of each paragraph that is read (Starke, 1990). Many authors are also beginning to advise students to use a combination of different markings in order to differentiate between main ideas and supporting details. Students are being told to distinguish main ideas from supporting details by highlighting each in a separate color (Joffe, 1982; Starke, 1990), or by using a double underline for main ideas and a single underline for supporting ideas (McWhorter, 1980; Pauk, 1962). As Devine (1991) states, simple highlighting or underlining may no longer be effective strategies. Instead, personal coding systems made up of combinations

of color and underlining may “involve students more directly with the text” (p. 745), and therefore lead to deeper processing of textual material. While a personal coding system may work quite well for the student who develops the system, another student who must later study from that system may find it distracting and confusing.

For now, there is evidence that a simple cueing system contained within a textual passage will have an effect on the type of information that a reader will focus on and recall. Whether real used textbooks contain more complex coding systems, and whether such systems aid or distract students, is not completely known, although research does suggest that very complex cueing systems may hinder the learning process (Hershberger, 1964; Hershberger & Terry, 1965). To determine the actual state of used textbooks, direct observation is needed in order to identify the types of problems that students who buy used books might be faced with. To accomplish this, students must be asked about their experiences with used textbooks, and about the qualities of such books that make them easy or difficult to study from. A better understanding of the potential shortcomings of used textbooks will then allow study skills authors and instructors to provide better guidance to the many students who purchase and study from used books.

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Appendices

Appendix A

Human Subjects-Institutional Review Board Letter of Approval

A campus of The California State University

Office of the Academic Vice President • Associate Academic Vice President • Graduate Studies and Research
One Washington Square • San Jose, California 95192-0025 • 408/924-2480

TO: Michelle Gaddy
1708 Grand Teton Drive
Milpitas, CA 95035

FROM: Serena W. Stanford *Serena W. Stanford*
AAVP, Graduate Studies & Research

DATE: October 5, 1995

The Human Subjects-Institutional Review Board has approved your request to use human subjects in the study entitled:

"Studying from Highlighted Material: The role of
Color in Memory for Text"

This approval is contingent upon the subjects participating in your research project being appropriately protected from risk. This includes the protection of the anonymity of the subjects' identity when they participate in your research project, and with regard to any and all data that may be collected from the subjects. The Board's approval includes continued monitoring of your research by the Board to assure that the subjects are being adequately and properly protected from such risks. If at any time a subject becomes injured or complains of injury, you must notify Serena Stanford, Ph.D., immediately. Injury includes but is not limited to bodily harm, psychological trauma and release of potentially damaging personal information.

Please also be advised that each subject needs to be fully informed and aware that their participation in your research project is voluntary, and that he or she may withdraw from the project at any time. Further, a subject's participation, refusal to participate, or withdrawal will not affect any services the subject is receiving or will receive at the institution in which the research is being conducted.

If you have any questions, please contact me at (408) 924-2480.

Appendix B

Energy Usage Text

Energy

Since the Industrial Revolution, developed countries have become increasingly reliant on the production of energy to maintain their economies and standards of living. Primary sources of energy have been oil, coal, natural gas and, more recently, nuclear power. The fossil fuels of coal, oil and gas share several important characteristics that helped establish them as favored sources of energy. They are all relatively accessible natural resources. They are all relatively abundant natural resources. They are transportable. The technology to convert them to energy is widely available and *the technology is relatively inexpensive*. Since its development beginning in the 1950's, nuclear power has become an important energy source for the same basic reasons that the fossil fuels are so prominent. In recent years, however, we have witnessed some of the limitations of fossil fuels and nuclear power. Because of our society's addiction to cheap, abundant energy and the dependence on fossil and nuclear fuels that it has created, we are now confronted by immense problems. We face important decisions concerning how best to respond to these issues.

One side-effect of industrialization has been known for a long time. Many factors contribute to air pollution, but the burning of fossil fuels is a major source of such pollution. Fossil fuels contribute various dangerous particulates to our atmosphere. *One particulate attributable to fossil fuels is sulfur*. It is also widely known that fossil fuels are a source of carbon monoxide and ozone in the atmosphere. Yet another particulate resulting from fossil fuels is lead. Nearly half of the U.S. population live in areas with unhealthy air, according to the Environmental Protection Agency (EPA). In the case of smog ozone alone, approximately one-third of the population live in areas where ozone

regularly exceeds acceptable levels. Further, smog ozone is not restricted to urban areas. At least in the eastern U.S., summer smog ozone levels regularly exceed standards even in rural areas.

Another side-effect of industrialization is oil spills. Oil spills by damaged supertankers are so common that we can easily become complacent about them. However, the recent spill by the Exxon Valdez in Alaska tragically demonstrates how destructive and costly oil spills can be. To put the accident into perspective, if it had occurred along the eastern coast of the U.S. *the spill would have affected half of the entire eastern seaboard.* Perhaps a spill along the eastern U.S. would have been preferable to the Alaskan location because the pristine wilderness of Alaska is likely to suffer more extensive damage than would the eastern coastline. It is difficult to put a price tag on the immediate or long-term effects of oil spills on wildlife. However, one indication of the enormous economic implications of the Valdez spill is that the spill threatens the world's largest salmon fishing ground.

The problem of what to do with radioactive waste, or "radwaste", from nuclear power plants is a huge one. A good idea of the extent of the problem is provided by the example of the \$700 million Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico. The WIPP is a proposed major site for the storage of radwaste from the nation's nuclear weapons plants. The WIPP consists of 56 rooms carved out of salt deposits located 2,100 feet below ground. It is designed so that the rooms of salt will slowly collapse and encapsulate the waste during the next hundred years. Currently, tests are being conducted to determine whether the facility will meet EPA standards for storing nuclear waste. The plan had been to start placing waste in the facility in October of 1988 as part of a five-year series of safety tests. As of August of 1989, loading of waste had not yet begun. Serious concerns have surfaced. Water may seep into the storage rooms and dissolve the steel

drums containing the radwaste. The resulting radioactive slurry could potentially reach the surface. Also, *gas generated by the radwaste could build pressure and enlarge cracks in the salt*. This might give the waste an exit route to the surface or nearby underground water supply.

The burning of fossil fuels, especially coal, causes dangerous particulates to be released into the atmosphere. These particulates return to the earth in the form of rain with high levels of acidity. In recent years, environmental scientists have focused a great deal of attention on the effects of acid rain. It is now clear that acid rain can have devastating effects on lake and forest ecologies. One important study of mountain lakes within the Adirondacks, Poconos and Catskills mountain ranges of the northeastern U.S. indicates that acid rain affecting these lakes may have caused the loss of: *50 percent of the mollusks (e.g., clams)*, 45 percent of the insects, 69 percent of the leeches, and 18 percent of the crustaceans (e.g., shrimp). A study by Canadian researchers has further shown that once these organisms are destroyed, fish cease to reproduce and thus the fish population is endangered.

Another study of spruce trees in a forest in Germany also demonstrates the damaging effects of acid rain. About 10 years ago, an unhealthy spring yellowing of needles appeared within occasional stands of spruce in a high-elevation Bavarian forest. Over the next two years, the blight spread and worsened and gave rise to an increase in tree mortality throughout Germany's high-elevation forests. In 1982, approximately 8 percent of all West German trees were affected; by 1987, roughly 52 percent of all trees were affected. A careful study of the causes of the devastation showed that acid rain initiated a chemical imbalance in the soil. The soil changes led to the gradual development of serious deficiencies of essential nutrients for the trees. *The lack of appropriate nutrients made the trees much more susceptible to weather extremes*. The trees were also more

susceptible to pests. The lesson is a sobering one: The accumulation of the waste (i.e., acid rain) of decades of coal-burning had few observable effects for a long time. When the effects began to be noticed, they were so extensive, so fast to progress, and so poorly understood that nothing could be done to prevent them.

Perhaps the greatest threat to the global economy is global warming due to the greenhouse effect. The greenhouse effect results when certain gases, particularly carbon dioxide, trap heat that would otherwise radiate into space. Levels of carbon dioxide have increased more than 23 percent since before the Industrial Revolution and continue to rise roughly 0.4 percent annually. As the levels of carbon dioxide increase, more and more heat will be trapped and global temperatures will rise. If the greenhouse effect has really initiated a global warming, the implications are widespread indeed. Current levels of smog could be greatly increased by the warming. We can expect significant shifts in climate. Melting of the polar icecaps will cause flooding of low-lying coastal areas worldwide. *The overall increase in global temperatures will harm agriculture.* Temperature increases can also be expected to adversely affect industry and water resources. Many scientists consider global warming and the resulting changes in the global environment to be the most important problem facing us in the next century.

One strategy for dealing with the problems resulting from our current patterns of energy use is to develop alternative energy sources. The remainder of this article will discuss several alternatives.

Geothermal energy stems from the natural heat of the Earth. This steady source of heat promises to be a valuable energy source in the future, but currently the most readily available forms of geothermal energy are pockets of hot water and steam trapped near the surface. Geothermal power plants exploit these accessible heat sources, using them to power turbines to generate electricity.

There are abundant supplies of geothermal power in the world. The total power potential of geothermal hot water systems in the U.S. alone has been estimated to be as much as 10 million megawatts, *with a resource life of between 100 and 300 years*. Further, systems using the natural heat gradient of the earth are virtually unlimited in power potential. Geothermal plants are also relatively easy to put into operation. They can be operational in as little as 2 years, compared to 5 years for fossil fuel plants and 10 years for nuclear operations.

Several factors have inhibited the use of geothermal energy, however. The development of geothermal reservoirs is often unfeasible because they are too far from major population centers. Geothermal power plants release many pollutants from processing mineral-laden steam and water. They also release a tremendous amount of heat. Further, they are by no means foolproof. Well blowouts have been known to rage out of control for days. The pumping or reinjection of thermal fluids may cause earthquakes. *Geothermal plants are extremely noisy*. Lastly, geothermal drilling is expensive.

An ocean thermal power (OTP) plant is basically a large heat-powered engine built either on a platform in the ocean or on the seashore. The plant operates by extracting some of the solar energy stored in the warm surface waters of tropical oceans. Because OTP plants use solar energy, they do not require fuel combustion to generate electricity and so *do not produce pollutants*. Unlike other solar energy technologies, OTP plants do not need solar energy collectors or energy storage facilities; the ocean serves both of these purposes. Related to this, OTP plants can be operated almost continuously. Because the oceans receive more than twice as much solar radiation as the land masses, an immense amount of energy exists for OTP plants to convert without danger of exhausting the renewable resource base.

Although no fundamentally new technology is needed for OTP, some engineering problems exist. Very large pipes would have to be deployed in the ocean for some OTP designs. Also, not much is known about the possible environmental effects of OTP operations resulting from the cooling of the ocean's surface and the mixing of the plant's cold-water discharge plume with warmer subsurface layers. Some forms of marine life might be adversely affected and large numbers of OTP plants might even have a perceptible effect on the climate.

The sun has always been the ultimate source of most of the earth's energy, but until very recently, plants did the job of capturing its power in wood, coal, natural gas, and oil. In the face of the Arab oil embargo during the 1970's, more money has been devoted to researching alternative energy sources, including solar energy.

Coal is dirty, oil and natural gas are becoming increasingly scarce, and nuclear power is dangerous. In contrast, solar energy is safe, clean, abundant, and free. Within a two-week period, the earth gets as much energy from the sun as is stored in all known reserves of coal, oil, and natural gas. Moreover, solar heating and cooling do not require transporting energy hundreds of miles, thereby avoiding the loss of energy, added expense, unpredictability, and dependence on large energy networks.

The main problem with solar power is that current technology is not yet efficient enough to compete with other energy sources. *Solar energy is diffuse* and so must be collected in some way. Also, solar energy is intermittent and so must be stored. On a small scale, solar power technology is becoming less expensive. On a large scale, the technology is prohibitively expensive for general use.

Mills powered by ocean tides existed along the coasts of France in the 12th century. The world's first tidal electric plant was built by 1967, again in France. This plant is essentially a huge dam with a hydroelectric power plant inside. When the rising tide

comes in, water passes through the dam gates and fills the tidal basin behind the dam. When the dam gates are closed, huge masses of water are trapped in the tidal basin behind the dam until the height of water on the basin side is higher than on the ocean side. The gates are then opened again and the water spills back through the dam to the sea. *Each time water passes through the dam, it powers the turbines and generates electricity.*

Plants using tidal power have the same advantages as other types of hydroelectric power plants. Tidal power plants do not need an external source of fuel. Tidal energy is therefore a natural, renewable energy source that makes a lot of sense in some areas of the world.

Unfortunately, there are few areas where tidal power is feasible. Tidal power plants require extremely large tidal ranges in narrow-mouthed bays or inlets in order to make competitive electricity. In fact, only about 15 suitable sites exist for tidal power plants in the world. In those places where tidal power plants can be built, they pose some threat to marine ecology.

Humans first made large-scale use of wind power almost 3,000 years before the birth of Christ when Egyptians built the first sailing ships. Persians built the first windmills sometime in the 6th or 7th century A.D. to power irrigation pumps. By the 18th century, windmills were commonly used in Europe and America for grinding grain and irrigation. Also, windpower, along with waterpower, provided the basic energy source early in the Industrial Revolution.

The wind is an attractive energy source. Once the basic equipment is set up, the wind is free and unlimited. *Windmills also require minimal maintenance.* They produce no thermal, air, radioactive, or noise pollution. In addition, windmills last for a long time. However, there are many locations where there is insufficient wind to power wind machines. In those locations where there is sufficient wind, it is often intermittent. Thus,

wind-generated power must be stored and current technology is not economical. Finally, wind-generated electricity must be converted from DC to AC current and existing converters are only 80% efficient at best.

The use of waste products for fuel dates back to the dawn of civilization. In fact, from the discovery of fire to the beginning of the 19th century, dung and debris were second only to wood as an energy source. *As recently as 1953, waste accounted for nearly 20 percent of the world's fuel consumption.* Today there are over 120 plants worldwide converting refuse into energy.

Garbage-to-energy schemes solve two pressing problems in one stroke. They produce energy and dispose of trash. Thus, they reduce the drain on other energy sources and also cut down on pollution. The major problem with garbage-to-energy schemes is that they are not very efficient. Even if all our garbage were converted to fuel, the net amount of energy saved would be negligible. This is because a substantial amount of fuel is required to collect, transport, sort, and treat waste. On the other hand, we must handle the waste to dispose of it anyway, so better to eliminate it and produce energy than pollute land and waterways with it.

END

Appendix C

Cued Recall Test

INSTRUCTIONS FOR MEMORY TEST

On the following 2 pages, you will be presented a set of 18 questions about information in the article you just read. Most of the questions require very brief answers; you need not write in complete sentences. Answer the questions to the best of your memory. **DO NOT LOOK BACK AT THE ARTICLE.** When you are done, please turn in your materials to the experimenter and you may leave.

- 1.) According to the article, what are the important characteristics of fossil fuels that helped establish them as favored sources of energy?
- 2.) According to the article, what are the dangerous particulates fossil fuels contribute to our atmosphere?
- 3.) If the Exxon Valdez oil spill had occurred along the eastern coast of the U. S., how much of the coastline would have been affected?
- 4.) The Exxon Valdez oil spill threatens the world's largest what?
- 5.) Some serious concerns have been raised about the adequacy of the WIPP storage facility's ability to safely contain radioactive waste. What are those concerns?
- 6.) Acid rain affecting mountain lakes in the northeastern U. S. have cause great losses of several types of organisms. List the organisms affected.
- 7.) Acid rain has devastated trees in West Germany. A careful study of the causes of the losses has demonstrated that a chain of events has led to the devastation. Recall as many of the events as you can.
- 8.) According to the article, what are all the anticipated adverse effects of global warming caused by the greenhouse effect?

- 9.) According to the article, what are all of the advantages of geothermal power (i.e., power from the natural heat of the Earth)?
 - 10.) According to the article, what are all of the disadvantages of geothermal power?
 - 11.) According to the article, what are all of the advantages of Ocean Thermal Power Plants (i.e., plants to extract energy from the heat of tropical oceans)?
 - 12.) According to the article, what are all the advantages of solar energy?
 - 13.) What properties of solar energy make it difficult to deal with?
 - 14.) How do tidal electric power plants generate electricity?
 - 15.) What requirement of tidal power plants make them unfeasible in most locations?
 - 16.) According to the article, what are all of the advantages of windmills?
 - 17.) How efficient is current technology to convert wind-generated electricity from DC to AC current? (Give a percentage.)
 - 18.) As recently as 1953, what percentage of the world's fuel consumption was accounted for by the use of waste products?
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