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The effects of reader-generated and previously existing text marking on comprehension in readers of different skill levels

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THE EFFECTS OF READER GENERATED AND PREVIOUSLY EXISTING TEXT MARKING ON COMPREHENSION IN READERS OF DIFFERENT SKILL LEVELS

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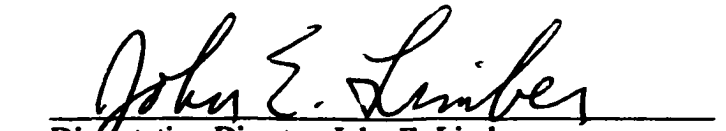

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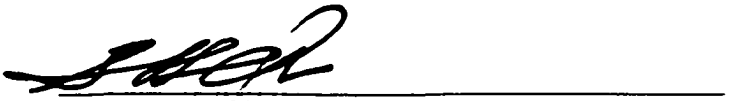

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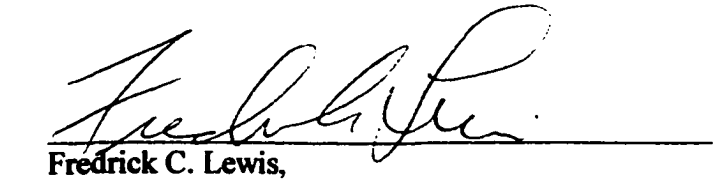

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DEDICATION

This dissertation is dedicated to Athena, my wonderful and patient daughter.

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ABSTRACT

THE EFFECTS OF READER GENERATED AND PREVIOUSLY EXISTING TEXT MARKING ON COMPREHENSION IN READERS OF DIFFERENT SKILL LEVELS

by

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University of New Hampshire, September, 2002

Previous research examining effects of previously existing and reader generated text marking has failed to demonstrate whether or not it is beneficial or detrimental to the reader. Furthermore, whether or not text marking has differential effects on readers of different skill has not been determined. The studies reported here attempted to clarify the questions that remain about the effects of text marking on comprehension, in readers of different skill levels, through analysis of marking in student textbooks as well as through the use of experimental methods.

Study 1 demonstrated that low-skill readers claim to highlight on more occasions when studying, but do not claim to mark more of the text. However, textbook analyses failed to support this finding. Additionally, low-skill readers claim to prefer a previously marked textbook to a greater degree than high-skill readers. Study 2 found that low-skill readers claim to, and use text-marking strategies more often and mark more of the text than high-skill readers. Study 2 also confirmed that low-skill readers report higher preference for studying previously marked texts and a tendency to study only material marked by a previous reader. Finally, Study 2 demonstrated that low-skill readers are less capable of identifying the most relevant material in textbooks and that this inability is

related to poorer course performance. The finding that low-skill readers report greater reliance on previously marked material, use text-marking strategies more often, and are less capable of identifying the most relevant material suggests that many low-skill readers study irrelevant material in textbooks. Study 3 examined the effects of irrelevant text marking on comprehension and found that low-skill readers are differentially affected by the presence of irrelevant marking, such that the study of text containing irrelevant marking leads to poorer comprehension. Practical implications of these findings and suggestions for future research are discussed.

INTRODUCTION

Stroll into any college bookstore, grab a used textbook for sale, and randomly turn to any given page. Chances are you will be looking at a page of text that not only contains words in bold, colored or italicized print, in the body of the text, but you will likely be looking at pages with student notes in the margin, underlined sentences, or sentences isolated with various colors of highlighter pens. In fact, H. J. Jackson, in the book *Marginalia*, claims that making marks in texts (i.e. writing in the margins) "may be as old as script itself, for readers have to interpret writing, and note follows text like thunder follows lightning."

As mentioned above, authors often use visual cues in a text to direct the reader's attention to certain terms, or key segments of text. In the reading research literature, these types of cues, and the study of their effectiveness, falls under the broad heading of *typographical cuing*. Common typographical cues include *underlining, highlighting, color, italics, brackets, indentation*, and *numbering*. The common belief is that the use of such cuing methods will result in enhanced learning because they direct the reader's attention to text material deemed to be of particular importance.

In addition to author-provided cues aimed at directing attention, many readers actively employ typographical cuing study methods such as underlining and highlighting while reading expository texts for their classes. According to Anderson and Armbruster (1984), the "prime tasks" of the student studying a textbook "are to (a) *focus attention*, and (b) *engage in encoding activities* in a way that will increase the probability of

understanding and retrieving the high pay-off ideas and relationships." That is, they need to identify the most important elements of the text they are engaging and take active measures to ensure that the material is "understood" and "remembered." Nist and Hogrebe (1987) have made similar suggestions, as they pertain to the use of text marking, and suggested other reasons why students might benefit from the employment of such strategies. First, consistent with the idea of focusing attention, Nist and Hogrebe (1987) argued that it is impossible for students to learn everything they read. Thus, the identification and isolation of key concepts through the use of text marking can be a useful organizational tool. Secondly, most college students are tested on a great deal of information spread over relatively long time spans (e.g. two to three exams over a semester). Selecting information through the use of highlighting or underlining serves to reduce the amount of information needed to learn by isolating the most important for later review. Finally, consistent with the encoding function suggested by Anderson and Armbruster (1984), Nist and Hogrebe (1987) argue that employing text marking study strategies forces the student to actively engage the text, rather than just engaging in passive reading. This type of active interaction with the text can lead to better memory because of the increased "elaboration and recitation." (Nist & Hogrebe, 1987).

This dissertation examines the subjective and objective aspects of text marking in students studying Introductory Psychology textbooks. The use and effects of text marking will be explored through the use of student self-reports, analysis of marked textbooks and an experimental study examining the effects of text marking on comprehension. Finally, the use and effect of text marking will be evaluated, not only in terms of the reader in general, but rather in terms of differences in reading ability.

CHAPTER I

THE EFFECTIVENESS OF HIGHLIGHTING/UNDERLINING AS TYPOGRAPHICAL CUING

Taking into consideration both author-provided typographical cuing and the use of text marking by students, the utility of text marking, then, can be evaluated in two ways. The first involves the overall effects of previously existing text marking on reader comprehension of the text. The second deals with the degree to which the use of text marking strategies employed by students, during the process of reading, leads to increased comprehension.

Experimenter-Generated Text Marking

The effectiveness of previously existing text marking in enhancing learning has been addressed in a number of studies that have employed experimenter-provided underlining or highlighting. However, these studies have produced mixed results. Some studies have found increased performance on comprehension measures when readers studied materials containing experimenter-provided underlining (Cashen & Leicht, 1970; Fowler & Barker, 1974; Hartley, Bartlett, & Branthwaite, 1980; Schnell & Rocchio, 1978). In one study, Hartley, Bartlett and Branthwaite (1980) asked sixth-grade children to read a 282-word passage that contained 15 words that were underlined by the experimenter. Another group read the same passage without the underlined words.

Using a Cloze procedure, in which children were instructed to fill in blanks, recall for the underlined words was assessed. In the recall test, 35 words were omitted from the text, including the 15 underlined words. It was found that recall was higher for words in the underlined condition when compared to the same words in the control condition. It was concluded that the presence of experimenter-provided underlining leads to enhanced performance on a recall task. Furthermore, this enhanced recall was present in both immediate and 1-week delay recall conditions. Other studies, examining performance for larger segments of text material, have found similar results. For instance, Cashen and Leicht (1976) had college students enrolled in an Introductory Psychology course read three articles from *Scientific American* under instructions that they would be tested on the article content during their upcoming course exam. The experimenters underlined five statements in each of the articles. The course exams contained one question on each of the underlined sections as well as questions from other sections of the article text. Results demonstrated that there was increased performance for statements that were underlined. It was concluded that the increased performance on these "isolated" text sections was the result of increased rehearsal due to the attention-capturing nature of the underlined material.

In general, researchers who have found a benefit of text marking have argued that it leads to enhanced recall because it makes material distinct (Cashen & Leicht, 1971, Nist & Simpson, 1988). The effects of distinctiveness are well documented in the literature starting with research conducted by von Restorff (1933). Cashen and Leicht (1971) applied the von Restorff effect to the effectiveness of text marking by examining the effect of underlining on recall. In their study, subjects read passages that had

different material underlined or no material underlined. There were three underlining conditions, which differed based on type of material underlined. This material included: (1) general principles, (2) examples of principles, and (3) trivial material. Results demonstrated that performance on an exam following study in these conditions was superior when the material used during testing matched the study condition. For example, when the student read text that included underlining of principles, their recall was better than for examples of principles or for trivial details. Based on these findings, Cashen and Leicht concluded that underlining material leads to an "isolation effect," in the von Restorff sense, which serves to enhance recall of the isolated material.

Other studies examining the effectiveness of experimenter-provided text marking have failed to find a significant effect (Hershberger, 1964; Hershberger & Terry, 1965; Leicht & Cashen, 1972; Rickards & August, 1975). In fact, some studies have found that the presence of experimenter-provided marking can even lead to poorer performance. For instance, Rickards and Denner (1979) had 10-year-old children read 800-word passages under one of the following conditions: (1) self-generated underlining, (2) experimenter-generated underlining, or (3) no underlining. In the experimenter-generated underlining condition, the topic sentence for each paragraph was underlined. In addition to the underlining conditions, readers in each condition were either given post-questions (conceptual questions aimed to focus on the topic) or no post-questions. Rickards and Denner found that the worst performance was found in the condition that involved experimenter-generated underlining followed by post-questions. Performance was also compromised in the experimenter-generated underlining condition without post-questions. It was concluded that the presence of underlining and post-questions can

actually hinder comprehension in younger readers.

Reader-Generated Text Marking

Empirical studies examining the efficacy of these study techniques, when readers generate their own underlining have also produced mixed results. Some studies have found that text-marking strategies have no significant impact on comprehension (Arnold, 1942; Fowler & Barker, 1974; Idstein & Jenkins, 1972). In one study, Fowler and Barker (1974) asked college students to study reprints from *Scientific American* and *Science* (8,000 words total) for an hour in one of four conditions: (1) highlighting while reading the articles, (2) reading articles highlighted by another reader, (3) reading articles highlighted by the experimenter, and (4) reading articles that contained no highlighting. Students were dismissed following the hour-long study session and returned a week later to complete a comprehension test that followed a 10-minute review. Performance on the comprehension measure did not differ between the four groups. Thus, there was no significant benefit of subject-generated highlighting. In another study, Idstein and Jenkins (1972) examined the differential effectiveness of repetitive reading and reading with underlining in 1200-word passages outlining government procedures. Two groups of students were given 10 minutes to study passages following different instructions and with different amounts of time allotted for review, prior to testing. The underlining group was instructed to underline any material that would benefit them in the later review session prior to a 24-item comprehension test. The other group was instructed in a similar manner, but told not to mark the passages. Following the initial study session, students were dismissed, until a week later, when they returned and were provided their

booklets to review for either 9 or 4.5 minutes. Idstein and Jenkins found that there were no significant differences between the two methods of study in preparing for a comprehension test. However, it was found that the 9-minute review, prior to testing, led to better performance on the comprehension test than the 4.5-minute review.

Other studies have produced similar results (Arnold, 1942; Hoon, 1974). For example, Hoon (1974) had students study passages in one of three conditions. In one condition, students were instructed to underline important ideas while they read (Read-Underline). In the second condition, they were instructed to take notes while they read (Read-Write Notes). Finally, in the last condition, students read without taking notes or underlining (Read Only). Following the study session, students were given 2 minutes to review their reading materials in preparation for a multiple-choice quiz. It was found that there were no significant differences between groups on the comprehension test. However, there was a significant difference between the Read-Write Notes group and the other groups in the amount of time spent studying, with the Read-Write Notes group allocating the most time to study. It was concluded that note-taking and underlining were no more superior than just reading, even though these methods led to more time studying the material. Taken together, it can be concluded from these studies that, at least under some circumstances, marking text while reading is no more useful than reading the text twice prior to a comprehension test.

In fact, some researchers have provided evidence that the employment of self-generated underlining during study can actually lead to decreased comprehension. For example, Peterson (1992) asked college students to read a 10,000-word chapter from a history textbook. Students either: (1) freely used underlining while reading and then

studied the chapter they underlined during review, (2) freely underlined while reading the chapter, but studied a "clean" chapter during review, or (3) studied the chapter without underlining and reviewed a "clean" chapter. Results on recognition and recall tests showed that those students who underlined while reading and then reviewed what they had underlined scored significantly lower on inferential recall than the other groups. It was concluded that underlining, in order to isolate information for review purposes, could be counterproductive to learning.

Other researchers have found that subject-generated highlighting/underlining is beneficial (Annis & Davis, 1978; Davis & Annis, 1979; Rickards & August, 1975). For example, Rickards and August (1975) had students enrolled in an Introductory Psychology course read 16-paragraph passages under instructions to underline only one sentence per paragraph. Performance of this group was compared to students who read passages that contained experimenter-provided underlining or no underlining. Results of the study showed that the group which underlined any sentence they chose in each paragraph performed significantly better than the other groups. Rickards and August concluded that subjects who were free to underline the material of their own choosing would identify the most important information. Furthermore, this self-identification leads to better performance than when the same important material is underlined by an experimenter. It is believed that this benefit is due to the fact that self-generated text marking actively involves students in learning, which leads to improved comprehension (Nist & Hogrebe, 1987).

CHAPTER II

READER AND TEXT CHARACTERISTICS

Whether or not the text marking being studied was done by an experimenter or by the reader are two of the important factors in the effectiveness of such study strategies. However, there are other factors that have been suggested to contribute to the utility of text-marking strategies. Firstly, characteristics of the reader can influence the effects of text marking. Secondly, characteristics of the text itself can contribute to text marking effectiveness.

Reader Characteristics and the Effectiveness of Text Marking

Some studies have found that text marking can have positive effects on comprehension, but these effects seem to be dependent on other variables, such as reader familiarity with the material covered in the text (Annis & Davis, 1976), whether or not text marking, as a strategy, is a preferred method of study (Annis & Davis, 1976; Annis & Davis, 1977), and the reader's level of motivation (Fass & Schumacher, 1978).

Research aimed at determining the effect of study preference and familiarity with the topic on test performance has shown that students who underline while studying text perform the best on a comprehension test only when they do not normally use underlining as a study technique and when the topic is familiar. For example, Annis and Davis (1976) asked college students to complete a study survey that identified their preferred

mode of study (e.g. read only, read while underlining, read while taking notes). Students were then assigned to experimental conditions that required them to read an article under the following conditions: (1) preferred reading only, (2) non-preferred reading only, (3) preferred underlining, (4) non-preferred underlining, (5) preferred note taking, and (6) non-preferred note taking. A week later, one half of the students were allowed to review their study materials for 10 minutes, immediately before taking a multiple-choice test on the article, while the other half of the students were not allowed to review. The results indicated that students in the read-only condition performed the best on the comprehension measure. Interestingly, those students who underlined during study, but did not prefer underlining, performed better than those students who underlined and preferred to do so. Furthermore, this increased performance for the non-preferring underliners was best when the students were familiar with the topic. Thus, when a student is unfamiliar with a topic and is forced to underline, performance declines. The fact that students who underlined familiar text material demonstrated increased performance when this was not a preferred mode of study was attributed to the "increased concentration and attention to the learning material required for the use of an unfamiliar study technique" (Annis & Davis, 1977).

In a review of their previous studies, Annis and Davis (1978) concluded, based on these findings, that "blanket statements" about the effectiveness of text-marking study methods cannot be applied to all students in all situations. Rather, factors such as preferred mode of study and familiarity with the text material influence the effectiveness of these study strategies. It was further suggested that the inconsistent findings regarding the effectiveness of underlining as a study method may be due to the fact that previous

researchers assigned students to treatment groups without considering the degree to which the subject preferred or did not prefer a particular study method, or was familiar with the topic of the experimental passages (Annis & Davis, 1978).

Another reader characteristic that can influence the effectiveness of text marking is the degree to which the reader is motivated. For example, Fass and Schumacher (1978) asked college students to only read or to read and underline the same scientific passage that was modified into two levels of difficulty (7^{th} grade versus high-school level). In addition, students were either paid, based on the result of their performance, or received no payment. As expected, it was found that performance was the best for those students who were highly motivated (i.e. paid) and who read easier text material. Furthermore, performance in the reading and underlining condition was better than in the read-only condition. This result was attributed to the possibility that underlining forced the reader to spend more time "interacting" with the content of the article. Finally, underlining was superior for motivated students, but not unmotivated students, even though there was an equal amount of underlining present in both the motivated and non-motivated groups. Fass and Schumacher concluded that the non-motivated student "may not have interacted appropriately with the materials, resulting in poorer performance."

The Nature of the Text Marked and Comprehension

The utility of text marking, as a study strategy, use can also be diminished as a result of factors other than reader characteristics. That is, text marking can lose its effectiveness: (1) when the text is difficult (Fass & Schumacher, 1978: Spyridakis & Standal, 1987), and (2) when too much of the text is marked (Lorch, Pugzles-Lorch &

Klusewitz, 1995). Based on these findings, the use of text marking, while reading expository text, should be more effective when it is done selectively. Consistent with this notion, Snowman (1986), in a review of the highlighting/underlining literature, argued that "underlining should be used sparingly and judiciously."

It is believed that when these text-marking strategies are not used selectively, and too much of the text is marked, any beneficial signaling effect is eliminated because too much of material becomes signaled. For example, Lorch, Pugzles-Lorch and Klusewitz (1995) asked participants to read a 2400-word expository text in one of three conditions: (1) no underlining, (2) light underlining (5% of words underlined), or (3) heavy underlining (50% of words underlined). In addition, 28 sentences from the passage were identified as "target sentences" (i.e. sentences that "supported or elaborated the theme of the paragraph in which it was embedded"). Half of the target statements were underlined and the other half were not. Using a cued-recall test, it was found that memory was better for target sentences in the light-underlining condition than for the heavy-underlining condition. Lorch, Pugzles-Lorch and Klusewitz argued that this finding suggests that the indiscriminate use of cuing leads to a decrease in reliance upon those cues. It may not be the case, however, that the overuse of text marking is the sole cause of poorer performance. Rather, the nature of the material marked (i.e. whether or not the marked material is relevant or irrelevant) may also contribute to the effectiveness of text marking, independent of the amount of text that is marked.

CHAPTER III

IDENTIFICATION OF RELEVANT TEXT MATERIAL

As was previously mentioned, text authors use typographical cues as devices to signal important elements of the text. Lorch (1989) suggests that a "writer begins with a mental representation of the information to be communicated to an audience." He further points out, based on the model proposed by Kintsch and van Dijk (1978), that the author's representation "may be conceptualized as a hierarchically organized network of related propositions." Thus, one role of typographical cuing, from an author's standpoint, is to communicate this representation more efficiently by isolating information important for the purpose of creating an accurate representation of the text. That is, text signaling can be employed to "explicitly mark both important information and text organization, thus simplifying some of the decisions [that the reader makes] (e.g. about relevance)" (Lorch, 1989). The end result, according to Lorch (1989) is that the reader who encounters text signaled by the author, "processes 'the gist' more efficiently and effectively," which ultimately leads to better comprehension and better recall. In fact, studies examining recall for signaled content has found this to be the case (Lorch & Pugzles-Lorch, 1986; Lorch, Pugzles-Lorch, & Klusewitz, 1995). Furthermore, this enhanced memory is highly selective such that memory is improved only for signaled content (Lorch, 1989).

Consistent with the finding that text marking can lead to enhanced recall for the

signaled material is the fact that the over use of text marking can lead to decreased performance. As was previously discussed, Lorch, Lorch and Klusewitz (1995) pointed out that when too much of the text becomes signaled, the isolation effect of text marking becomes diminished. That is, in the case of excessive text marking, the cue "loses it effectiveness" (Lorch, Lorch & Klusewitz, 1995). However, this reduction in effectiveness, in and of itself, may or may not lead to a decrease in comprehension. Rather, greater decreases in comprehension would be expected if the signaled material is not relevant, independent of the actual amount of material that is marked. That is, the utility of text marking should be intimately linked to the relevance of the isolated text material. In support of this claim, Rickards and August (1975) suggested that underlining, in and of itself, is not detrimental if over used. Rather, they claimed that the debilitative effects of underlining were more related to whether or not the material that was highlighted was of high- or low-structural importance in the text. For instance, Smart and Bruning (1973) examined the effect of relevant or irrelevant underlining on recall. In their study, subjects studied passages in one of the following conditions: (1) passages with relevant material underlined by the experimenter, (2) passages with irrelevant material underlined by the experimenter, (3) passages with relevant material underlined by the student, (4) passages with irrelevant material underlined by the student, (5) passages that were not marked. The most general finding was that the relevant underlining conditions led to the best recall. However, the best performance was observed in the group that studied relevant material that was underlined by an experimenter. It can be concluded from these results that studying previously marked material that is *relevant* can result in increased comprehension. Furthermore, Rickards

and August (1975) found that subject-generated underlining that included the most important sentence per paragraph led to very good recall. However, when subjects underlined material that was of low structural importance, recall performance dropped significantly.

The Effects of Irrelevant Text-Marking

As was discussed in the previous section, studies examining the effect of previously marked *irrelevant* information on comprehension have demonstrated that it can have a negative impact on comprehension (e.g. Smart & Bruning, 1973). Other studies have found similar results (Johnson & Wen, 1976; Silvers & Kreiner, 1997). For example, Johnson and Wen (1976) tested the effect of extraneous markings on comprehension by marking a two-page narrative in one of three ways: (1) 75% appropriate marking; 25% extraneous marking, (2) 25% appropriate marking; 75% extraneous marking, and (3) 50% appropriate marking; 50% extraneous marking. Results indicated that the presence of extraneous markings had a negative effect on reading comprehension. Unfortunately, Johnson and Wen's report did not include condition means, so it is impossible to determine if the presence of more extraneous marking had a more detrimental effect than on the group that had less extraneous marking.

In a more comprehensive study examining the effect of extraneous marking, Silvers and Kreiner (1997) had students read passages for a later comprehension test under three conditions: (1) appropriate highlighting (i.e. relevant information was highlighted), (2) inappropriate highlighting (i.e. irrelevant information was highlighted, and (3) no highlighting. Results of the comprehension measure demonstrated that the

students in the inappropriate-highlighting condition performed more poorly than those in the appropriate-highlighting and control group conditions. This performance decrement even persisted when participants were warned that the passages that they would be reading might contain highlighting that was inappropriate. Given these findings, it becomes quite evident that irrelevant text marking can have a detrimental impact on comprehension.

The Role of Reading Skill

Based on the findings described above, an important question to address, in examining the utility of study strategies, is the effectiveness of text-marking strategies for both high *and* low skill readers. Unfortunately, few studies have examined skill differences and how they relate to the effectiveness of such strategies. Furthermore, studies have not examined the differential effects that the marking of irrelevant information may have on readers of different skill levels.

One study, conducted by Johnson (1988), which examined subject-generated underlining in readers of lower skill, found that the use of underlining may be beneficial for these readers. Johnson (1988) had students read a 20-paragraph (1844 words) passage about the Kalahari Desert. Half of the students were instructed to underline only one sentence per paragraph, while the other half did not underline. It was found that underlined sentences were recalled better than sentences that were not underlined, even though overall passage retention did not differ between groups. Interestingly, when comparing the overall recall of superordinate versus subordinate sentences, it was determined that recall was best in both groups for superordinate sentences, but recall of

subordinate information was enhanced in the underlining condition. These results suggest that underlining does have an effect on recall for the lower-skilled reader.

From a review of the studies described in the previous section, as well as Johnson's (1988) study, it appears as though text marking may provide some benefit to the reader of lower skill in a recall task. However, that benefit is dependent on whether or not the material that is marked is the most relevant material. Thus, when evaluating the use of such strategies by readers of different skill levels, the most significant question becomes "How good are students at identifying the most relevant material in the text they read?"

One consistent finding in research on student ability to identify the most relevant material is that only the high–skilled reader is effective in this task (Smiley, Oakley, Worthen, Campione, & Brown, 1977; Meyer, Brandt & Bluth, 1980, Memory, 1984). For instance, Smiley, Oakley, Worthen, Campione, and Brown (1977) had seventh-grade students read passages of prose for a later recall and comprehension tests. It was found that high-skill readers recalled significantly more of the passages relative to low-skill readers. Furthermore, recall of material was based on the structural importance of the sentences in the text. That is, sentences of high structural importance were recalled with far greater probability than those sentences deemed of low structural importance. However, low-skill readers did not demonstrate the same pattern of recall. In general, they recalled less of the passage and there was no clear relationship between the material that was recalled and structural importance. Thus, the reader of lower skill seems to have greater difficulty identifying the more relevant material in the text that they read. Other studies have also demonstrated that readers of different skill level differ in what they

consider to be the most important material in a body of text (Winograd, 1984).

If there are differences observed in younger readers of lower skill in the ability to identify the most relevant material in the text, there is reason to suspect that the low-skill reader at the college level will have similar problems with identifying the most relevant material. In fact, previous research, using college students, that has addressed reading skill differences has shown that high-skill readers attend to information, in the text, that is important to a greater degree than readers of lower-skill (Lorch & Pugzles-Lorch, 1986). This finding is a particularly important concern. Given the dense nature of expository college textbooks, the ability to focus on relevant information is an invaluable asset to the success of the student. College textbooks tend to have longer and more difficult sentences; thus reading them tends to demand a great deal of attention in order for many students to fully comprehend the content. Consistent with this claim, research has suggested that less-skilled readers have deficits in attention while reading, which results in poor comprehension (Grabe, 1980; Wade & Trathen, 1989). Related to this, it has been argued that the fundamental deficit in the poorer reader lies in a reduced working memory capacity (Daneman & Carpenter, 1980). That is, the reader of lower skill has less working memory resources available for the task of integrating "concepts and relations from the preceding parts of the text" with the current representation (Daneman & Carpenter, 1980). When reading denser, expository texts, these deficits can be even more pronounced. For instance, Goldman, Hogaboam, Bell, and Perfetti, (1980) suggest that word recognition demands in long or difficult sentences, in particular, can overload less skilled reader's working memory capacity resulting in poorer comprehension.

In the real world setting of studying texts for classes, this reduced working

memory capacity might force the low-skill reader to focus on material marked by a previous reader as a compensatory measure. Furthermore, that compensatory measure may not be based on comprehending the text as a whole, rather on the retention of text elements that are deemed to be important for later recall. This would certainly be the case for a student preparing for a multiple-choice exam, that may be less focused on comprehension, but more focused on the recognition of facts. Thus, the reader of lower-skill, as opposed to a high-skill reader, may be more likely to focus on previously marked material. In fact, Johnson (1988) argued that "advanced and more sophisticated readers might realize that achieving an overall grasp of the material is better than simply retaining underlined sentences." However, as was previously mentioned, the low-skill reader may only be focusing only on this type of retention. Knowing this, and given that researchers have found a differential encoding effect for signaled material, the overall effect of underlining on recall can be problematic if the enhanced memory includes information that is not of particular relevance.

In her review of comprehension differences in high- and low-skill readers, Golinkoff (1976) pointed out that the low-skill reader does not integrate text information as it is read. Rather, these readers tend to approach the reading task "word by word" and "sentence by sentence," instead of relating each encountered word or sentence to the whole of the text. This practice of reading text elements in an isolative manner, by the low-skill reader, could be particularly problematic when the reading task is accompanied by the active use of text marking, which serves to isolate material. In this case, the low skill reader, who may be less capable of identifying the most relevant material, is isolating that material during the text-marking process. If there is a differential encoding

effect for the isolated material, as a result of actively marking text, as some researchers have suggested (e.g. Anderson & Armbruster, 1984; Nist & Hogrebe, 1987), then the marking of irrelevant text material will lead to decreased performance on any subsequent comprehension measure.

An additional concern centers on the effect of previously marked material and the differential effects that it may have for comprehension in readers of different skill levels. Given that readers of lower skill are less able to identify the most relevant material in the text and they have attention limitations during reading, that may be enhanced during the reading of expository texts (which tend to contain longer and more difficult sentences), these readers may come to rely on a previously-marked text for identification of the most relevant material as a compensatory strategy. In effect, the material marked by the previous reader may serve to indicate to the current reader which elements of text need to be held in working memory as the reader progresses through the text material. However, this practice can be problematic if the previous owner of the text was a prolific highlighter (that marked too much of the text) or a low-skill reader (that was not able to mark the most relevant information), in which case the text could be over-highlighted, which defeats the purpose of directing attention, or mis-highlighted, which will result in the maintenance of irrelevant information in working memory.

Lorch and Pugzles-Lorch (1985) argued that "whenever a new topic is encountered during reading, readers retrieve their topic structure representations and integrate the new topic into their representation." If the reader in question is of lower skill and that reader is reading a text that has been marked by a previous reader of lower skill, who was less able to mark the most relevant material, the signaled material can

have a detrimental effect because it will be incorporated into the current reader's representation of the text. This effect on the text representation will undoubtedly lead to poorer comprehension. In support of this idea, Lorch and Pugzles-Lorch (1985) further argued that "any factors interfering with readers' ability to accurately represent a text's topic structure will interfere with recall." For example, text material that does not have logically ordered topics will be "less coherent." A reader that relies on material that has been previously marked by another reader may be forming a less coherent representation if the marked material was marked by a low-skill reader and is not relevant. If this is the case, the isolated material will not be logically ordered which will result in a less coherent representation leading to poorer comprehension.

Furthermore, given that there is enhanced memory for signaled text material, the presence of previously marked text that is not relevant may result in increased memory for the irrelevant material at the expense of the rest of the text. Consistent with this idea, Lorch, Pugzles-Lorch, and Klusewitz (1995) found that memory for signaled content is improved during a reading task involving marked text, while memory for unsignaled material is not affected. In terms of the overall task of reading for comprehension, this finding can be problematic for the low-skill reader who is reading a text that has been marked by a previous reader that was not capable of identifying the most relevant material during the reading process. That is, the fact that the low-skill reader does not integrate smaller text units (i.e. words or sentences) into the representation of the text as a whole, during the reading process, coupled with an enhanced memory for isolated text material can result in an even greater deficit in comprehension if the signaled material, marked by a previous reader of lower skill, is irrelevant. In effect, the material isolated

by the previous reader may become maintained in working memory, for the purpose of consolidation, as important information when that material, in reality, is unimportant to the understanding of the meaning of the text.

Research examining the potential negative impact of irrelevant highlighting or underlining, specifically concerning readers of lower skill, is relatively non-existent. The study described above conducted by Johnson and Wen (1976) purported to investigate differences in reading ability. However, the study lacked the information required to make a definitive statement about the differential effect of extraneous markings on readers of different ability levels. Furthermore, Johnson and Wen's conceptualization of reading ability was based purely on course grade. While there is undoubtedly a relationship between reading ability and course performance, the use of course grade as an index of reading ability alone may be inappropriate. The question remains whether or not readers of different skill levels are differentially affected by the presence of inappropriate text markings.

CHAPTER IV

THE STUDIES

When considering the results obtained from the earlier studies conducted on the effectiveness of subject-generated and experimenter-generated text marking, no solid conclusion can be drawn due to the inconsistent findings. One contributing factor to the disagreement found in the literature may have its basis in the comparisons between students sampled from different populations employed in the studies. That is, studies have been conducted using students ranging from third graders to college students. From a practical standpoint, the results obtained in the studies using younger subjects should be viewed with some skepticism because, prior to college, students do not have as much opportunity to engage in the use of highlighting or underlining their texts. In fact, many elementary and secondary level children are often explicitly told not to make marks in their books.

In addition to the problems associated with comparisons based on such disparate age groups, some researchers have claimed that the inconsistent results found in the text marking effectiveness literature are the result of methodological shortcomings stemming from highly controlled laboratory studies (Hartley, Bartlett & Branthwaite, 1980;Wade & Trathen, 1989; Lonka, Lindblom-Ylanne, & Maury, 1994). For example, Wade and Trathen (1989) have suggested that these methodological concerns have involved (1)

forcing students, in the experimental setting, to adopt a singular strategy at the expense of spontaneously adopted strategies, and (2) forcing students to study under imposed time constraints. Both of these methodological concerns can have a marked impact on the performance of a normal, or skilled reader, in an experimental recall task.

Based on the arguments provided by Wade and Trathen (1989), it may be the case that the lower-skilled reader's performance on reading tasks in a time constrained laboratory environment may be differentially lowered by the experimental task itself (i.e. relative to the reader of higher skill). Under normal study circumstances, the strategies that these readers spontaneously employ to aid comprehension are more readily available. Furthermore, under normal study circumstances, the attentional limitation seen in the low-skill reader could be less of problem for comprehension because, if he/she can identify important information in a text, then he or she could engage in text-marking in order to narrow attentional focus in subsequent exposure to the material. On the other hand, it may be the case that the low-skill reader cannot identify the relevant material, outside of the laboratory, in which case highlighting or underlining will be overused and/or ineffective. For instance, when a fairly natural study situation was set up in an experiment conducted by Paris and Myers (1981), in which pencils, paper highlighters and dictionaries (as well as no study time limit) were available, low-skill readers were shown to not engage in any "spontaneous" study behaviors, involving the use of these aids. However, when directed to underline, there were no differences between low and high skill readers in a recall task (Paris & Myers, 1981).

Based on these findings examining the effectiveness of typographical cues, already present in the text, as well as the utility of self-generated highlighting and

underlining as methods of study, questions still remain about the relationship between these factors and reading skill. In addition, it is important to investigate how strategy use differs between readers of different skill levels under normal, rather than experimental, study conditions. Thus, more ecologically valid research is needed to capture the individual differences in study methods in "real life" learning situations. For instance, Lonka, Lindblom-Ylanne, and Maury (1994) argued that "the strategies that people use when they study for an exam may be quite different from those adopted in experiments." It was further suggested that the use of such strategies, under these circumstances "may have a stronger effect on learning" (Lonka, Lindblom-Ylanne, & Maury, 1994).

The studies described here are empirically-driven studies that were designed to shed some light on these issues by (1) examining the frequency and degree of use of text-marking strategies such as highlighting and underlining, (2) determining if there are reading-skill differences in the employment of such strategies, (3) examining the degree to which readers of differing skill levels are capable of identifying the most relevant material in a course textbook, (4) determining the effect of text marking on classroom performance, and (5) investigating the effects of previous text markings on comprehension for readers of different skill levels.

Study 1

Study 1 was a preliminary study, designed to collect normative data, in order to examine the frequency and degree of use of text marking study strategies such as highlighting and underlining. Participants were asked closed-ended as well as open-ended survey questions about their use of text marking, as well as other study strategies

(e.g. takingnotes in the margins of text). In addition to the survey questions, student textbooks were examined for the degree of text marking present. In order to gain more comprehensive understanding of the nature of text marking use by readers, the relationship between study strategy use and reading skill was also explored.

Thus, the major goals of Study 1 were to (1) gather data about students' claimed reliance on study strategies, (2) determine whether or not the claimed use of these strategies is related to reading skill, (3) investigate the degree to which student textbooks are marked with highlighting and/or underlining, either by the current owner of a new text, or by a previous owner of the text, (4) to determine the relationship between what students say they do with respect to the use of text marking and the degree to which they actually mark their texts, and (5) to determine if actual degree of text marking is related to reading skill.

Method.

Participants. Two hundred and twenty University of New Hampshire undergraduates who were enrolled in Introductory Psychology courses participated for course credit. Data obtained from nine of the participants were discarded for failure to complete all aspects of the study.

Materials. All students were asked to complete a study-strategy survey containing a number of both scaled- and open-ended items that asked them demographic information and asked them to rate themselves on the following dimensions: (1) their use of colored highlighters, (2) their use of underlining, (3) the condition of the textbooks currently in their possession, and (4) the degree to which they use study strategies other than highlighting and underlining (see Appendix A). In addition, all students completed the

vocabulary subsection of the Nelson Denny Reading Test, which is a timed (15 minute) 100-item multiple-choice test, in order to get an estimate of reading skill (see Appendix B for example and typical distribution of scores). Previous researchers have used vocabulary tests as indices of reading skill, suggesting that high-skill readers have more knowledge about vocabulary than low-skill readers (e.g. Butler, Jared & Hains, 1984). Furthermore, the vocabulary subsection of the Nelson-Denny test, in particular, has been used as an index of reading ability in other research comparing high- and low-skill readers (e.g. Long, & Chong, 2001). Finally, students completed a textbook survey, which asked them to identify the degree to which their introductory psychology textbooks were highlighted and/or underlined by counting the number of sentences that were highlighted on 20 pages of the text that were randomly selected by the experimenter in advance (see Appendix C).

Procedure. All sessions were conducted, using 20 students at a time, in a classroom in the Psychology Department at the University of New Hampshire. In two sessions, students were asked to complete (1) the study survey, (2) the Nelson Denny Vocabulary Test, and (3) the textbook-condition survey.

During the first session, students were given the study survey. For fixed-scale items, they were asked to indicate their responses by selecting the appropriate number on the rating scale. For example, for the question: "On how many occasions, when you sit down to read a textbook, do you highlight material?" students circled a number on a scale from 1 (never) to 7 (always). For open-ended items, they were asked to complete the survey item by writing their answer in the space provided. Upon completion of the study survey, students were given the vocabulary subsection of the Nelson-Denny Reading test.

students were then dismissed and provided with instructions for attending the second session.

Upon arriving at the second session, students were asked to turn to 20 pages (spaced 15 pages apart that started at a random page number between 15 and 30), in their textbooks and were asked to (1) count how many paragraphs were on the page, (2) count how many sentences were highlighted on each page, (3) indicate whether or not the highlighted sentences were marked by them or by the previous owner of the text, and (4) indicate the degree of confidence they had that the highlighted material on each page was marked by them or was marked by the previous owner if the text was used.

Results.

Unless otherwise specified, all analyses carried out were conducted using SPSS for Windows (Version 10.0).

Study-Strategy Survey Analyses. Examination of the self-report data reveals that the students who participated in the study rely heavily on adjunct study strategies. Figure 1 shows that only 7% claimed to not use any study strategy whatsoever (None). This finding was consistent with previous research demonstrating that only 8 % of college students never use a text-marking strategy (e.g. Peterson, 1992). At the opposite extreme, 38% of the students claimed to use highlighting (H), underlining (U) and some other study strategy (O) simultaneously. Other study strategies include: making marks (e.g. asterisks), writing notes in the margin, using tabs or page folding, and making flashcards (see Figure 2 for frequencies). In addition, 23% reported using both highlighting and underlining while studying texts. Thus, well over half of the students surveyed claim to use at least two adjunct study methods while reading their textbooks. For the students

who claimed to only use one study method, highlighting was a more popular method than underlining. When taken together, over 90 percent of students surveyed reported using a text-marking strategy, which is consistent with previous research examining frequency of text marking (e.g. Brennan, Winograd, Bridge, & Hiebert, 1986; Peterson, 1992).

Figure 1.

Proportion of Students Employing Different Study Strategies.

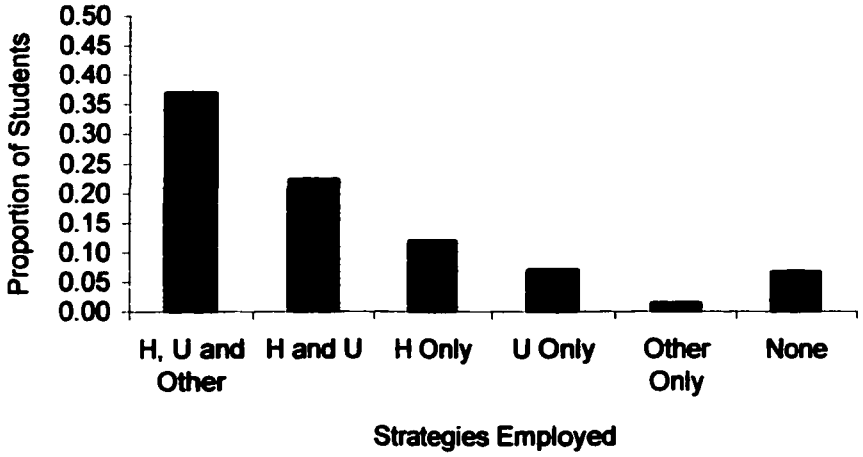


Figure 2.

Types and Frequency of Study Strategies other than Highlighting or Underlining.

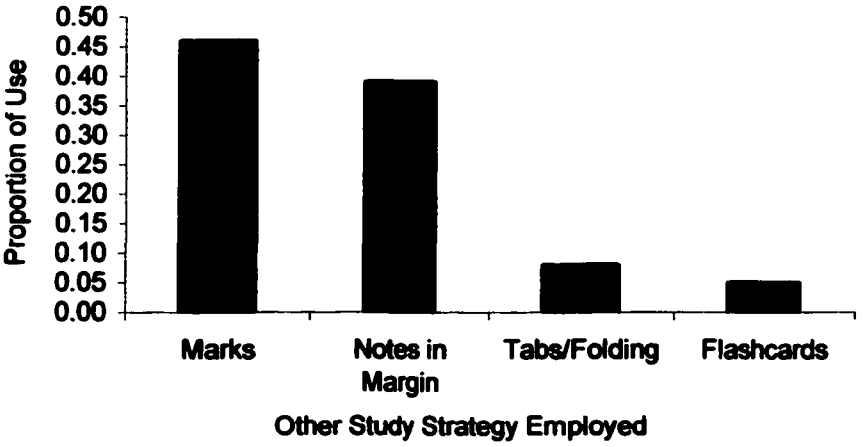


Table 1 lists obtained Pearson's Product Moment Correlations obtained from the entire sample of students responding on the survey variables ($n = 211$). Examination of the table demonstrates that those students who claim to use highlighting and underlining more frequently (OccasH and OccasU, respectively), when they study, also tend to report highlighting or underlining more of the material on the pages they are studying (DegreeH and DegreeU, respectively) ($r = .73, p < .01$ for highlighting; $r = .83, p < .01$ for underlining). Thus, those students who claim to highlight or underline on more occasions, when they sit down to read a textbook, also claim to highlight and underline a greater proportion of each page they read. Consistent with the finding that many students who use study strategies use more than one strategy, obtained correlation coefficients demonstrate that there is a significant positive relationship between the frequency of highlighting use (OccasH) and the frequency of underlining use (OccasU) ($r = .23, p < .01$). Furthermore, those students who do use more than one strategy who claim to highlight more of the text (DegreeH) also claim to underline more of the page (DegreeU) ($r = .26, p < .01$).

Table 1.

Survey Variable and Reading Skill Correlations.

	Nelden	OccasH	DegreeH	OccasU	DegreeU	PrefUsed	OnlyUsed
Nelden	1.00						
OccasH	-.20**	1.00					
DegreeH	-.13	.73**	1.00				
OccasU	-.13	.23**	.20**	1.00			
DegreeU	-.12	.15*	.26**	.83**	1.00		
PrefUsed	-.12	-.01	.11	.14*	.12	1.00	
OnlyUsed	-.03	.13	.17*	.04	.11	.46**	1.00

** p < .01
* p < .05

In order to examine the relationship between reading skill and type of study strategy used, average reading-skill scores were plotted as a function of type of study method(s) reported. Figure 3 shows that the students who do not use any study strategies ($n = 6$), or only use one strategy (highlight only, $n = 53$; underline only, $n = 14$) have higher average Nelson-Denny scores than those students who use more than one study strategy (highlight and underline, $n = 46$; highlight, underline and other, $n = 78$). The group with the highest average Nelson-Denny score was the group that uses strategies that do not involve the use of highlighting or underlining (i.e. notes in the margin, etc.) ($M = 65.20$, $SD = 21.16$). The lowest average Nelson-Denny scores were obtained from the students who highlight, underline, and use other study strategies as well ($M = 56.06$, $SD = 13.54$) and those students who claim to use both highlighting and underlining ($M = 54.74$, $SD = 14.64$). An analysis of variance was conducted in order to establish whether or not these differences were significantly different. However, based on the unequal sample sizes, in each group, a Levene's test for homogeneity of variance was necessary to ensure the appropriateness of the ANOVA, but was found to be non-significant ($F_{5,204} = 1.07$, $p = .38$). Results of the ANOVA demonstrate that none of the groups differ significantly ($F_{5,204} = 2.09$, $MSE = 213.82$, $p = .07$).

Figure 3.

Reading Skill and Type of Study Strategies Employed.

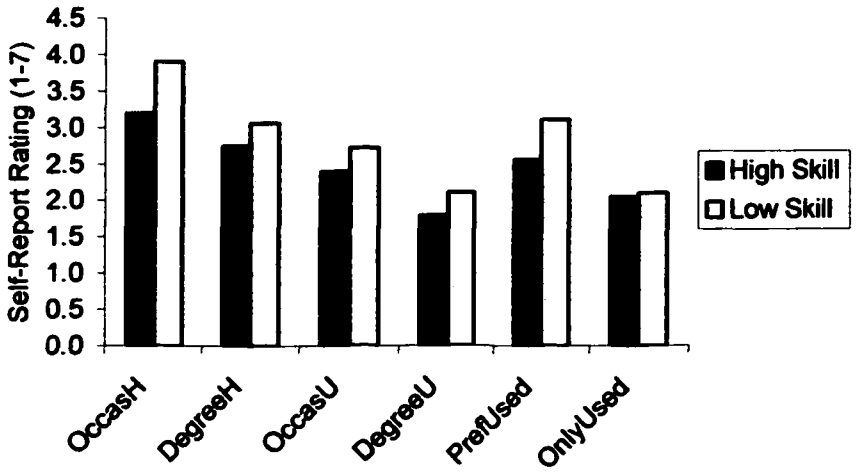
In order to further examine the relationship between reading skill and self-reported use of study techniques, Nelson-Denny scores were correlated with the survey variables (see Table 1). The obtained correlation between frequency of highlighting use (OccasH) and reading skill (Nelden) was negative and significant ($r = -.20, p < .01$) suggesting that lower-skill readers report using highlighting on more occasions. Lower-skilled readers also reported highlighting a greater proportion of the text, when they do highlight, but the obtained correlation was not statistically significant ($r = -.13, p = .052$). Taken together, these obtained correlations suggest that as reading–skill level decreases there is an increase in the self-reported frequency of highlighting use. However, this type of relationship is not present for underlining. Furthermore, there are no significant relationships between self-reported frequency of highlighting and underlining use and the self-reported degree to which pages are marked using either of these text-marking methods. Finally, there is no relationship between reading skill and reliance on a previously marked text.

The correlations between reading skill and the self-report variables reported above were based on the entire sample of students, which included readers of all skill levels (n = 211). The inclusion of all readers in those analyses may have concealed actual differences that may exist between readers of high- and low-skill. In order to determine if readers of high- and low-skill differed on each of the self-report variables outlined above, skill groups were created by taking the top (n = 75) and bottom third (n = 72) of Nelson-Denny scores and comparing the two groups on the self-report data (M = 73.87 for high skill; M = 42.67 = for low skill). Figure 4 shows average survey-variable ratings for each of the two reading-skill groups. Examination of the figure shows that the low-skill groups are higher on each of the highlighting and underlining variables. That is, it appears that low-skill readers report highlighting and underlining more often and also report highlighting and underlining a greater amount of the text material than readers of higher skill. In order to test for statistically significant differences between skill groups on each of these variables, Independent-Groups t-tests were performed. Results of the group comparisons revealed that the only statistically significant difference between skill groups and use of highlighting or underlining was obtained with the occasion of highlighting use variable (OccasH) ($t_{145,.05} = -2.16, p < .05$). Thus, lower-skilled readers claim to highlight on more occasions, when they sit down to read a textbook, than the higher-skilled readers. The only other statistically significant result obtained from the reading-skill group comparisons of self-report data was on the preference for a previously highlighted text variable (PrefUsed). Here, it was found that the reader of lower skill preferred to study a textbook that had been marked by a previous owner to a significantly greater degree than the reader of higher skill ($t_{145, .05} = -2.00, p < .05$).

While statistical significance was reached in comparing high- and low-skill readers on only two of the survey variables, the overall pattern present is of note. That is, on every variable (except the OnlyUsed variable) the low-skill reader shows higher ratings than high-skill readers. Approached from a binomial probability standpoint, this pattern, in and of itself, is significant (i.e. the probability of 5 out of 6 increases is less than .001).

Figure 4.

Survey Variables and Reading Skill Differences.



The finding that lower-skilled readers prefer previously used texts more than higher skilled readers was intriguing. Thus, the survey data was examined to determine the reasons why students would prefer, or not prefer a previously highlighted/underlined text. From the open-ended survey question inquiring as to reason why a student prefers previously highlighted/underlined texts, three categories of response were created: (1) focuses attention, (2) trusts previous reader, and (3) other. Likewise, there were three categories of reason for why students do not prefer previously used texts: (1) distracts attention, (2) does not trust previous reader, and (3) other. Figure 5 shows proportion of

students in each of the "prefer" and "do not prefer" response categories. Examination of the figure reveals that the most commonly reported reason for preferring a used text was that the previously highlighted material "focuses attention." On the other hand, the most commonly reported reason for not preferring a previously highlighted text was that it "distracts attention." In order to determine if reading-skill differences were present between the readers who claimed that previously marked material "focuses attention" or "distracts attention," preference groups ($n = 45$; n = 49, respectively) were created and average Nelson-Denny scores were calculated for each group. Figure 6 shows that the average Nelson-Denny score for the "focuses attention" group ($M = 57.20$, $SD = 13.75$) was lower than the "distracts attention" group ($M = 62.70$, $SD = 12.12$). To determine if the differences between the groups was statistically significant, an Independent-Groups *t*-test was performed. However, results of this comparison failed to demonstrate a statistically significant difference between the groups ($t_{91, .05} = -1.88$, $p = .06$).

Figure 5.

Reasons Why Students Prefer/Do Not Prefer Previously Highlighted Material.

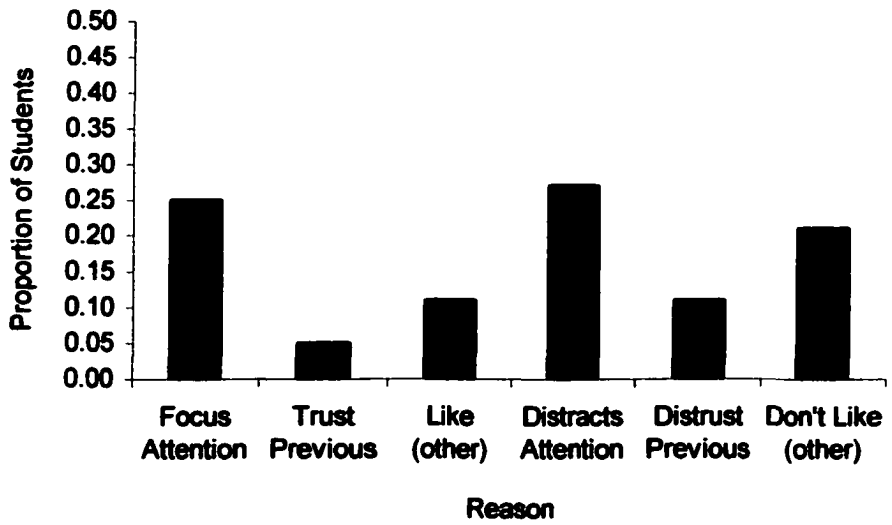


Figure 6.

Focuses or Distracts Attention Groups and Average Nelson-Denny Score.

Text-Marking Analyses. Of the textbooks analyzed, there were equal amounts of new and used texts. Thus, 50% of the textbooks used by students who participated in the study were previously owned books. Of these used textbooks, 70% contained text that had been highlighted or underlined by a previous reader.

Examination of the relationship between self-reported degree of highlighting/underlining (DegreeH and DegreeU, respectively) and the actual amount highlighted/underlined (SentHigh and SentUnd, respectively) by students was examined by performing analyses on only those students with new textbooks who actually highlight or underline (n = 40). Table 2 shows that none of the relationships between self-reported use of text marking and actual use of text marking were statistically significant. From these obtained correlations between self-reported use of text marking and actual degree of marking found in new textbooks, it can be concluded that students who claim to highlight or underline more of the text do not, in fact, highlight or underline more of the text.

Table 2.

Correlations Between Reported Use and Actual Use of Text Marking.

	DegreeH	DegreeU	SentHigh	SentUnd
DegreeH	1.00			
DegreeU	.04	1.00		
SentHigh	.16	-.20	1.00	
SentUnd	-.17	.14	-.16	1.00

In order to examine the relationship between actual text marking and reading skill, correlations were obtained between Nelson-Denny Score (Nelden) and number of sentences marked with either highlighting (SentHigh) or underlining (SentUnd) as well as with highlighting and underlining considered together as text marking (SentMark). Again, these analyses were conducted using only the students with new textbooks (n = 40). Table 3 reveals that there are no statistically significant relationships between reading skill and actual degree of text marking.

Table 3.

Correlations Between Reading Skill Level and Amount of Text-Marking.

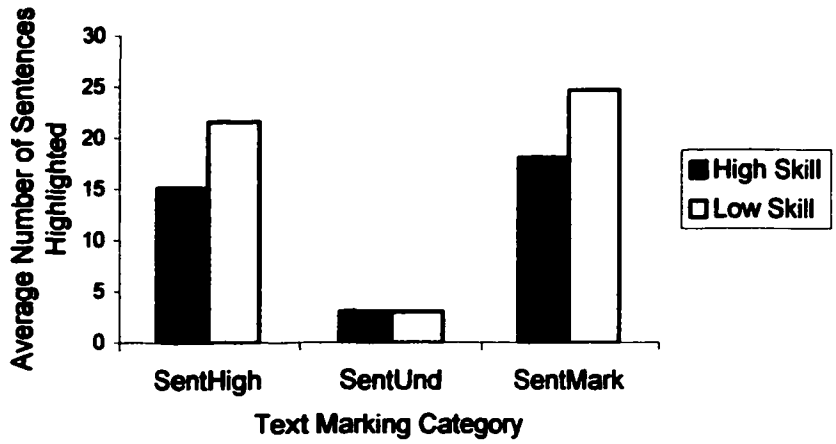
	Nelden	SentHigh	SentUnd	SentMark
Nelden	1.00			
SentHigh	-.15	1.00		
SentUnd	.12	-.16	1.00	
SentMark	-.11	.92**	.24	1.00

** $p < .01$
* $p < .05$

As an additional analysis to determine if differences were present between readers of different skill in the degree to which text marking was employed, high- and low-skill reader groups were created by using a median split of the reading skill scores and calculating averages for each group. An Independent-Groups *t*-test was performed on average number of sentences highlighted by each group in three text-marking categories: number of sentences highlighted, number of sentences underlined and number of sentences marked (highlighting and underlining collapsed). Figure 7 shows that high-skill readers highlighted fewer sentences than the low-skill readers ($M = 15.10$, $SD = 12.12$; $M = 21.60$, $SD = 23.32$, respectively), however, this difference was not statistically significant ($t_{38, .05} = -1.09$, $p = .28$). The means between skill groups for number of sentences underlined were roughly equal ($M = 3.00$, $SD = 7.17$; $M = 3.05$, $SD = 8.47$, respectively). Finally, mean differences between reader groups on the collapsed text-marking variable were examined, revealing that low-skill readers appear to mark more of the text ($M = 24.70$, $SD = 22.70$) than high skill readers ($M = 18.10$, $SD = 14.70$). However, the observed difference was not statistically significant ($t_{38, .05} = -1.08$, $p = .29$).

Figure 7.

Average Number of Sentences Marked and Reading Skill Level.



Discussion.

Taken together, the preliminary results of Study 1 suggest that the reader of lower skill claims to highlight more often, but does not claim to highlight more of the page, when compared to high-skill readers (see Table 1 & Figure 4). Furthermore, the low-skill reader claims to, but does not actually highlight significantly more of the text material on a page than the high-skill reader (see Table 1 & Figure 7). Finally, the low-skill reader reports a greater preference for previously marked text than the high-skill reader (see Figure 4) and that this preference may be related to the idea that the previously marked material "focuses attention" on the most important material in the text (see Figure 6).

While the findings reported here comparing high- and low-skill readers in degree of text marking failed to reach statistical significance, there were a number of methodological problems associated with the textbook marking data. One serious problem involved the fact that the students, themselves, were counting the number of sentences marked in their texts. Another serious problem for the textbook-marking data

was due to the fact that, in some cases, participants were unsure if their textbooks were new or used upon purchase and, furthermore, were not sure if the material highlighted was actually done by them or by the previous reader (in the case of a used text). The data from these subjects were not included in the textbook marking analyses for this reason, which resulted in an overall smaller sample size. Finally, it was difficult to gain an understanding of the actual degree of highlighting done because there was no provision made to calculate proportion of the pages highlighted (i.e. total number of words/sentences on the page were not counted). One final methodological problem associated with the textbook markings was due to the method of page selection for analysis. Only twenty pages of text were selected for analysis and the pages were spread throughout the entire textbook. Given the fact that some students chose to participate in the study early in the semester, the amount of text material highlighted/underlined would have been seriously underestimated. This is particularly problematic when trying to evaluate how much a student actually highlights by examining a new textbook. However, this method would have had no impact on the estimate of degree to which used texts tend to be marked by previous readers. Finally, many of the comparisons being made involved relatively small sample sizes.

Study 2

The results obtained in Study 1, along with those reported in previous research, suggest that the relationship between reading skill and use of text marking should be examined more thoroughly. Despite the failure to demonstrate statistically significant differences between high- and low-skill readers in amount of text marking, the problem

of what is marked in the text still remains. That is, failure to demonstrate a difference between the skill groups still suggests that at least half of all used textbooks contain text marking done by readers of lower skill, who may not be as capable of identifying the most important information in the text. As previously mentioned, research examining student ability to identify the most relevant material in a textbook suggests that only the higher–skilled reader is effective in this task (e.g. Smiley, Oakley, Worthen, Campione, & Brown, 1977; Winograd, 1984). Therefore, it is possible that a great deal of information that is marked in a used textbook may not be the most relevant, if the previous owner was a lower-skilled reader who used text-marking as a study strategy. Furthermore, if the new owner of a textbook (that was previously marked by a low-skill reader) is also a low-skill reader, there are additional problems because the low-skilled readers surveyed in Study 1 indicated a preference for studying material that was marked by the previous reader. In short, a low-skill reader who prefers to study material that was marked by a previous reader may be focusing their attention on irrelevant information if that previous reader was also a low-skilled reader.

Study 2 was designed to further explore the relationship between reading skill and the use of text marking strategies, while attempting to address the methodological shortcomings of Study 1. The first methodological change was associated with the assessment of the frequency and degree of text-marking strategies employed by students. Given the potential problems associated with asking subjects to count the number of sentences marked in their texts, Study 2 involved analysis of text marking by the experimenter, rather than the student. Secondly, in order to gain a better understanding of the degree of text marking, on any given page, a method was employed that would

allow for easier calculation of proportion of the text that was marked. Furthermore, in order to ensure that the marked material being included in analyses was actually done by the student, only textbooks that were new at the time of purchase were used in the analyses. Finally, in order to address the problem of target-page selection that surfaced in Study 1, a more careful, systematic target-page selection method was employed.

Considering the questions raised by Study 1 and the methodological changes, the major goals of Study 2 were (1) to examine the relationship between a student's self-report of text marking use and their actual use of text marking, (2) to examine the degree to which the frequency and degree of text marking is related to reading skill, (3) to evaluate the relationship between preference for studying previously-marked text, reading-skill level and performance in a course, (4) to determine how capable high- and low-skilled readers are at identifying the most relevant material in a textbook during study, and (5) to examine the relationship between use of text-marking strategies, ability to identify the most relevant material in a textbook and actual performance in a course.

Method.

Participants. Four hundred and seventy nine University of New Hampshire undergraduates who were enrolled in Introductory Psychology courses participated for course credit. Data obtained from thirty-three of the participants were discarded from analyses for failure to complete all aspects of the study.

Materials. Based on the survey results obtained in Study 1, a survey was created using six study-habit variables of interest (see Appendix D). The variables of interest focused on (1) the number of occasions the student employs text marking strategies when they study textbooks, (2) the degree of text marking used when employing these

strategies (i.e. how much of the page is marked), and (3) the degree to which the student prefers to study, or only studies, material in a textbook that has been marked by a previous reader. In addition to the study-habit variables, the survey included information about text condition (i.e. new or used). Finally, consistent with Study 1, all students completed the vocabulary subsection of the Nelson Denny Reading Test.

Procedure. The study involved two sessions using two large Introduction to Psychology classes on the UNH campus. For each class, during the first in-class session, participants were asked to complete the vocabulary section of the Nelson-Denny Reading test followed by the study survey. Next, participants were given instructions to write their participant number, and whether their book was new or used, in the front cover of their Introductory Psychology textbooks. This was accomplished by providing the student with an instruction sheet for completion of the study that had spaces in which participant number and text condition could be noted. Upon completion of text identification, the experimenter instructed students to bring their textbooks to one of four instructor-administered exam days (roughly one quarter of the students in each class were instructed to bring their texts to each exam day). This was accomplished by announcing the range of participant numbers assigned to each exam day and asking students to write the date, corresponding to each range of subject numbers, on the study instruction sheet. Finally, at the end of the first session, the students were asked to sign a release statement allowing access to their course exam scores. On each of the four appointed exam days, the experimenter and assistants arrived to collect the textbooks for coding. Textbooks were coded and returned to students at the beginning of the next class meeting.

Results.

Study-Strategy Survey Analyses. Table 4 lists Pearson's Product Moment Correlations obtained from the survey variable data obtained from the 446 participants who were included in the study. Consistent with the results found in Study 1, there was a significant relationship between reading skill (Nelden) and the reported frequency of highlighting use (OccasH) ($r = -.13, p < .01$). Unlike Study 1, however, the relationship between reading skill and the degree to which students claim to highlight the text while reading (DegreeH) was statistically significant in Study 2 ($r = -.15, p < .01$). From consideration of these obtained correlations, it can be concluded that, as reading-skill level decreases, the claim to highlight more often and report highlighting more of the text increases. However, this relationship does not hold for those students who choose to underline text while reading.

Table 4.

Survey Variable and Reading Skill Correlations.

	Nelden	OccasH	DegreeH	OccasU	DegreeU	PrefUsed	OnlyUsed
Nelden	1.00						
OccasH	-.13**	1.00					
DegreeH	-.15**	.75**	1.00				
OccasU	-.04	.18**	.20**	1.00			
DegreeU	-.04	.14**	.27**	.84**	1.00		
PrefUsed	-.13**	-.06	-.02	.05	.09*	1.00	
OnlyUsed	-.19**	.13**	.16**	.13**	.18**	.32**	1.00

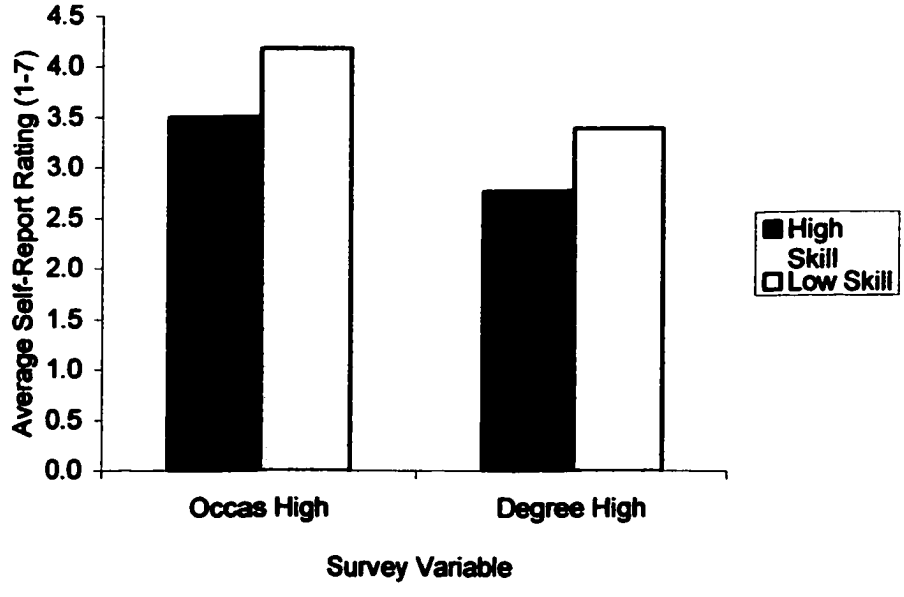
** p < .01
* p < .05

In order to better demonstrate differences between readers of differing skill on the self-reported use of text marking, Independent Groups *t*-tests were performed using reading-skill groups obtained by taking the upper and lower third of Nelson-Denny scores

of all the participants and creating high- and low-skill reader groups (n = 144; n = 153, respectively). Given the lack of statistical significance obtained in the correlational data for the underlining variables, group comparisons were only carried out on the highlighting variables. Examination of Figure 8 demonstrates that low-skill readers (M = 4.18, SD = 1.83) report using highlighting on more occasions than high-skill readers (M = 3.50, SD = 1.95). This difference was statistically significant ($t_{295, .05}$ = -3.10, $p < .01$). Likewise, low-skill readers report highlighting more of the text (M = 3.39, SD = 1.73) than high-skill readers (M = 2.76, SD = 1.84). Again, this group difference was statistically significant ($t_{295, .05}$ = -3.02, $p < .01$). From consideration of these results it can be concluded that readers of lower skill, do, in fact, claim to make more frequent use of highlighting and, when they do so, claim to highlight more of the text being read.

Figure 8.

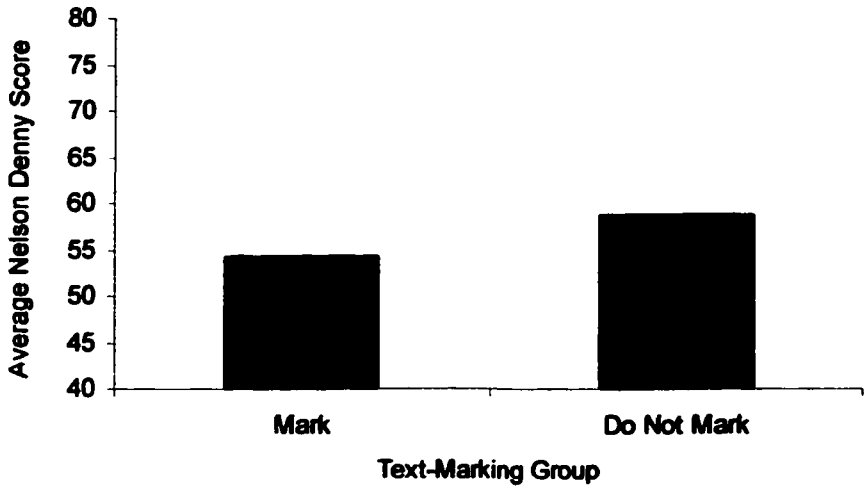
Reading Skill and Self-Reported Use of Highlighting.



As a final comparison of reading-skill differences in claimed frequency and degree of text-marking use, students who choose, or choose not to highlight or underline were collapsed to create a category of text markers. Creation of this grouping variable resulted in 399 students who claim to use a text-marking strategy and 47 students who claim to not mark their texts. Average Nelson-Denny scores were obtained for both groups. Figure 9 shows that the average Nelson-Denny score for the group who claimed to mark their texts during study ($M = 54.25$, $SD = 13.62$) is lower than the average of the group that claimed to not mark their texts ($M = 58.77$, $SD = 15.00$). Given the substantial difference in sample sizes, a Levene's Test for Equality of Variances was conducted and was found not to be significant ($F = 2.23$, $p = .14$). Given that the homogeneity of variance assumption was not violated, an Independent-Groups t-test was performed on average Nelson-Denny scores for each of the marking groups. The results of this analysis demonstrated that the groups were significantly different ($t_{444, .05} = -2.13$, $p < .05$). It can be concluded from this analysis that the students who choose to use a text-marking strategy, such as highlighting or underlining while reading a textbook, have significantly lower reading-skill scores than those students who choose not to use a text-marking strategy.

Figure 9.

Text-Marking Groups and Average Reading-Skill Score.



When examining the relationship between reading skill and preference for studying previously marked material, obtained correlation coefficients demonstrate that there is, in fact, a significant relationship between the preference for previously marked textbooks (PrefUsed) and reading skill, which confirmed the results obtained in Study 1 ($r = -.13, p < .01$) (see Table 4). However, unlike the results found in Study 1, the relationship between reading skill and the self-reported tendency to study *only* previously marked material (OnlyUsed) was statistically significant in Study 2 ($r = -.19, p < .01$). Thus, the lower the reading-skill level, the more the student reports a preference for a previously-marked text and the more likely the student is to report studying only the material marked by a previous reader.

Again, in order to better demonstrate differences between readers of differing skill on the self-reported reliance on previously highlighted material during study,

Independent-Groups *t*-tests were performed on the PrefUsed variable using reading-skill groups obtained by taking the upper and lower third of the total participants and creating high (n = 144) and low-skill (n = 153) reader groups. Figure 10 shows group differences obtained on the preference for studying previously marked material and the self-reported tendency to only study previously marked material. It is clear that readers of lower skill (M = 3.45, SD = 1.63) prefer to study previously marked material more than high-skill readers (M = 3.02, SD = 1.58). Results of the *t*-test confirm that this difference is statistically significant ($t_{295, .05}$ = -2.31, $p < .05$). A further test of reading skill differences in preference was conducted by creating groups who prefer (n = 219) and do not prefer (n = 227) studying previously marked text and obtaining an average Nelson-Denny score for each group. Figure 11 shows that the average Nelson-Denny score for the group that prefers to study previously-marked text (M = 52.90, SD = 13.27) is lower than the average reading-skill scores for the group that does not prefer to study this type of material (M = 56.50, SD = 14.15). Results of an Independent-Groups *t*-test confirmed that these group means are significantly different ($t_{444, .05}$ = -2.76, $p < .01$).

Figure 10.

Reading Skill and the Self-Reported Reliance on Previously Highlighted Text.

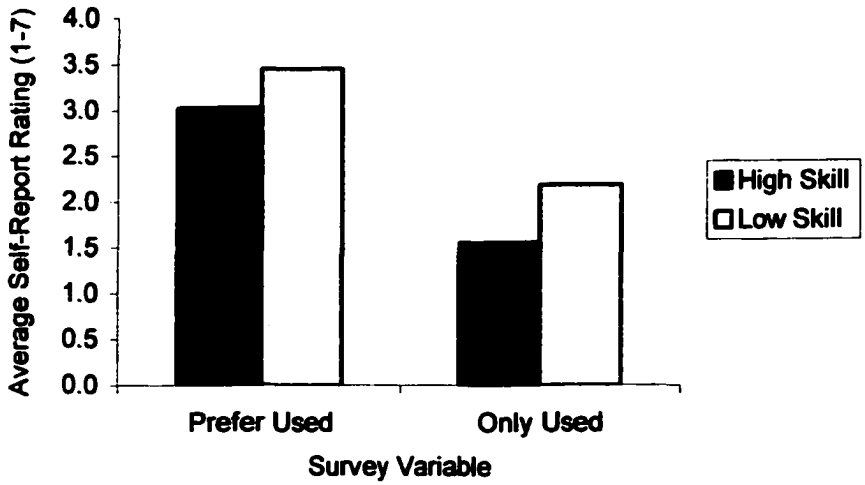
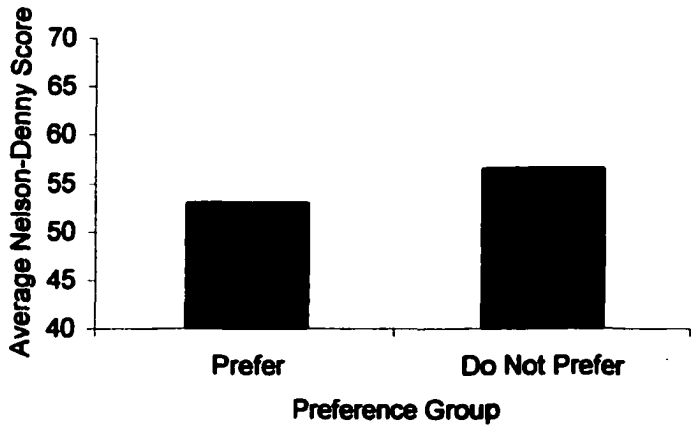


Figure 11.

Reading Skill and Self-Reported Preference for Previously Highlighted Text.

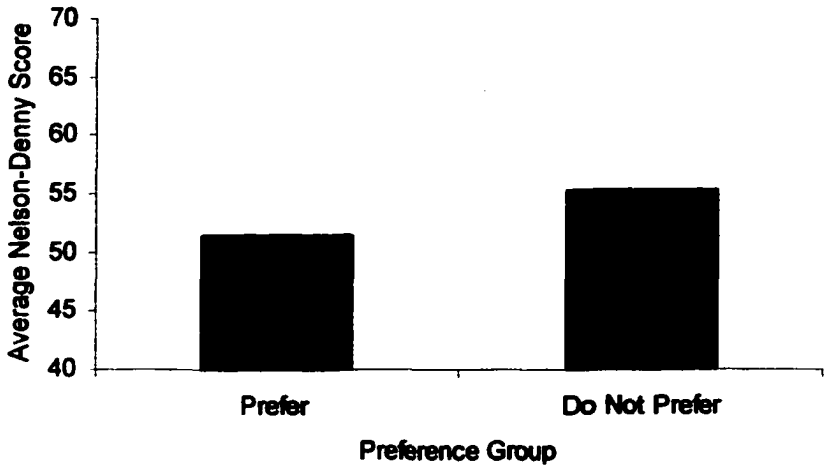


As Figure 10 also demonstrates, the self-reported tendency to study only previously marked material is also significantly higher in low-skill readers ($M = 2.18$, $SD = 1.38$) than high-skill readers ($M = 1.56$, $SD = 1.13$) ($t_{295, .05} = -4.28$, $p < .01$).

As an additional analysis to confirm that high- and low-skill readers show different preferences for relying solely on text marked by a previous reader, during the study of their texts, preference groups for studying only previously marked material were created and average Nelson-Denny scores were obtained for each group. The group that preferred to only study previously highlighted material contained 65 participants and the group that did not prefer to study this material contained 381 participants. Figure 12 shows that the average Nelson-Denny score for the group that prefers to only study previously-marked material ($M = 51.49$, $SD = 13.49$) is lower than the average reading-skill scores for the group that does not prefer to only study previously highlighted material ($M = 55.28$, $SD = 13.82$). Given the substantial differences in sample sizes between these two groups, a Levene's Test for Equality of Variances was performed and was found to be non-significant ($F = .019$, $p = .89$). Thus, an Independent-Groups t-test was performed to compare the group means. Results of the t-test confirmed that the group that prefers to only study previously highlighted material has a significantly lower average reading skill score ($t_{444, .05} = -2.05$, $p < .05$) than the group that does not prefer only studying this material.

Figure 12.

Average Reading-Skill Scores and the Self-Reported Tendency to Study Only Previously-Marked Text.



From these results, it can be concluded that readers of lower skill rely more heavily on the existence of previously marked text material than high-skill readers. This reliance does not merely indicate a tendency to study previously marked material, but involves a tendency, on the part of the low-skill reader, to study only the material that the previous owner of the textbook marked. Based on survey results obtained in Study 1, this reliance is likely guided by the idea that the previously marked material will "focus" the low-skill readers' attention on the most important material in the text.

Textbook Analyses. As mentioned in the Methods section, there were two classes used in the study. Thus, there were two texts (*Psychology*, 3rd Edition by Kassin and *Psychology*, 6th Edition by Wade & Tavris). Prior to textbook collection, 15 pages were randomly selected from each text for text analyses. The pages that were selected were taken only from the section of the text that was assigned for the exam that was given on that textbook collection day. For example, if the exam that the student was assigned to

bring his/her text to, for his/her assigned collection day, was covering text chapters 1, 2, and 3, which encompassed 100 pages of text, then the 15 randomly-selected pages were taken only from that section of 100 pages. During coding, all of the material that was marked by the student was identified by (1) paragraph number, (2) sentence number, and (3) word number. For example, if the student marked only the last 7 words of the second sentence (which contained 20 total words) in the third paragraph, then this would be indicated by entering that the student marked: paragraph 3, sentence 2, words 14-20. This manner of coding was followed for all target pages and all subjects who brought new texts to the collection.

Of the 446 total students who were included in Study 2, 399 reported using a text-marking strategy (90%), which is consistent with the results found in Study 1 in which 92 percent of students reported using a text-marking strategy. 412 of the total participants reported that the textbook they were currently using was new. Of these 412 participants with new texts, 342 textbooks were collected across the four collection periods. Of the 342 new texts collected, 309 were from students who reported to use a text-marking strategy. As a collected sample, this proportion is consistent with both the findings in Study 1, as well as the findings in Study 2 that roughly 90% of students use a text-marking strategy. However, of these 309 new textbooks submitted by students who claim to use a text-marking strategy, only 149 of these collected texts actually contained text marking on one or more of the target pages. Thus, the proportion of texts actually marked was closer to 50% rather than 90%. In actuality, there were 157 texts submitted that contained text marking, however cross-checking of reported book condition (some of the books submitted as *new* were indicated as *used* in the survey) and subject numbers

indicated in the cover of textbooks (there were duplicate subject numbers recorded in two cases) resulted in the elimination of 8 texts.

In order to get an index of frequency of text-marking use from the 342 new textbooks that were collected, the number of target pages actually marked in the text was divided by 15 (the total number of target pages). This provided an index of proportion of pages marked (PageProp). Those students who submitted new texts during the collection period and indicated in the survey that they never mark text while reading, were assigned a 0.00 for this index. In order to obtain an index of the degree of text marking, the number of words actually marked on a page was divided by the total number of words on that page. This resulted in a proportion of the page marked. These individual page proportions were then averaged across the 15 pages for each participant (Proport). Consistent with the procedure for handling students who submitted new texts, but chose not to use text-marking strategies, a proportion value of 0.00 was assigned to these students.

In order to get an understanding of the relationship between self-report of text-marking use and actual use of text marking, Pearson's Product Moment Correlations between self-reported use of text marking (OccasH) and actual use of text marking (PageProp) were obtained for the 342 students who submitted new texts (see Table 5). As can be seen from an examination of the table, there is a significant positive relationship between those students who claim to use text marking as a study strategy on more occasions and the proportion of pages that actually contained text marking ($r = .42$, $p < .01$). In addition, the relationship between self-reported degree of text marking (DegreeH) and actual proportion of the text marked (Proport) was also significantly

positive ($r = .24, p < .01$). From these obtained correlations, based on all collected texts, it can be concluded that those students who claim to use text marking on more occasions tend to do so in actuality. Furthermore, those students who claim to mark more of the text when using a text marking strategy, such as highlighting, also tend to actually do so.

Table 5.

Correlations Between Reading Skill, Self-Reported Use of Text Marking and Actual Use of Text Marking.

	Nelden	OccasH	DegreeH	Proport	PageProp
Nelden	1.00				
OccasH	-.16**	1.00			
DegreeH	-.16**	.75**	1.00		
Proport	-.10*	.39**	.24**	1.00	
PageProp	-.07	.42**	.27**	.87**	1.00

** p < .01
* p < .05

Based on the differences obtained in the comparisons of average Nelson-Denny scores of the entire sample of students who claimed to either use text-marking strategies or to not use them (see Figure 9), there is reason to suspect that differences in actual use of text-marking may be present between these reader groups. In order to more fully examine the relationship between reading skill and the use of text-marking strategies, two questions must be addressed. First, do high and low-skill readers actually differ in the frequency with which they rely on the use of text-marking strategies when they study a textbook? Second, when readers of different skill levels do mark text, do they differ in the actual amount of the text that they mark?

The first question can be addressed by determining if there are differences between reading-skill groups in the number of target pages that contain text marking. Thus, high ($n = 114$) and low-skill ($n = 114$) groups were created by taking the upper and

lower third of the Nelson-Denny scores from the 342 participants who submitted new texts across the four collection periods. Figure 13 shows that high-skill readers ($M = .22$, $SD = .35$) demonstrate a significantly lower average proportion of pages marked than low-skill readers ($M = .31$, $SD = .38$) ($t_{226, .05} = -1.74$, $p < .05$).

The second question can be addressed by examining the amount of text that readers of different skill level mark when they study a textbook. Figure 14 shows that the average proportion of text marked for the high-skill group ($M = .03$, $SD = .06$) was significantly lower than that of the low-skill group ($M = .046$, $SD = .07$) ($t_{226, .05} = -1.85$, $p < .05$). Thus, readers of lower skill do, in fact, use text marking on more occasions than high-skill readers and tend to mark more of the text when they do employ these strategies.

Figure 13.

Average Proportion of Pages Marked and Reading Skill Based on all Submitted Texts.

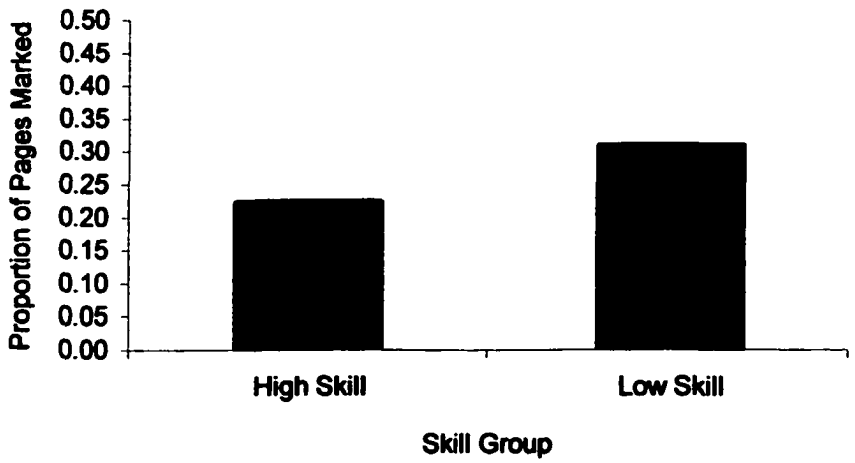
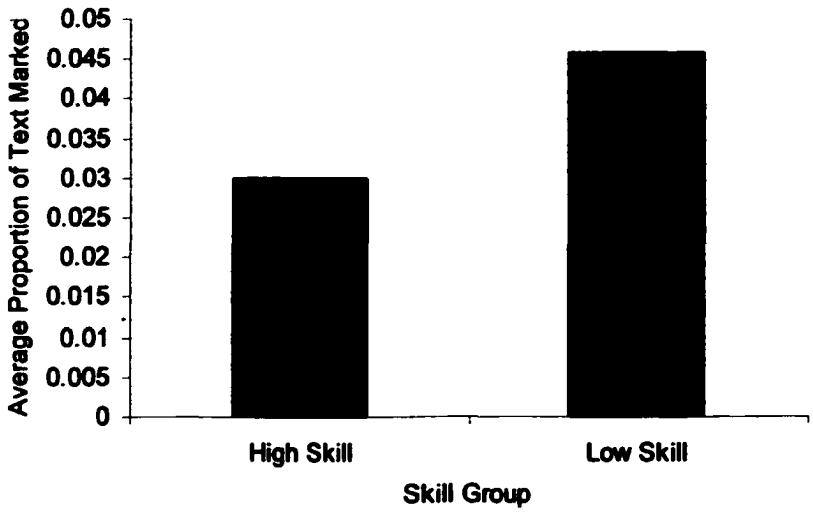


Figure 14.

Average Proportion of Text Marked and Reading Skill Based on all Submitted Texts.



While 342 new texts were collected for coding, only 149 of these texts actually contained text marking. Thus, to more directly evaluate text-marking characteristics, these 149 texts were examined and it was found that, on average, 63% (9.5 pages) of the 15 target pages were marked. This average was based on a range of marking involving 7% of the target pages (1 page) to marking found on each of the 15 target pages. Examining the overall averages involving degree of text marked on each page, roughly 9% of each page in a textbook is marked with either highlighting or underlining. This average is based on a range of proportions that include 27% of the page marked to 0% marked. An average proportion of .0 would indicate that the student highlighted only a few words across all 15 target pages.

Figure 15 shows the average proportion of text marked (across all students) for each page plotted across all 15 of the target pages. As the figure demonstrates, there is a decrease in proportion of text per page marked across pages. That is, the average

proportion for the first target page is roughly 13%, which decreases to an average of approximately 6% for the last target page. Thus, for each section of text that a student is assigned to read for a given exam, there is an overall tendency for students to begin the study of that section with the use of a greater degree of text marking that decreases as they approach the end the assigned reading for that exam.

When examining text-marking patterns, for all students, across the course of an entire semester, there is more stability than observed when examining patterns across pages for a given section of reading for a particular exam. Figure 16 shows that the average proportion of text marked early in the semester (the first collection) is slightly higher than the two collection points that occurred during the middle of the semester. It can also be noted that there is a slight increase in average proportion of text marked seen at the last collection, which is near the end of the semester. Overall, however, the pattern of text marking averaged across all readers remains fairly stable throughout the course of the semester.

Figure 15.

Text-Marking Trend Across Target Pages Averaged Across all Students.

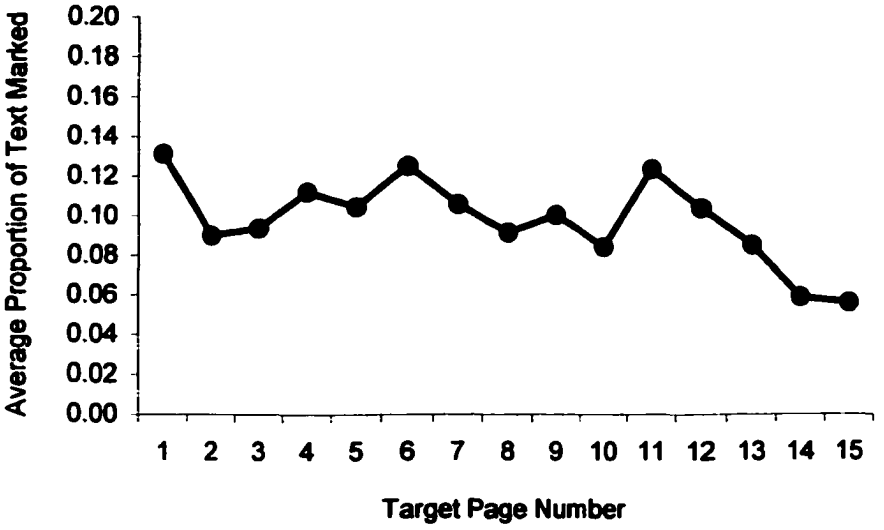
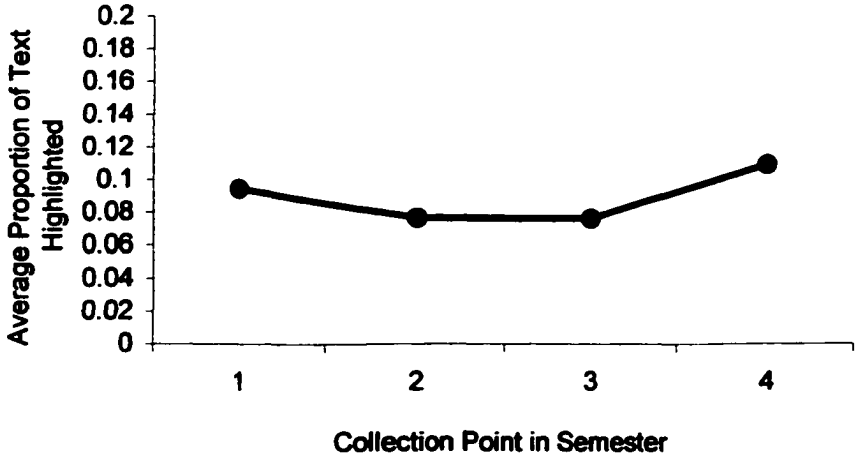


Figure 16.

Text-Marking Trend Across The Semester Averaged Across All Students.

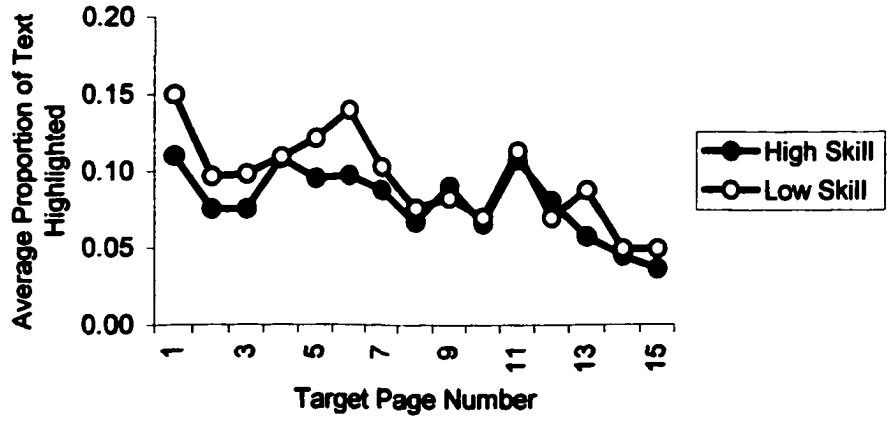


In order to determine if there were reading-skill differences in patterns of text marking, high- and low-skill reader groups were created by taking the upper and lower third of Nelson-Denny scores (n = 50) from the 149 students who submitted new textbooks that contained text marking. Consistent with the results described above, there

is an overall decrease in proportion of text highlighted across target pages seen in both groups of readers (see Figure 17). In general, there tends to be a substantial degree of overlap between the two groups in this linear decrease, although readers of lower skill show a higher proportion (roughly 15%) of text marking at the beginning of the text section than higher skilled readers (roughly 11%). Other than this difference observed at the beginning of the target-page text section, there are no apparent differences in overall trend of proportion of text marked across the 15 target pages between the reading-skill groups.

Figure 17.

Reading-Skill Differences in Text-Marking Trends Across Target Pages.



When examining skill differences in patterns of text marking across the semester, there are more visible differences between the skill groups. Figure 18 shows that both reader groups are roughly equivalent, in the average proportion of text marked, across the first three collection points. However, there is a substantial difference between the two groups seen at the last collection point. That is, the low-skill group averages 7% more of the text marked at the last collection point than the high-skill group. Thus, it appears

from examination of these text-marking pattern differences between skill groups that both groups of readers mark roughly equivalent proportions of text during most of the semester. However, there is a dramatic increase in the proportion of text highlighted by the lower-skilled reader at the end of the semester relative to that observed in the high-skill group.

Figure 18.

Reading-Skill Differences in Text-Marking Trends Across The Semester.

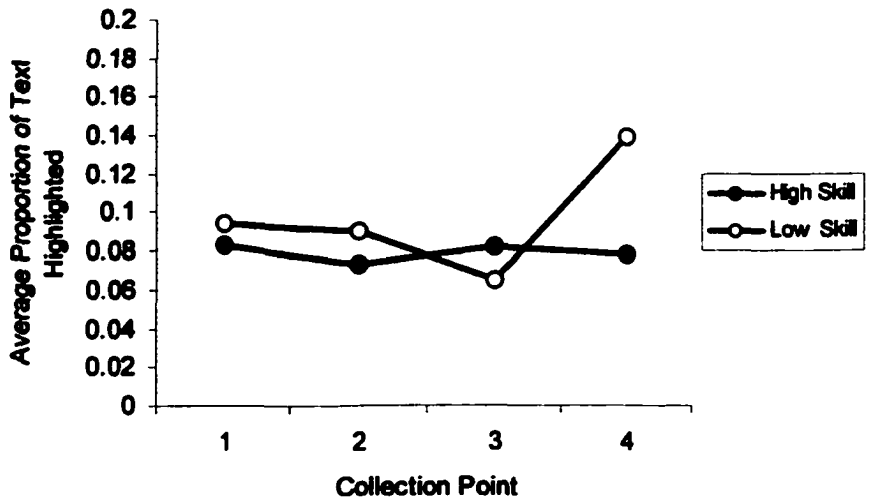


Table 6 lists correlations between reading skill level and average proportion of pages highlighted (PageProp) from the participants who submitted new texts that contained text marking (n = 149). As can be seen in the table, there was not a significant relationship between reading skill and proportion of pages marked for those students who submitted marked texts (r = .02, p = .82). As a follow up, to the correlational data, an Independent-Groups t-test was performed on proportion of pages marked using high (n = 50) and low-skill (n = 50) groups taken from the top and bottom third of the distribution of Nelson-Denny scores, respectively. Figure 19 shows that the average proportion of

pages marked by high-skill readers ($M = .62$, $SD = .32$) was nearly identical to that of the low-skill readers ($M = .61$, $SD = .3$) ($t_{98, .05} = .03$, $p = .98$). From these results, it can be concluded that there is no significant difference between the high- and low-skill readers, who submitted new textbooks for coding, in the frequency with which they employ text-marking strategies such as highlighting or underlining.

Table 6.

Correlations Between Reading Skill and Text Marking Based on Coded Texts Only.

	Nelden	Proport	PageProp	Relindex
Nelden	1.00			
Proport	-.07	1.00		
PageProp	.02	.79**	1.00	
Relindex	.21**	-.07	.03	1.00

** p < .01
* p < .05

In order to determine if readers of different skill level mark more of the text when they study, correlations between reading-skill level and average proportion of text per page highlighted (Proport) were obtained from the participants who submitted textbooks for coding ($n = 149$). Results of the correlational analysis failed to demonstrate a significant relationship between these two variables ($r = -.07$, $p = .40$) (see Table 6). Thus, like the correlation observed for proportion of pages marked, the relationship between reading-skill level and proportion of text marked is also not significant. Consistent with the analyses performed on proportion of pages marked, an Independent-Groups *t*-test was performed on proportion of text marked using the same high- and low-skill groups. Figure 20 shows that the average proportion of text marked by high-skill readers ($M = .079$, $SD = .07$) was roughly equal to the average proportion of text marked

by low-skill readers ($M = .094$, $SD = .08$) ($t_{98, .05} = -.99$, $p = .33$). From these results, it can be concluded that there is no difference between high- and low-skill readers, who submitted marked texts, in the degree to which they mark their texts while using study strategies such as highlighting or underlining.

The failure to find significant differences between skill groups, when only examining the coded texts, does not necessarily suggest that there are no differences between high- and low-skill readers in frequency and degree of text marking. As was demonstrated in Figure 9, the group of students who claim to use text-marking strategies have a significantly lower average Nelson-Denny score than the group that claims to not use text-marking strategies. Thus, the comparisons between skill groups conducted using only the coded texts are, in effect, comparisons between groups that have overall lower reading-skill scores. In support of this claim, an Independent-Groups *t*-test was carried out on average Nelson-Denny score taken from the group of students who submitted marked texts ($n = 149$) ($M = 53.56$, $SD = 13.71$) and the group of students who claim to not use text-marking strategies ($n = 47$) ($M = 58.77$, $SD = 15.00$). The difference between these group means was statistically significant ($t_{194, .05} = -2.22$, $p < .05$), suggesting that the group of students who submitted marked texts have a significantly lower average reading-skill level. Due to the unequal sample sizes involved, a Levene's Test for Equality of Variances was performed and determined that the group variances did not significantly differ ($F = 1.67$, $p = .20$).

Figure 19.

Reading Skill and Proportion of Pages Marked Based on Coded Texts Only.

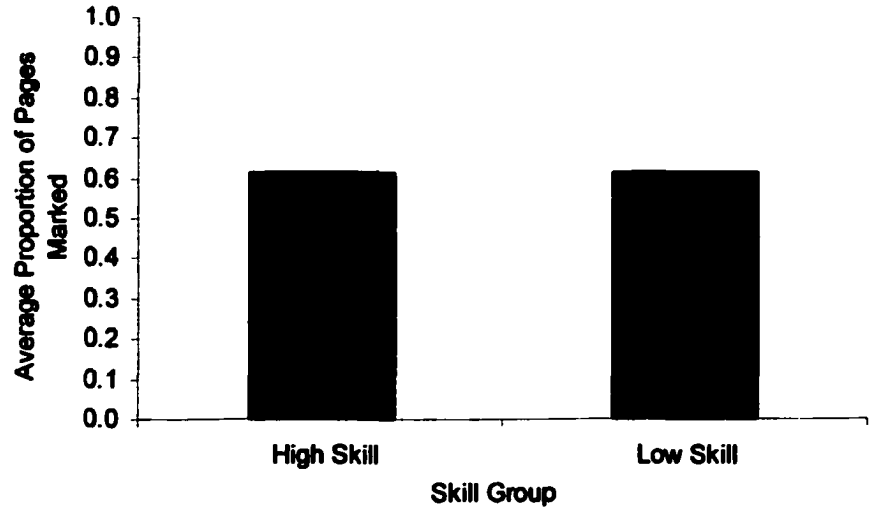
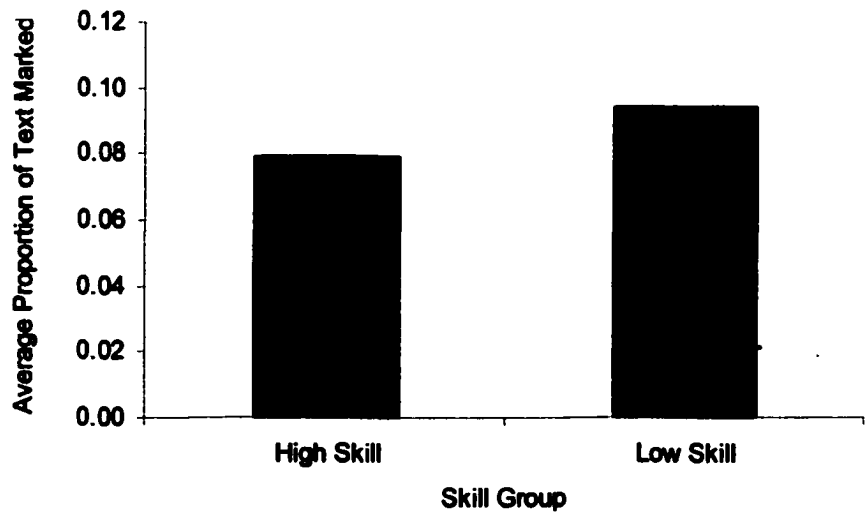


Figure 20.

Reading Skill and Proportion of Text Marked Based on Coded Texts Only.



Relevance Analyses. The results described in the previous section describing analyses performed using only the coded texts suggests that there were not significant differences between readers of different skill levels in the proportion of pages in the text marked or in

the proportion of text, on any given page, that is marked. However, despite the lack of statistical significance between skill groups in the textbook coding analysis, there is still reason to explore the text-marking habits of readers of differing skill. Firstly, as was previously described, the analyses conducted on the marked texts are, effectively, analyses of the marking habits of readers of overall lower skill. Secondly, even when ignoring this fact, the results described above suggest that at least 50% of marked textbooks contain highlighting or underlining done by readers of lower skill. As previously mentioned, this finding could be particularly problematic for the next owner of the textbook if, in fact, the previous owner was a low-skill reader because (based on findings in previous research that lower-skill readers are less adept at identifying relevant material) much of what had been previously marked may not be the most relevant material. This, coupled with the findings in Study 1 and the results described here that low-skill readers, who are in possession of a used text, prefer and tend to only study the material marked by the previous owner of the text, makes the question of whether or not the low-skill reader actually marks the most relevant material, while reading a textbook, a particularly important one.

In order to examine whether or not low-skill readers mark the most relevant material in the new text they are using, the text material marked by readers who submitted new, and marked, texts (n =149) was examined for degree of relevance. Identification of the most relevant material was accomplished by having five Introductory Psychology instructors identify the most important sentence for each paragraph of each target page and assessing the degree to which student text-marking overlapped with what the raters deemed as most important. In order to accomplish this, the instructors were

given copies of all of the target pages from each collection for each class, which totaled 120 pages of text (i.e. 15 pages by 4 collections for 2 classes). These raters were asked to indicate, by highlighting or underlining, which single sentence (per paragraph) was the "most important/relevant" sentence in that paragraph. A comparison of the 5 raters of which sentence per each paragraph was the most important resulted in an average of 41% agreement between the five raters. This degree of agreement was obtained by calculating the total number of paragraphs across all 15 target pages for both textbooks. The first textbook contained a total of 316 paragraphs and the other text contained 389 paragraphs. All five raters agreed on the most important sentence in 124 paragraphs of the first textbook (39% agreement) and 169 paragraphs in the second textbook (43% agreement).

Given the relative lack of agreement found between raters as to which sentences were the most relevant for each paragraph, a method of identifying the most relevant sentences per paragraph was devised which would take into consideration rater disagreement when comparing student marking to rater marking. This method involved assigning a probability that a given sentence, within a given paragraph, would be identified by a rater as the most relevant. For instance, if all five raters indicated that the first sentence of a paragraph was the most relevant, then a rater probability value of 1.0 would be assigned to that sentence. However, if only one rater identified that sentence as the most important, the assigned probability value would be .2 for that sentence. These probability values were then multiplied by the number of words in that particular sentence that the student marked. For instance, using the example from above, if the first sentence of a paragraph contained 20 words, the student marked all 20, and all five raters identified that sentence as the most relevant, then the 20 student-marked words were

multiplied by 1.0, which resulted in 20 relevant words identified. Likewise, if only one rater indicated that the same sentence was the most relevant, the student would be given assigned a value of 4 relevant words marked in that sentence. If four raters identified that sentence as the most relevant, but one rater identified a different sentence in the same paragraph (e.g. sentence 2 containing 10 words) and the student highlighted both sentences, the student would be credited for identifying 16 words for the first sentence (20 words marked multiplied by a probability of rater identification of .8) and 2 words for the second sentence (10 words marked multiplied by .2). If none of the raters identified a sentence as the most important then the student would be assigned 0 relevant words for that sentence.

In order to obtain a relevance index for each page, the sum of all of the rater-probability based relevant words, identified by the student, across paragraphs, for each target page was calculated. In order to control for possibility that a student could achieve a perfect match with the rater probabilities merely by marking every word on the page, the sum of all of the other words, not assigned any relevance value by rater identification, was also calculated for that page (irrelevant words). The sum of irrelevant words was then subtracted from the sum of relevant words resulting in a relevance index for each target page. Thus, a student who marked a great deal of irrelevant words, relative to relevant words, would end up with a negative relevance index for that page, whereas a student who marked a great deal of relevant words and few irrelevant words, would obtain a positive relevance index for that page. Finally, relevance indices for each target page were averaged across the 15 target pages in order to establish an average relevance index for each student.

Table 6 also shows the correlation between Nelson-Denny score and the average relevance index (Relindex), which was significantly positive ($r = .21, p < .01$). This suggests that as reading-skill level increases, the ability to identify the most relevant material also increases. In order to determine if there was a significant difference between high-skill readers and low-skill readers in ability to identify the most important information in a text, the reading skill groups used in the prior analyses were used as a grouping variable in an Independent-Groups *t*-test on the average relevance index. Figure 21 shows that high-skill readers had a positive relevance index ($M = 1.27, SD = 17.22$) relative to the low-skill readers ($M = -8.45, SD = 20.27$). This difference was statistically significant ($t_{98, .05} = 2.58, p < .05$). Based on this analysis, it is clear that readers of lower skill are not as capable of identifying the most relevant material in the text that they are reading as high-skill readers.

Figure 21.

Reading Skill and the Ability to Identify the Most Relevant Material in the Text.

The fact that low-skill readers are not as capable of identifying the most relevant material, coupled with the fact that these readers mark a great deal of the text, creates a serious problem, not only for the student doing the marking, but also for the current reader of a previously-owned textbook that has been marked by a low-skill reader. As previously mentioned, this is especially the case for the reader who prefers to study only the material that someone else has marked, which is most likely a reader of lower skill. In this case, the low-skill reader studying the used textbook by focusing only on previously-marked material may, in fact, be focusing their attention on a great deal of irrelevant information. Obviously, this practice can have a detrimental impact on performance in a course that the student is using the text for.

Due to the idiosyncratic grading methods used by the instructors in both of the courses used in the study, it was necessary to obtain equivalent indices of course performance for all subjects prior to analyses. Thus, raw exam scores for each exam, given by each instructor, were transformed into percentile ranks. These percentile ranks based on the exam covering the material coded for a given collection (RankColl) were used as a way to evaluate the more immediate effects of text marking. As a more general measure of course performance, average percentile ranks were calculated for each of the exams a student took over the course of the semester (RankAve).

Table 7 shows correlations between the self-reported reliance on the previously-marked text survey variables and exam performance for all participants ($n = 446$). Examination of the table reveals that those students who report a stronger preference for previously marked texts (PrefUsed) tend to have lower scores on the exam covering the material studied just prior to the textbook collection (RankColl) ($r = -.13$, $p < .05$) ($n =$

330). The same relationship was found for preference for previously highlighted textbooks and the average exam performance for the course ($r = -.15, p < .01$) ($n = 446$).

Table 7.

Correlations between Reliance on Previously-Marked Texts and Exam Performance.

	PrefUsed	OnlyUsed	RankColl	RankAve
PrefUsed	1.00			
OnlyUsed	.32	1.00		
RankColl	-.13*	-.15**	1.00	
RankAve	-.15**	-.21**	.85**	1.00

** p < .01
* p < .05

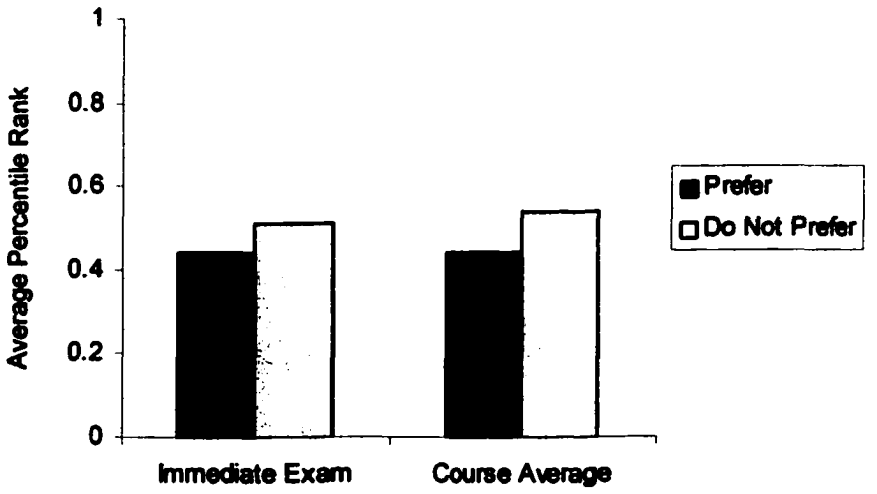
When examining those students who claim to only study previously marked material, similar relationships were observed with respect to exam performance (see Table 7). First, the relationship between the degree to which the student reports having only studied material that was marked by a previous reader (OnlyUsed) and average exam performance for the exam taken at the collection point is also significantly negative ($r = -.15, p < .01$) ($n = 330$). Likewise, there is a significantly negative relationship between degree to which students only study previously marked material and average exam performance ($r = -.21, p < .01$) ($n = 446$).

In order to determine if the students who report a preference for previously marked textbooks differ significantly in terms of exam performance from those students who do not prefer previously marked texts, Independent-Groups *t*-tests were performed on both exam measures using students who prefer and students who do not prefer previously-marked texts as the grouping variable. Figure 22 shows that the prefer group ($n = 156$) has a lower overall average ($M = .44$, $SD = .29$) on the exam at the textbook

collection point than the group that does not prefer (n = 174) previously marked texts (M = .51, SD = .27). This difference was statistically significant ($t_{328, .05}$ = -2.26, p < .05). The results of the group comparisons were similar for exam performance averaged over the entire course, such that the prefer group (n = 219) demonstrated a lower average percentile rank (M = .44, SD = .29) than the group that did not prefer (n = 227) (M = .54, SD = .28). This difference was also statistically significant ($t_{444, .05}$ = -3.53, p < .01). From these analyses, it becomes apparent that those students who prefer previously marked textbooks do more poorly in the course that they are using that textbook for.

Figure 22.

Self-Reported Preference for Previously-Marked Texts and Exam Performance.



Independent-Groups t-tests were also performed on the exam performance measures using students who prefer to only study previously marked material and those who do not prefer to study this material as a grouping variable. Unlike the previous analysis, the sample sizes compared in the analyses reported here were substantially different (n = 51 for prefer, n = 278 for do not prefer on RankColl; n = 65 for prefer, n =

381 on RankAve). In order to ensure that the homogeneity of variance assumption was not violated in conducting the tests, Levene's Tests for Equality of Variances were conducted on the average percentile rank for a given text collection ($F = 2.19, p = .14$) and average percentile rank across the semester ($F = 1.80, p = .18$). Given the non-significant F-values obtained in the Levene's Tests, the t-tests performed were considered appropriate. Figure 23 shows a similar pattern for the only study previously marked material grouping variable to the preference for previously marked texts variable discussed above. That is, the average percentile rank (for the exam at the collection period) for the group who reports a tendency to only study previously-marked material is significantly lower ($M = .40, SD = .25$) than the average of the group who has a preference against the sole study of previously-marked material ($M = .49, SD = .28$) ($t_{327, .05} = -2.18, p < .05$). The same significant difference was found between the preference groups on exam performance over the course. Figure 23 also shows that the prefer group demonstrates lower average exam performance than the group that does not prefer ($M = .41, SD = .26$; $M = .51, SD = .29$, respectively) ($t_{444, .05} = -2.51, p < .05$). Thus, like the results seen with the preference for previously marked texts variable, those students who tend to study only previously marked material show significantly lower exam scores than those students who do not prefer to study only the material that another student marked.

Figure 23.

Self-Reported Reliance on the Study of Only Previously-Marked Material and Exam Performance.

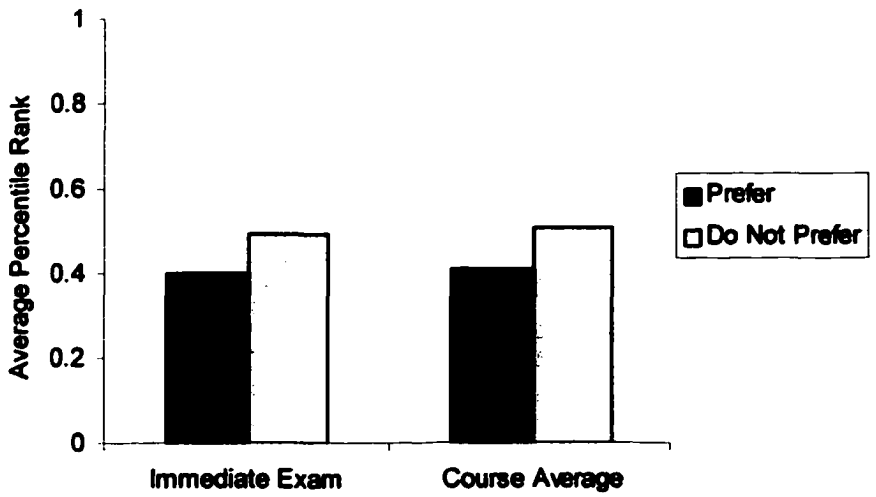


Table 8 shows obtained correlations between the ability to identify the most relevant information (Relindex), performance on the exam at the semester collection point (RankColl) (n = 137) and average exam performance over the entire course (RankAve) (n = 149). The relationship between ability to identify the most relevant material in the text and performance on the exam for the section of the course, in which the submitted text was coded, failed to reach statistical significance (r = .14, p = .12). When examining the relationship between ability to identify the most relevant material and exam performance averaged over the course, the same positive relationship was present, but was statistically significant (r = .20, p < .05). Taken together, it appears as though those readers who are less able to identify the most relevant material (i.e. low-skill readers) show poorer overall exam performance in a course.

Table 8.

Correlations Between Ability to Identify the Most Relevant Material and Exam Performance.

	Relindex	RankColl	RankAve
Relindex	1.00		
RankColl	.14	1.00	
RankAve	.20**	.85**	1.00

** $p < .01$
* $p < .05$

As a final analysis, Multiple Regression Analyses were performed on the 149 coded texts to determine how well the survey variables, text-marking habits and ability to identify the most relevant material predicted exam scores. Results of the analysis using the exam scores at the time of textbook collection (RankColl) as the criterion variable, and Nelson-Denny score (Nelden), frequency of text marking use (PageProp), degree of text marking (Proport) and ability to identify the most relevant material (Relindex) were used as predictors. The linear combination of predictors was significantly related to performance on the exam following the text collection ($F_{6, 130} = 7.33$, $MSE = .056$ $p < .001$). The sample multiple correlation coefficient was .503 indicating that approximately 25 % of the variance of the criterion variable was accounted for by the linear combination of predictors. However, the only significant predictor was reading skill, which, itself, accounted for 22% of the variance accounted for. The analysis done on average exam performance across the course revealed similar results in that the predictors were significantly related to average exam performance ($F_{6, 142} = 12.14$, $MSE = .053$ $p < .001$). Again, however, the only significant predictor was reading skill score, which, itself, accounted for 31 % of the 33 % total variance accounted for by the linear

combination of predictors.

Discussion.

The first goal of Study 2 was to confirm the degree to which the frequency and degree of text marking use is related to reading skill that was found in Study 1. Consistent with the results found in Study 1, correlational data (see Table 5) demonstrated that as reading skill level decreases the claim to highlight more often and the tendency to report highlighting more of the text increases. However, this relationship was not observed for underlining as a text-marking strategy. This lack of significance obtained for underlining was likely based on the fact that relatively few students employ it as a marking strategy. Based on comparisons between reading skill groups (created by taking the upper and lower third of the distribution of Nelson-Denny scores, respectively) it can be concluded that readers of lower skill, do, in fact, claim to make more frequent use of highlighting and, when they do so, claim to highlight more of the text being read (see Figure 8).

Given that underlining as a strategy is not very popular, and functionally no different than using a highlighting as a means of isolating material, reported use of highlighting and reported use of underlining were collapsed to create a category of text markers. A comparison of groups who mark or do not mark texts, while reading a textbook, revealed that those students who mark textbooks while reading have significantly lower reading skill scores than those students who choose not to mark their texts (see Figure 9).

Taking the combined results from these analyses, it becomes apparent that readers of lower skill claim to make more frequent use of text-marking strategies during the

reading of a textbook. Furthermore, they claim to mark more of the text material while doing so. Finally, group comparisons of those readers who claim to mark their texts and those who don't mark their texts, confirmed that the marking group has a significantly lower reading skill level.

The next question of interest was whether or not there was correspondence between what students claim they do and what they actually do, when it comes to the use of text marking strategies. Results obtained in Study 1 failed to find this type of relationship. The results of Study 2, on the other hand, found that there is a relationship between a student's self-report of text-marking use and actual use of text marking. That is, when examining the entire sample of textbooks collected across the four collection periods in both classes, it appears that there is a positive relationship between claimed frequency of text marking use and the tendency to actually use a text-marking strategy. Furthermore, there is also a positive relationship between the degree to which students claim to mark each page they read and the actual proportion of the page marked (see Table 6). From these obtained correlations, it can be concluded that those students who claim to use text marking on more occasions may tend to do so in actuality. Furthermore, those students who claim to mark more of the text when using a text marking strategy, such as highlighting, also tend to actually do so.

Next, Study 2 sought to more fully examine the relationship between reading skill and the use of text-marking strategies. In order to address the nature of this relationship, two questions were addressed. First, do high and low-skill readers actually differ in the frequency with which they rely on the use of text-marking strategies when they study a textbook? Second, when readers of different skill levels do mark text, do they differ in

the actual amount of the text that they mark? Based on an analysis of new collected texts, the answer to these questions seems to be that readers of lower skill do, in fact, make more frequent use text-marking strategies and tend to mark more of the text when they do so, than readers of higher skill (see Figures 13 & 14). However, when examining this relationship using only new textbooks that actually contained text marking, the same conclusions cannot be drawn (see Figures 19 & 20). The failure to find a difference in this case is likely due to the fact that the group that submitted textbooks with actual text marking have overall lower reading skill scores (see Figure 9). This finding suggests that a student who purchases a used text, that contains marking, is likely buying a text marked by a low-skill reader. The important question, then, becomes: Does the marking that is present in a used text represent the most relevant material in the text? If not, then the new owner of the text who chooses to focus on someone else's text marking may be at a disadvantage if the material marked is not the most important.

The results obtained in Study 1 suggest that readers of lower skill have a preference for previously marked texts because the marked material helps to "focus" attention on what is important. Study 2 sought to replicate this finding by evaluating the relationship between preference for studying previously highlighted text and reading-skill level. Based on the correlations obtained, the lower the reading-skill level, the more the student reports a preference for a previously-marked text and the more likely the student is to report only studying that material marked by a previous reader (see Table 6). Furthermore, comparisons of mean Nelson-Denny scores between groups who prefer and do not prefer to study previously highlighted material demonstrate that low-skill readers rely more heavily on the existence of previously highlighted material than high-skill

readers. This reliance does not merely indicate a tendency to study previously highlighted material, but involves a tendency, on the part of the low-skill reader, to claim to study only what a previous student marked in a textbook (see Figures 10 and 11, 12).

The reliance on studying previously highlighted material becomes problematic only if the previous reader was incapable of identifying the most relevant information in the text. Thus, Study 2 examined how capable higher and lower-skilled readers are at identifying the most relevant material in a textbook during study. Some research has suggested that readers of lower skill are less capable of identifying the most relevant material (e.g. Rickards and August, 1975; Winograd, 1984). Results reported here, confirm findings from previous research in that as reading-skill level decreases, the ability to identify the most relevant material also decreases (see Table 6). Direct comparisons between reading-skill groups confirmed the relationship between skill and ability to identify the most relevant information, in that low-skill readers are significantly less capable than high-skill readers of identifying the most relevant material in a textbook when they employ a text-marking strategy (see Figure 21).

Given the finding that low-skill readers are not as capable of identifying the most important information in a text, it is likely that many used texts contain irrelevant text marking. Previous research has demonstrated that the presence of irrelevant text marking can hinder comprehension (Johnson & Wen, 1976; Silvers & Kreiner, 1997). Thus, the final aim of Study 2 was to examine the relationship between use of text-marking strategies, ability to identify the most relevant material in a textbook and actual performance in a course. Results obtained in Study 2 reveal that those students who report a stronger preference for previously-marked texts tend to have lower scores on a

course exam that covers the material studied immediately prior to that exam, as well as average exam performance for the course (see Figure 22). Furthermore, those students who prefer to study only material marked by the previous reader show lower performance on both exam measures (see Figure 23).

Finally, Study 2 examined the relationship between ability to identify the most relevant material in the text and exam performance. However, only the relationship between exam average and ability to identify the most relevant material was significant (see Table 8). Thus, as ability to identify the most relevant material decreased, exam performance averaged over the course decreased. This finding is consistent with the idea that text marking can lead to poorer performance, as suggested by Peterson (1992), but it may not be that the act of text marking itself that results in this decreased performance. Rather, diminished performance seems to be more related to the nature of the material marked. Thus, exploration of the potentially negative effects of irrelevant text marking becomes particularly important.

Study 3

Results obtained in Study 2 suggest that a great deal of marked material in previously marked texts is, in fact, irrelevant material. In addition, those students who tend to rely on the study of material that a previous reader marked tend to be of lower skill. Furthermore, based on the self-report data obtained in Study 1, low-skill readers claim to find the presence of previously marked text material "helpful" because it focuses their attention. On the other hand, readers of higher skill tend to not prefer previously marked material because they find that material to be "distracting." Finally, results of Study 2 found that those students who report a preference for studying previously marked

texts show significantly lower performance on exams in the course they were enrolled in, suggesting that the focus on previously marked material that may be irrelevant might lead to poorer comprehension.

Thus, an important question to address in the study of text-marking strategies deals with the effect of previously marked material on comprehension. As previously discussed, previous research has shown that the presence of irrelevant text marking can adversely affect comprehension. For instance Silvers and Kreiner (1997) found that subjects forced to read text that was marked with "inappropriate" material performed worse on a comprehension test than students who read passages marked with "appropriate" material or passages that contained no text marking. Of particular interest in Silvers and Kreiner's study was the high variability observed in the inappropriate-marking condition relative to the other two conditions. This increased variability is likely due to the differential effect of inappropriate text marking on readers of different skill.

When considering student reliance on the study of a previously marked textbook, it should be the case that, if the material that was previously marked is the most relevant material, then the reader (the low-skill reader in particular) should not be adversely affected by the presence of the highlighting. However, if the previously marked material is less relevant, the lower-skill reader should suffer because of the belief that the previously marked material that is, in fact, irrelevant, is going to aid them during the study process and they will tend to focus on it during study. However, high-skill readers who claim that the previously marked material is "distracting" and, therefore, not helpful, would choose to ignore it. Thus, high-skilled readers should be less affected by the presence of irrelevant text marking.

Unfortunately, Silvers and Kreiner's study did not address the effect that previously highlighted material can have on readers of different skill. The purpose of Study 3 was to examine these potential differences by employing the same design used by Silvers and Kreiner in order to determine if there are differences in the effect of irrelevant text marking on the comprehension performance of readers of different skill levels. Thus, in Study 3 students were asked to read passages for a later comprehension test under three text-reading conditions: (1) no text marking, (2) relevant text marking, and (3) irrelevant text marking. Furthermore, Study 3 employed three passages, rather than one. These passages varied in level of difficulty to assess potential differences in effect of previously marked text based on the difficulty of the reading material.

Based on the results obtained in Study 1 and Study 2, Study 3 was designed to test the following predictions: (1) high-skill readers will report being more distracted by the presence of previously-marked text, while low-skill readers will claim that the previously-marked text is helpful, (2) high-skill readers will be unaffected by the presence of previously-marked text independent of the degree to which that marked text is irrelevant or relevant, (3) low-skill readers will show improved performance in the relevant text-marking condition because of their tendency to focus on previously-marked material, (4) low-skill readers will perform the worst in the irrelevant-marking condition, relative to the other conditions, because of their reliance on previously-marked material, and (5) low-skill readers will show significantly lower comprehension performance in the irrelevant-marking condition relative to high-skill readers.

Method.

Participants. Three hundred and twenty three University of New Hampshire and

Notre Dame College undergraduates participated for course credit. Data from 19 of the participants were discarded due to failure to complete all aspects of the study. The removal of these participants resulted in unequal sample sizes across the three conditions, so four additional subjects were dropped from further analyses (two subjects from each of two conditions). These four subjects were eliminated by using a random-selection of cases method in SPSS for Windows. This resulted in 100 subjects per text-reading condition.

Materials. Participants were asked to complete a survey asking how distracting/helpful the presence of the marked text was in addition to the survey variables used in Study 2 (see Appendix E). The reading materials were three passages covering topics in science, averaging 528 words in length, taken from the verbal section of the Graduate Record Exam (see Appendix F). The passages used were rated in a previous norming study by 60 subjects as "difficult" (528 words), "moderately difficult" (514 words), and "easy" (547 words) by a majority of the participants in the norming study (see Appendix F). For a measure of passage comprehension, six comprehension questions that accompanied each passage in the GRE preparation book were used for each passage. In order to create passages with relevant text-marking, roughly 15% of the text that would lead the reader to correct answers in the comprehension test, for each of the three passages, was marked with a yellow highlighter pen (see Appendix G). Creation of the irrelevant passages involved marking 15% of the text in each of the three passages with the highlighter pen, but the material marked led the reader away from the correct responses on the comprehension items (see Appendix H). Finally, consistent with both Study 1 and Study 2, the vocabulary subsection of the Nelson-Denny Reading Test

was employed as a measure of reading skill.

Procedure. Experimental sessions were conducted in classrooms located in the psychology department on the UNH Durham, UNH Manchester and Notre Dame College campuses. At the beginning of the experimental session, participants were randomly assigned to one of the three reading conditions: (1) reading the passages that contained no highlighted material, (2) reading the passages that had relevant material highlighted, or (3) reading the passages that had irrelevant material highlighted.

At the beginning of the study, the passages were administered and students were instructed that they would have "Ten minutes to read the passages for a later comprehension test." They were also told: "Some of the passages may contain text-marking done by previous readers, but to please make no other marks on the passages while reading." Ten minutes of reading time was judged as adequate by administering the passages to 10 students and asking them to read at their own pace and notify the experimenter when all three passages had been read. Average passage reading time for the 10 students was roughly 6 minutes, which provided participants in Study 3 a few minutes to review the text material prior to passage collection. Finally, the passages were provided to subjects in a mixed order for each condition, in order to avoid the possibility of floor effects in performance on the last passage that might result from slower readers.

Once the reading portion of the experiment was completed, the passages were collected and participants were asked to complete the vocabulary section of the Nelson-Denny Reading Test. Following completion of the reading test, participants were given the comprehension questions corresponding to each of the three passages and asked to circle the most appropriate answer for each question. After completion of the

comprehension questions, participants were asked to complete the survey. Following completion of the survey, participants were provided with a debriefing sheet outlining the purpose of the study and dismissed.

Results

Table 9 displays obtained correlation coefficients for the variables taken from the survey. The study-habit variables, described in detail in Study 1 and Study 2, show similar significant relationships to those obtained in the previous two studies and will not be addressed here (e.g. the relationships between Nelden, OccasH, DegreeH, PrefUsed and OnlyUsed).

Table 9.

Survey Variables and Reading Skill Correlations.

	Nelden	OccasH	DegreeH	PrefUsed	OnlyUsed	Distract	Help
Nelden	1.00						
OccasH	-.12*	1.00					
DegreeH	-.11*	.50**	1.00				
PrefUsed	-.12*	.07	.12*	1.00			
OnlyUsed	-.23**	.21**	.12*	.37**	1.00		
Distract	.22**	-.05	-.05	-.13*	.002	1.00	
Help	-.18**	.18**	.04	.31**	.21**	-.16*	1.00

** $p < .01$
* $p < .05$

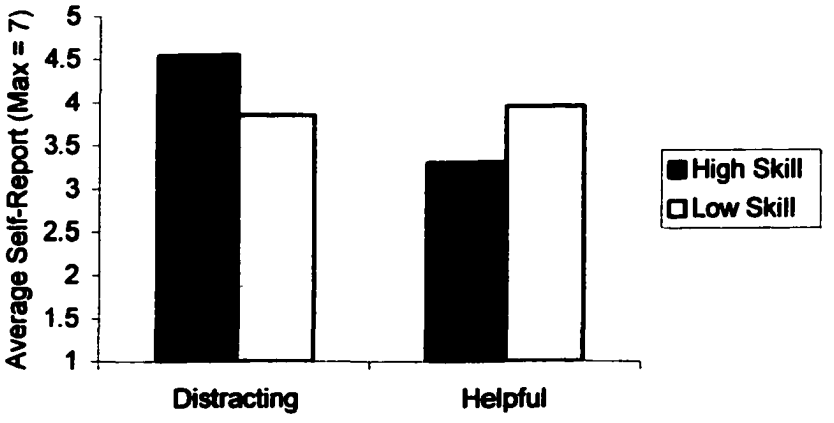
As Table 9 shows, there is a significantly positive relationship between reading-skill score (Nelden) and the participant's tendency to claim that the marked material present in the passages was distracting (Distract) ($r = .22, p < .01$) ($n = 200$). On the other hand, there is a significant negative relationship between reading-skill score and the participant's tendency to claim that the presence of the marked material in the passages was helpful (Help) ($r = -.18, p < .01$) ($n = 200$). Thus, the reader of lower skill claims

that the text marking is helpful. This finding is consistent with the results reported in Study 1, in which low-skill readers claimed that the study of previously marked text "focuses attention" on the most relevant material. As a direct measure of this relationship, Table 9 shows that the correlations between preference for previously highlighted texts (PrefUsed) and the tendency to only study previously highlighted material (OnlyUsed) and the students' claim that the marked material present in the text was helpful (Help) are both significantly positive ($r = .31, p < .01$; $r = .21, p < .01$, respectively) ($n = 200$). From examination of these obtained correlations, it can be concluded that those students with a preference for, and a tendency to study only material that another reader marked (the lower-skilled reader) tend to believe that the previously marked material is helpful.

In order to determine if, in fact, high-skill readers find previously marked material distracting and low-skill readers find that same previously marked material helpful, Independent-Groups *t*-tests were performed on the average rating for the "Distract" and "Help" variables using high-skill ($n = 66$) and low-skill ($n = 66$) groups (collapsed across the two text-marking conditions). Figure 24 shows that high-skill readers find the presence of text marking significantly more distracting ($M = 4.55$, $SD = 1.64$) than low-skill readers ($M = 3.85$, $SD = 1.67$) ($t_{130, .05} = 2.42, p < .05$). Likewise, skill-group comparisons on the "Help" variable found that low-skill readers ($M = 3.95$, $SD = 1.57$) reported that the previously marked material was helpful to a significantly higher degree than readers of higher skill ($M = 3.30$, $SD = 1.71$) ($t_{130, .05} = -2.28, p < .05$) (see Figure 24).

Figure 24.

Skill Differences in Reported Degree to which Previously-Marked Passages were Distracting/Helpful.



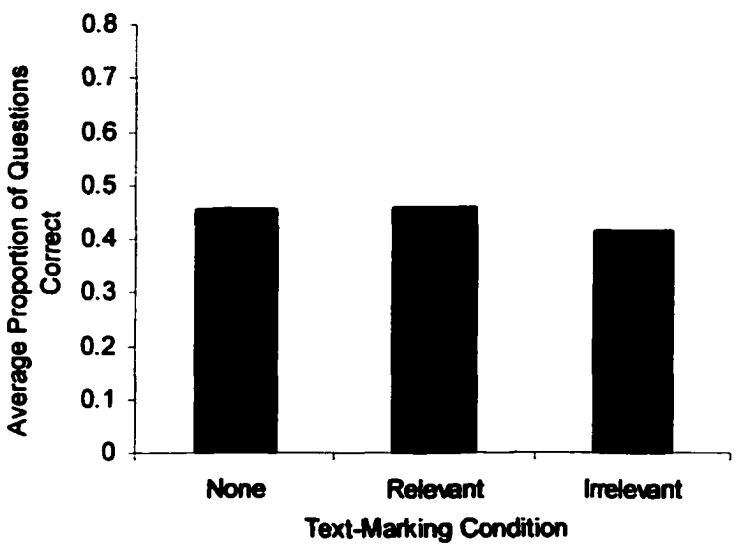
In the analyses conducted on passage performance within conditions, three reading-skill groups were employed: (1) high skill ($n = 99$, $M = 71.6$), (2) average ($n = 102$, $M = 56.1$), and (3) low-skill ($n = 99$, $M = 39.8$) by dividing the distribution of Nelson-Denny Scores into thirds. Finally, as previously reported, the passages used were considered "easy," "moderately difficult," and "difficult." In order to examine differences in comprehension between text-marking conditions and the potential reading-skill differences within these conditions for each passage type, a Mixed-Model ANOVA using GLM was performed on proportion of comprehension questions correct using passage type as the repeated-measures factor (3 levels), while condition (3 levels) and reading skill (3 levels) were the between-groups factors.

Figure 25 shows average proportion of questions correct, collapsed across reader type and passage type ($n = 100$ per condition), for each text-marking conditions. Results of the ANOVA revealed a significant main effect ($F_{2,291} = 4.060$, $MSE = .015$, $p < .05$).

Pairwise comparisons demonstrate that the no-marking condition (M = .46) and the relevant-marking condition (M = .46) do not significantly differ (p = .88). However, there was a significant difference between the no-marking condition and the irrelevant-marking condition (M = .42) ($p < .05$) as well as between the relevant-marking condition and the irrelevant-marking condition ($p < .05$).

Figure 25.

Average Proportion of Questions Correct for Each Condition.



Taken together, the results obtained by comparing performance on the comprehension questions across conditions suggest that comprehension performance in the present study was similar to that observed by Silvers and Kreiner (1997), in that performance in the irrelevant-marking condition is worse than performance in the relevant-marking or the no-marking conditions.

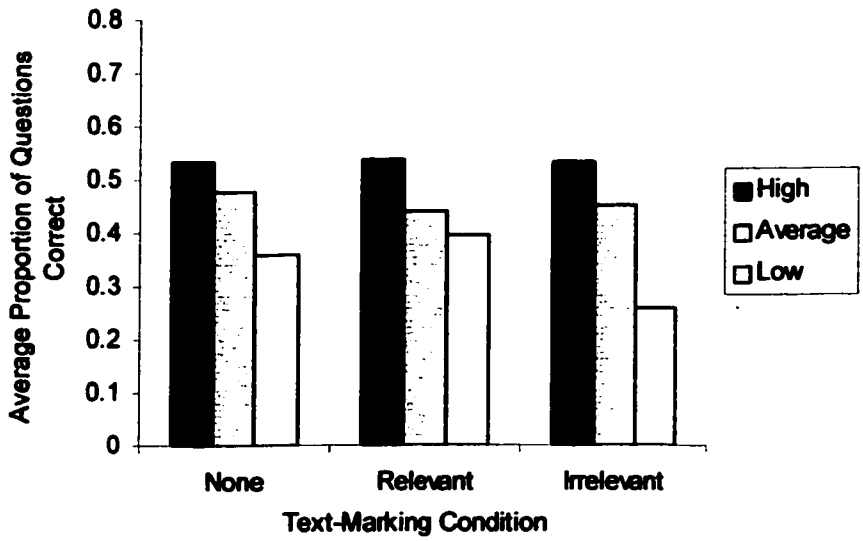
Results of the analysis also revealed a significant interaction between condition and reading skill ($F_{4,291} = 4.020$, $MSE = .015$, $p < .01$). An overall comparison of performance in Figure 26 shows a linear decrease in performance as a function of

reading-skill level for each condition. However, these decreases as a function of skill, within each condition, failed to reach statistical significance in all cases. In the no text-marking condition, high- (M = .53, SD = .11) and average-skill (M = .48, SD = .14) readers did not significantly differ in performance (p = .60). However, the low-skill group (M = .36, SD = .12) differed significantly from both of the other groups (p < .01 for each comparison). In the relevant text-marking condition, the high-skill group (M = .54, SD = .14) differed significantly from the average group (M = .44, SD = .10) (p < .05), but the low-skill group (M = .40, SD = .13) only differed significantly from the high-skill group (p < .01). Finally, in the irrelevant text-marking condition, the high-skill (M = .54, SD = .09) and average group (M = .45, SD = .15) means were not significantly different (p = .11). The low-skill group mean (M = .26, SD = .07) was significantly lower than both of the other group means (p < .01 for each comparison).

Comparisons across conditions reveal that there were no significant differences observed in either the high- or average-Skill readers in comprehension performance. Comparisons of low-skill reader performance across conditions revealed a non-significant difference between the no text-marking (M = .36, SD = .12) and the relevant text-marking (M = .40, SD = .13) conditions. However, low-skill readers in the irrelevant text-marking condition (M = .26, SD = .07) demonstrated significantly lower scores than both the no-text marking and the relevant text-marking conditions (p < .05; p <.01, respectively).

Figure 26.

Average Proportion of Questions Correct by Readers of Different Skill Levels for Each Condition.



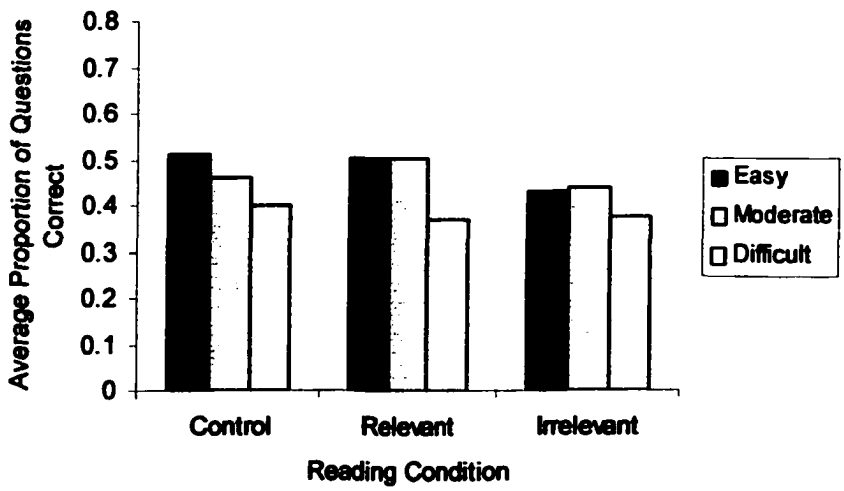
Taken together, the results of reading skill comparisons within and across conditions suggests that both readers of average and high skill do not show a decline in comprehension performance across the text-marking conditions. Rather, only readers of lower skill level are differentially affected by the presence of text-marking, such that there is a significant decrease in comprehension performance when they are exposed to text with irrelevant marking.

Performance differences in each condition were also evaluated in terms of passage difficulty. Statistical analyses revealed an significant interaction effect for passage type by condition ($F_{2,291} = 2.13$, $MSE = .04$, $p < .01$). Figure 27 shows average comprehension performance for each passage type within each condition. Pairwise comparisons conducted on the easy passage revealed that there was not a significant difference between the no-marking condition ($M = .51$, $SD = .23$) and the relevant-

marking condition (M = .50, SD = .22) (p = .825). However, there was a significant difference between the no-marking condition and the irrelevant-marking condition (M = .43, SD = .24) ($p < .01$) as well as between the relevant-marking condition (M = .50, SD = .22) and the irrelevant-marking condition (M = .43, SD = .24) ($p < .05$). Unlike the results obtained for the easy passage, Pairwise Comparisons between conditions in the moderately difficult passage revealed that the mean of the no-marking condition (M = .46, SD = .19) was lower than the mean of the relevant-marking condition (M = .50, SD = .19), but this difference only approached statistical significance (p = .09). However, consistent with the results found in analyses of the easy passage, the mean of the relevant-marking condition was higher than the mean of the irrelevant-marking condition (M = .44, SD = .18). There were no significant differences in comprehension performance across conditions for the difficult passage ($p > .05$ for each comparison).

Figure 27.

Average Proportion of Questions Correct for Each Level of Passage Difficulty Across Text-Marking Conditions.



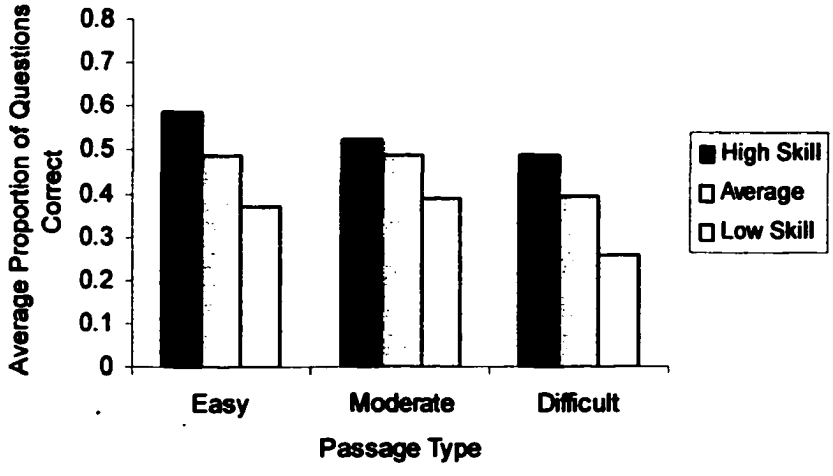
Taken together, the results obtained by comparing performance on the comprehension questions across conditions, for each level of passage difficulty, are also consistent with the results obtained by Silvers and Kreiner (1997), in that performance in the irrelevant-marking condition is worse that performance in the relevant-marking or the no-marking conditions. However, this pattern of difference only holds for passages that were rated as "easy" or "moderately difficult."

Results of the analysis also found a significant interaction between reading skill level and passage type ($F_{2,291} = 3.94$, $MSE = .04$, $p < .05$). Figure 28 shows the mean proportion of questions correct by passage type for each of the three reader groups. Pairwise comparisons conducted on the easy passage revealed that the mean for the high-skill group ($M = .59$, $SD = .22$) was significantly higher than the means of both the average ($M = .49$, $SD = .22$) and low-skill ($M = .37$, $SD = .21$) groups ($p < .01$ and $p < .000$, respectively). The pattern of means was similar across reader groups for the moderately difficult passage, although the mean of the high-skill group ($M = .53$, $SD = .18$) did not significantly differ from the mean of the average-reader group ($M = .49$, $SD = .18$) ($p = .13$). However, both the high-skill group and the average group differed significantly from the low-skill group ($M = .40$, $SD = .18$) ($p < .001$; $p < .001$, respectively). Comparisons between reader groups on the difficult passage revealed that the mean of the high-skill group ($M = .49$, $SD = .20$) was significantly higher than the means of both the average ($M = .39$, $SD = .22$) and low-skill ($M = .26$, $SD = .19$) groups ($p < .01$ and $p < .001$, respectively). Finally, the mean from the average group was significantly higher than the low-skill group ($p < .001$). Taken together, the results described here suggest that there is a linear decrease in comprehension as passage

difficulty moves from easy to difficult and that this linear decrease holds for all three reader groups, such that the highest comprehension is seen in the high-skill reader group for the easy passage and the lowest performance is seen in the low-skill group in the difficult passage.

Figure 28.

Mean Proportion of Questions Correct in Each Passage by Skill Group.



Consistent with the finding that readers of lower skill have a preference for, and a tendency to only study, material that was marked by a previous reader, it would be expected that low-skill readers would benefit from relevant text marking, but be hindered by irrelevant text marking in comprehension performance. This pattern would not be expected for the high-skill reader, however, because of the fact that they do not prefer to study previously marked material. Thus, in order to examine more fully the differences between high- and low-skill readers in the effects of relevant or irrelevant text marking, comparisons were conducted using only these two groups across the three text-marking conditions for each passage type.

Table 10 shows average proportion of questions correct for high- (n = 33), and low-skill (n = 33) reader groups for each passage type in each text-marking condition. As can be seen from examination of means obtained from the easy passages, there are no differences between the high-skill readers across the three text-marking conditions (None: M = .59, SD = .21; Relevant Marking: M = .61, SD = .25; Irrelevant Marking: M = .57, SD = .20). Comparisons revealed that none of these group means were significantly different ($p > .05$). Consistent with the idea that the lower-skilled reader might benefit from previously marked material, if that material is relevant, the difference between the mean of the low-skill group in the relevant text-marking condition (M = .42, SD = .19) is not different from the low-skill group in the no text-marking condition (M = .43, SD = .22) ($p > .05$). This lack of difference between low-skill readers disappears, however, when comparing the means of the relevant-marking condition (M = .42, SD = .19) and the irrelevant-marking condition (M = .23, SD = .15). This comparison demonstrates that the presence of previously marked text that is irrelevant has a significant negative impact on comprehension in the low-skill reader ($p < .01$). Finally, a comparison and high- and low-skill readers in the irrelevant-marking condition shows a dramatic difference between the groups on proportion of comprehension questions answered correctly (M = .57, SD = .20; M = .23, SD = .15, respectively)($p < .001$). Taken together, the results of comparisons based on reading-skill differences both across and between conditions, in the easy passage, suggest that the comprehension performance seen in readers of higher skill is not affected by the presence of relevant or irrelevant text marking, whereas readers of lower skill are negatively affected by previous text marking, but only if that marking is irrelevant.

When looking at differences between the reading-skill groups in the moderately difficult passage, the same overall pattern that was observed for the easy passage was present. Table 10 also shows that there were no significant differences between the high-skill readers across the three text-marking conditions (None: $M = .50$, $SD = .21$; Relevant Marking: $M = .54$, $SD = .19$; Irrelevant Marking: $M = .54$, $SD = .15$) ($p > .05$ for each comparison). The means between low-skill group in the relevant text-marking condition ($M = .44$, $SD = .21$) and the low-skill group in the no text-marking condition ($M = .39$, $SD = .17$) ($p > .05$) were not significantly different, as was the case with the easy passage ($p > .05$). When comparing the means of low-skill readers in the relevant-marking condition ($M = .44$, $SD = .21$) to the irrelevant-marking condition ($M = .34$, $SD = .14$) the pattern is the same as was observed in easy passage, in that comprehension performance is lower in the irrelevant–marking condition, but this difference failed to reach statistical significance ($p = .15$). However, the difference seen between high- ($M = .54$, $SD = .15$) and low-skill ($M = .34$, $SD = .14$) readers in the irrelevant-marking condition was significant as was the case in easy passage ($p < .01$). Taken together, these results of skill comparisons in the moderately difficult passage show similar patterns across conditions as was observed in examining comprehension performance in the easy passage. That is, the performance seen in high-skill readers is not affected by the presence of relevant or irrelevant text marking, whereas the low-skill reader demonstrates very poor comprehension performance in the irrelevant text-marking condition.

Finally, examination of reading-skill differences in comprehension performance in the difficult passage reveals patterns very similar to those observed in the moderately difficult passage. Table 10 also shows that there are no significant differences between

the high-skill readers across the three text-marking conditions (Control: $M = .51$, $SD = .19$; Relevant Marking: $M = .46$, $SD = .22$; Irrelevant Marking: $M = .50$, $SD = .19$) ($p > .05$ for each comparison). Consistent with the results seen with the both of the other passage types, the means between low-skill group in the relevant text-marking condition ($M = .32$, $SD = .20$) and the low-skill group in the no text-marking condition ($M = .26$, $SD = .21$) were not significantly different ($p > .05$). A comparison of low-skill readers in the relevant-marking condition ($M = .32$, $SD = .20$) to the irrelevant-marking condition ($M = .20$, $SD = .15$) demonstrated a result similar to that observed in the moderately difficult passage, in that performance is lower in the irrelevant–marking condition, but it only approached statistical significance ($p = .13$). Finally, when looking at the differences between high- and low-skill readers in the irrelevant-marking condition, the same pattern that was observed in the easy passage and the moderately difficult passage was present. That is, the mean comprehension performance in the high- ($M = .50$, $SD = .19$) was significantly higher than performance in the low-skill group ($M = .20$, $SD = .15$) ($p < .001$). Again, the results found in analyses of skill differences in the difficult passage show similar patterns to those seen in the other two passages, in that the performance seen in high-skill readers does not appear to be affected by the presence of relevant or irrelevant text marking, whereas the low-skill reader shows a marked decrease in performance, relative to the high-skill reader in the in the irrelevant text-marking condition.

Table 10.

Means by Condition and Reading Skill for Performance on all Three Passage Types.

		Text-Marking Condition		
Skill	Passage Type	None	Relevant	Irrelevant
High	Easy	.5908 (.2127)	.6110 (.2524)	.5659 (.1953)
	Moderately Difficult	.4999 (.2084)	.5407 (.1867)	.5354 (.1491)
	Difficult	.5050 (.1887)	.4596 (.2206)	.5000 (.1863)
Low	Easy	.4344 (.2164)	.4240 (.1915)	.2472 (.1835)
	Moderately Difficult	.3888 (.1650)	.5247 (.1598)	.3379 (.1410)
	Difficult	.2574 (.2086)	.3226 (.2038)	.1970 (.1469)

Discussion

One of the first questions addressed by Study 3 was whether or not there are differences in the degree to which readers of different skill levels find previously marked text material helpful or distracting. The survey data obtained demonstrated that readers

of lower skill, who have a preference for, and a tendency to study only material that another reader marked, tend to find previously marked material helpful (see Table 9). Furthermore, when high- and low-skill reader groups were compared in the degree to which they find previously marked text material helpful or distracting, it was clear that high-skill readers find the presence of previously marked text more distracting than readers of low skill, who reported that the presence of previously marked material was helpful (see Figure 24). Given that these comparisons were made across conditions, the statement can be made that low-skill readers claim that previously marked text is helpful independent of whether or not that material is relevant or irrelevant.

The question of whether or not previously marked material is relevant or irrelevant is particularly important, given the fact that irrelevant text marking has been shown to adversely affect comprehension in previous research (e.g. Johnson & Wen, 1976; Silvers & Kreiner, 1997). Study 3 attempted to replicate this finding by using a design similar to that used by Silvers and Kreiner (1997), who found that subjects who read text that was marked with "inappropriate" (i.e. irrelevant) material performed worse on a comprehension test than students who read passages marked with "appropriate" (i.e. relevant) material or control passages that contained no text marking. Results obtained here confirmed these findings in that overall performance, collapsed across reading skill and passage difficulty, in the irrelevant-marking condition was worse than performance in the relevant-marking or the no-marking conditions (see Figure 25). When considering the effect of text-marking condition on performance at each level of passage difficulty, there were no observed differences across conditions for the difficult passage. However, performance was hindered by the irrelevant text-marking condition when passages

considered "easy" and "moderately difficult" were employed (see Figure 27). This finding is likely due to the fact that the "difficult" passage used in Study 3 was taken from the Verbal subsection of the Graduate Record Exam, while the passages used by Silvers and Kreiner were taken from the Nelson-Denny Reading Test. This claim can be supported by the findings reported by previous researchers addressing the effectiveness of typographical cuing in more difficult texts. For instance, Spyridakis and Standal (1987) found that typographical cuing can lead to enhanced comprehension, but it loses its effectiveness as passages become longer or more difficult.

One of the questions not addressed by Silvers and Kreiner's (1997) study was whether or not the presence of relevant or irrelevant text marking has a differential effect based on level of reading skill. Thus, Study 3 sought to determine if high-skill readers, who claim to find previously marked material less helpful, and claim not to focus on it during study, would be affected by the presence of text marking. It was found that, for all three passage types, there were no significant differences in comprehension performance observed in either high- or average-skill readers across the text-marking conditions (see Figure 26).

Another question addressed by Study 3, which was based on the finding that low-skill readers claim to rely on previously marked material in study, was whether or not there would be improved performance in the relevant-marking condition when compared to the no-marking condition. Results reported here show this not to be the case. There were no significant differences in the means of low-skill reader groups between the relevant-marking condition and the no-marking condition (see Figure 26). Thus, it can be

concluded that the presence of previously marked text material, that is relevant, does not enhance comprehension performance for the low-skill reader.

Finally, Study 3 attempted to account for the higher variability observed in Silver and Kreiner's (1997) inappropriate text-marking (irrelevant text-marking) condition by examining the differences between high- and low-skill readers in this condition. It was believed that the lower-skilled reader would be more adversely affected by the presence of irrelevant text marking because of the self-reported tendency to focus on previously marked texts. This prediction held true when collapsing across passage difficulty, in that lower-skilled readers showed significantly lower comprehension performance when compared to high- and average-skill readers in the irrelevant-marking condition (see Figure 26). Finally, this performance deficit seen in low-skill readers in the irrelevant text-marking condition was demonstrated across all levels of passage difficulty (see Table 10).

CHAPTER V

GENERAL DISCUSSION

Previous research examining the overall effectiveness of text-marking strategies, such as highlighting or underlining, has produced mixed results. Thus, an answer to the question of whether or not students should employ such strategies while reading has yet to be answered. Some researchers have argued that the inconsistencies seen in the research literature are due to the constraints imposed by the experimental setting and have called for a more ecologically-valid approach (e.g. Hartley, Bartlett & Branthwaite, 1980;Wade & Trathen, 1989; Lonka, Lindblom-Ylanne, & Maury, 1994). Furthermore, few studies have addressed reading-skill differences in the use and benefit of text-marking strategies (e.g. Johnson and Wen, 1976; Paris and Myers, 1981; Johnson, 1988; Reutzel and Hollingsworth, 1988). The studies reported here were designed to shed some light on the inconsistent findings in previous research, through the use of a more ecologically-valid approach, while also examining the differences between high- and low-skill readers.

There are two fundamental issues raised when considering the use of text-marking strategies. The first issue centers on the comprehension benefits of *employing* such strategies. The second issue centers on the *effects of previously marked material* on comprehension. Study 1 was designed to gather pilot data in order to begin to address these issues. The first issue was directly addressed in Study 2 through the

examination of course performance differences between those students who choose to use, or not to use, text-marking strategies while studying a new textbook. The second issue was addressed in Study 3 by examining the differential effects of relevant and irrelevant text marking on comprehension. Furthermore, both of these fundamental issues were examined not only in terms of the average reader, but also by examining reading-skill differences in the use of text-marking strategies. Finally, the effects of previously marked text material on readers of differing skill was examined. Thus, the overall questions addressed by the studies reported here were: (1) whether or not there are reading-skill differences in the frequency and degree of text-marking use, (2) how capable readers of differing skill levels are at identifying the most relevant material in a course textbook and how that ability relates to classroom performance, and (3) what are the effects of previous text marking on comprehension for readers of different skill levels.

The results obtained in Study 1 demonstrated that a very high proportion of students employ text-marking strategies, the most common being the use of a yellow highlighting pen. Furthermore, it was found that readers of lower skill claimed to rely on the use of more than one study strategy, as opposed to readers of higher skill who reported using only one study strategy or no study strategies at all. This finding was inconsistent with findings reported by Paris and Myers (1981) who reported that lower-skill readers did not engage in any "spontaneous" study behaviors, involving the use of text marking. In addition to finding that students of lower reading skill tend to report using multiple text-marking strategies, it was also found that low-skill readers claim to use highlighting on more occasions, but did not claim to mark more of the text when they do employ such strategies. Finally, a particularly interesting finding demonstrated in

Study 1 was that students of lower reading skill claimed to prefer textbooks that have been previously marked by another reader and that this preference may be related to the idea that the previously-marked material "focuses attention" on the most important information in the text.

The benefit of text marking as a study strategy, and the effectiveness of focusing attention on previously marked material, is dependent upon whether or not the material marked is the most relevant. However, previous research has suggested that high-skilled readers are more capable of identifying the most relevant material than low-skilled readers are (e.g. Smiley, Oakley, Worthen, Campione, & Brown, 1977; Winograd, 1984). This issue is of particular importance when considering the student who claims to rely on the study of text material that a previous reader marked because the material that is marked may not be the most relevant, if that material was marked by a lower-skilled reader.

Study 2 sought to examine the relationship between preference for studying previously highlighted texts, reading-skill level and performance in a course. Furthermore, Study 2 was designed to determine how capable higher- and lower-skilled readers are at identifying the most relevant material in a textbook. Finally, Study 2 investigated the relationship between use of text-marking strategies, ability to identify the most relevant material in a textbook and actual performance in a course.

Results obtained in Study 2 demonstrated that low-skill readers claim to use text-marking strategies more often and claim to mark more of the text when employing such strategies. Furthermore, it was found that low-skill readers do, in fact, use text-marking strategies on more occasions and, when they do employ such strategies, also tend to mark

a greater proportion of text material than readers of higher skill. Even though analyses carried out on collected textbooks that contained text-marking failed to demonstrate differences between reading skill groups, the fact that those who did submit marked texts have lower overall reading skill scores suggests that any given used textbook that contains text marking was likely marked by a reader of lower skill level.

The next issue addressed by Study 2 was the nature of the material that is marked by the reader. That is, to what degree is the material in the text that is marked by a previous reader the most relevant material? If a significant proportion of previously marked text is irrelevant, then the new owner of the text who chooses to study a previous reader's text marking may find him/herself at a serious disadvantage.

The results obtained in both Study 1 and Study 2 suggest that readers of lower skill have a preference for previously-marked texts because the marked material helps to "focus" attention on what is important. In particular, results obtained in Study 2 found that low-skill readers report a tendency to only study previously marked material in their used texts. Through an analysis the text marking present in new textbooks submitted by students, Study 2 demonstrated that low-skill readers are not as capable of identifying the most relevant material in the text, which is consistent with previous research (e.g. Rickards and August, 1975; Winograd, 1984). Given this finding, it can be inferred that many used textbooks contain a significant amount of irrelevant text marking. Thus, there is a very high probability that a low-skill reader who prefers to study material marked by a previous reader in his/her current text is focusing on a great deal of irrelevant information.

Given that previous research has shown that the presence of irrelevant text

marking can hinder comprehension (e.g. Johnson & Wen, 1976; Silvers & Kreiner, 1997), the practice of studying previously marked material, much of which may be irrelevant, can be particularly problematic. Consistent with this claim, results obtained in Study 2 revealed that those students who report a stronger preference for previously marked texts, and tend to only study material marked by a previous reader, showed lower performance in the course they were enrolled in. Finally, an analysis of marked texts demonstrated that as ability to identify the most relevant material in the text decreases, the performance on exams in the course decreases. Taken together, these results suggest that the low-skilled reader, who marks texts during reading for a course, has a tendency to mark more irrelevant information and that this type of marking is related to poorer course performance. These results are contrary to the claim made by Nist and Hogrebe (1987), in their discussion of the utility of text marking, that "the only safe conclusion we can draw is that underlining is not detrimental." However, results presented here suggest that text marking is detrimental for the reader of lower skill. Finally, Nist and Hogrebe (1987) also argued that "studying the underlined information was more important to increasing test performance than the actual act of highlighting." Again, this claim seems to be more applicable to readers of average-, or above-average reading ability. The findings reported here suggest that low-skill readers tend to report studying previously marked texts, which contain a great deal of irrelevant text marking. This tendency to study the previously marked material is related to poorer performance in the course.

Taking the results found in Study 1 and Study 2 into consideration, Study 3 sought to experimentally confirm whether or not the presence of relevant text marking or irrelevant text marking has affects high- and low-skilled readers differently. Survey

results showed that high-skill readers report that previous text marking is distracting. On the other hand, low-skill readers claim to find previously marked text material helpful, independent of whether or not that material was relevant or irrelevant. Thus, it was expected that low-skill readers would be hindered more by the presence of irrelevant text marking than high-skill readers.

When examining performance across subjects, results obtained in Study 3 replicated the findings reported by Silvers and Kreiner (1997) who demonstrated that comprehension was the most negatively affected in an irrelevant text-marking condition relative to relevant and no text marking conditions. As predicted, the worst performance was seen by low-skill readers who read text marked with irrelevant information, but this prediction only held for an "Easy" passage. However, when compared to high-skill readers, low-skill readers performed significantly worse in all three passages in the irrelevant text marking condition. This finding helps to explain the higher degree of variability that was observed in Silvers and Kreiner's irrelevant marking condition.

When considering the two issues described at the opening of this discussion, in terms of reading-skill differences, the results presented in the three studies reported here suggest that when *employing* study strategies during the study of a new textbook for a course, low-skill readers tend to rely more heavily on text-marking strategies than high-skill readers. Unfortunately, low-skill readers are less capable than high-skill readers at identifying the most relevant material in the text and, thus, tend to mark a greater degree of irrelevant information than readers of higher skill. This tendency, on the part of the low-skill reader, to mark a high proportion of irrelevant material is related to poorer performance in the course they are studying for. This finding is consistent with previous

research showing that the use of text marking can be counterproductive to learning when it is not used discriminately (e.g. Peterson, 1992).

When it comes to the *effects of previously marked material* on comprehension, taking into consideration differences in reading skill, the studies presented here show that the low-skill reader reports a preference for, and a tendency to only study, text material marked by a previous reader because of the belief that it will focus their attention on the most important information in the text. Based on the fact that lower-skilled readers are less capable of identifying the most relevant material and tend to engage in text-marking strategies to a high degree, the low-skill reader of a previously marked text has a high probability that they are focusing attention on irrelevant information. Given that reading text with irrelevant text marking leads to poorer comprehension, this reliance on previously marked material, while studying for a course, can lead to poorer performance in that course.

Given that many textbooks offered for courses are used by students and then sold back to bookstores for resale, the most obvious implications of the research reported here centers on the importance of warning new college students of the potential negative consequences of purchasing a used textbook that contains text marking and focusing on that previously marked material during study. This is particularly important for the low-skill reader who is less able to identify the most relevant material and tends to focus on previously marked material that may be irrelevant. Readers of higher skill are more capable of identifying the most relevant material in the text during study and are more capable of ignoring irrelevant information.

Based on the findings outlined in previous studies and those described here, any

training methods designed to improve study habits, that may involve text marking, must involve assessment of reading skill. Consistent with this, Memory (1983) argued that the most important addition to the study of the effects of adjunct study strategies is the assessment of student ability. This could be accomplished by using scores on the Verbal section of the SAT, gained from incoming student records or, through the use of a reading-skill test during the matriculation process. Following this assessment, students can then be made aware of their reading skill level and instructed in the use of study strategies that will be most beneficial. Consistent with this suggestion, some research has suggested that training students in the effective use of text marking is beneficial (e.g. Nist & Simpson, 1988). This might be even more of a necessity for the low-skilled reader. However, one of the most important factors to consider, in these training methods, centers on the need to instruct readers in the identification of important elements in the text. Consistent with this idea, Lorch and Pugzles-Lorch (1985) argue that "readers must be made aware of the need to construct an efficient representation of topic structure in the course of text processing." That is, readers can be taught to "recognize and attend to text information relevant to topic structure" (Lorch & Pugzles-Lorch, 1985). Thus, any subsequent use of text marking during study is more likely to include information that is the most relevant to the reading task, which will lead to enhanced comprehension. For instance, Reutzel and Hollingsworth (1988) found that teaching lower skilled third-grade students how to use highlighting key vocabulary, led to a significant increase in inference-drawing ability of these lower-skilled readers.

However, training in the use of these study strategies should be addressed early. Consistent with this suggestion, some researchers have argued that study strategy training

for older readers may be less successful because the reader at the college level has likely developed "their own procedures for remembering complex material," and once these procedures have been developed "they are extremely difficult to change" (Thornton, Bohlmeyer, Dickson, & Kulhavy, 1990). Training the lower-skilled college student, in particular, in the effective use of text marking strategies may be even more difficult. Given the possibility that formal training methods may not be successful, as some researchers suggest, then a more informal approach might be made through an instructor him/herself. For instance, students could be given the Nelson-Denny vocabulary test and provided with their results. Following this, based on assessed skill level, appropriate warnings about the potentially harmful effects of studying only previously marked material in used texts can be made directly by the instructor to those students of lower skill.

The most obvious limitation in the studies reported here centers on the fact that the students who participated were primarily Introductory Psychology students in their first year of college. Despite the fact that different classes were used at different college campuses, there is still reason to question the generalizability of the results obtained here. Related to this is the additional concern of operationally defining high- and low-skill readers. Given that the students employed in these studies were college students, it needs to be stressed that any claims made in the present study with regards to the characteristics of low-skill readers, should not be viewed as claims about the characteristics of low-skill readers in general. Rather, the findings reported here apply to college students who tend to be less proficient readers than other college students.

Some of the other practical limitations of the present study focus on the effects of other personal factors that may have had an impact on preference for previously used texts that are independent of reading skill. For instance, socio-economic status may play a role in this preference. Thus, the student from a less privileged financial position may be forced to purchase a used text based solely on monetary constraints. In addition to this potential problem, other student characteristics that may have an influence on study strategy use were not addressed in this study. For example, student motivation to perform well in the course and, related to this, the amount of hours devoted to study, undoubtedly will have an effect on course performance that has nothing to do with the use of, or reliance upon text marking. This particular concern may be at the heart of the lack of statistical significance seen in course performance between text-marking groups. Thus, taking these concerns into account, future research should attempt to control for these factors by taking them into account in the design of the study and subsequent analyses. Despite these potential practical concerns, however, the results reported here that pertain to preference for used texts and its relationship to reading skill were significant in all three of the studies. This replication only serves to strengthen the claim that there is, in fact, a strong relationship between a reader's skill level and that reader's tendency to prefer and rely on the study of previously marked material in a used text.

From a more theoretical perspective, future research examining the utility of text-marking strategies for readers of different skill level should focus on the differential encoding effects that the marking of relevant and irrelevant text may have. From an "Encoding Specificity" standpoint (e.g. Tulving & Thomson, 1973), the study of previously marked text that is irrelevant may enhance memory for that material, but that

irrelevant material will unlikely be included at the time of testing. Thus, information that is isolated, through the use of text marking (i.e. during encoding), will not match the cues present at retrieval (i.e. during the course exam). Previous studies have found results that are consistent with this idea, but level of reading ability was not considered. For example, in Cashen and Leicht's (1971) study it was demonstrated that the study of underlined material that was trivial led to better performance on a recall test involving trivial material. This is of particular importance for those courses, such as the introductory psychology courses used in this study, that rely exclusively on the multiple-choice recognition tests as a measure of learning in the course. That is, the irrelevant material marked by the low-skill reader, during study, is not likely to be included in an instructor's exam, thus performance will suffer. Logically following from this, future research should also be directed at examining the potential differential effects of previous text marking on comprehension that involves memory for factually based information or comprehension involving the use of inference.

Furthermore, research examining the utility of text-marking strategies for readers of differing skill level should be directed at identifying particular subsets of readers who may, in fact, be more at a disadvantage in the use and reliance upon text marking. For example, Singer and Donlan (1989) point out that there are actually four types of readers that can emerge when assessing skill based on the use of tests of reading skill. That is, students who may score on a vocabulary subsection of the reading test, but score higher on the comprehension component are really *slow readers*, not necessarily low-skill in general. However, a student who performs poorly on both subsections of the reading skill test would be considered a low-skill reader. Given this, future research examining

skill differences in text-marking should employ both the vocabulary and comprehension subsections of a test of reading ability, such as the Nelson-Denny test, in order to determine, which subset of readers might be most susceptible to potentially damaging effects that the presence of, and reliance upon, previously marked text may have on comprehension.

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APPENDICES

Appendix A

Study Survey used in Study 1.

Instructions

The following survey will ask you a number of questions about your study habits. To indicate your response, please circle the appropriate number on the scale below the question or write your answer in the space provided. It is important that you be as honest as possible when answering the questions. Please feel free to ask the experimenter if you need any of the questions clarified.

Part I: Use of Colored Highlighters

1. On how many occasions, when you sit down to read a textbook, do you highlight material?

never sometimes always

1 2 3 4 5 6 7

2. If so, how much of the text do you highlight?

very little some of it most of it

1 2 3 4 5 6 7

3. How many different colors of highlighters do you use? _____

4. In your own words, please describe the nature of the material that you highlight. For example, what about the material makes you decide to highlight it?

5. If you use more than one color, please describe the method you use (e.g. certain colors for certain information) or indicate if you just use whatever color you happen to have lying around?

Part II: Underlining

1. On how many occasions, when you sit down to read a textbook, do you underline material?

never sometimes always

1 2 3 4 5 6 7

2. If so, how much of the text do you underline?

very little some of it most of it

1 2 3 4 5 6 7

3. If you have any underlining strategies to distinguish between types of information (e.g. solid lines for important/dashed lines for not as important) please describe them.

4. In your own words, please describe the nature of the material that you underline. For example, what about the material makes you decide to underline it?

Part III: Your Textbooks

1. How many textbooks are you using this semester? _____

2. How many of the textbooks that you are using this semester are used? _____

3. Of the textbooks that are used, how many are highlighted or underlined? _____

4. Please list the classes you are taking that use a textbook and indicate on the line below it the degree to which it is highlighted or underlined.

Class: _____

very little some of it most of it

1 2 3 4 5 6 7

Class: _____

very little some of it most of it

1 2 3 4 5 6 7

Class: _____

very little some of it most of it

1 2 3 4 5 6 7

Class: _____

very little some of it most of it

1 2 3 4 5 6 7

Class: _____

very little some of it most of it

1 2 3 4 5 6 7

5. To what degree do you prefer a used textbook that has been previously highlighted?

never sometimes always

1 2 3 4 5 6 7

6. How often have you studied *only* the material that was previously highlighted or underlined in your used texts?

never sometimes always

1 2 3 4 5 6 7

7. In your own words, describe why do you prefer or don't prefer a book that has been previously highlighted or underlined?

8. If you highlight or underline in a previously marked text, what degree of overlap is there between what you choose to mark and what was previously marked?

Part IV: Other Study Strategies

1. Do you use any form of marking in your texts, other than highlighting or underlining (e.g. notes in the margin or symbols such as arrows, etc)? If so, please explain what they are and how often you use them.

Part V. About Yourself

1. Age _____

2. Sex M F

3. Years in college (circle one): 0-1 1-2 2-3 3-4 4-5 5-6 7-8

4. Current Major in College: _____

5. **If you have previously majored in another area, which was it?**

   _____

6. **Other than texts for your classes, how many books do you usually read per semester?**

   _____

Appendix B

Instructions and Example Questions for the Nelson-Denny Vocabulary Test.

DIRECTIONS TO STUDENTS

A. Do not turn this page of the test booklet until directed to do so.

B. Do not make marks of any kind on this test booklet.

C. The Vocabulary Test containing 100 items is timed. You will have 15 minutes to complete the test. For each test item, mark the answer on the scantron that corresponds to your choice. The experimenter will tell you when the 15-minute period is over. Stop at the experimenter's instruction.

D. To make sure you know how to take the test, three practice questions are provided below.

Practice Examples

1. A *chef* works with: A. bricks B. music C. clothes D. food E. statues

Which word best completes the opening statement? Yes, food is the best answer.

2. To *repair* is to: A. destroy B. finish C. fix D. work E. show

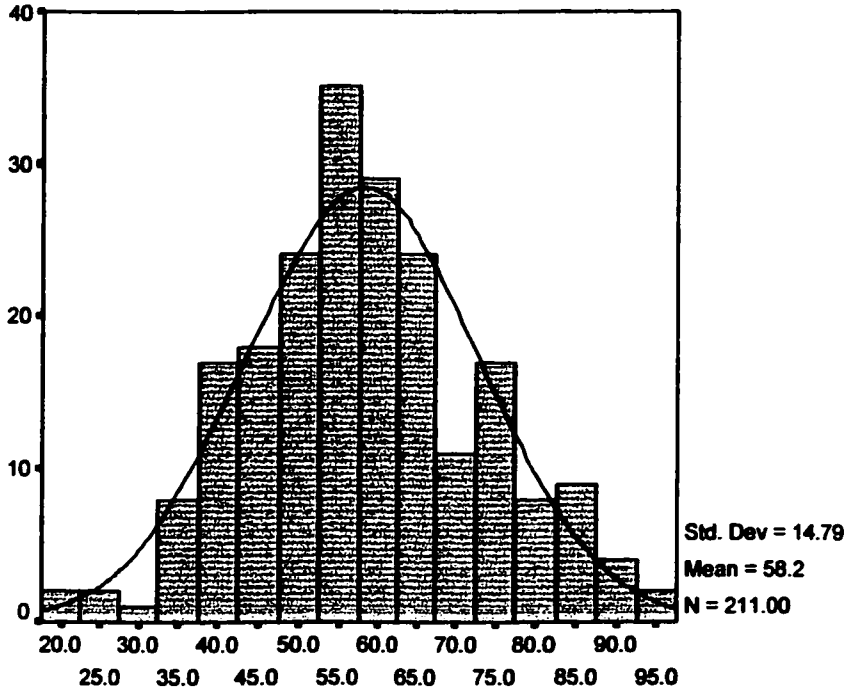
The correct answer is C. fix

3. *Mathematics* refers to: A. letters B. numbers C. machines D. plants E. stars

The correct answer is B. numbers

E. Wait for the signal to turn this page. Please ask the experimenter if you have any questions.

Distribution of Nelson-Denny Scores (Taken from Study 1).



Appendix C

Textbook Condition Survey (only cover page with example) Used in Study 2.

Instructions:

In this part of the experiment, you will be turning to pages in your text that the experimenter calls out. You will be asked to indicate how many paragraphs are on each page, how many sentences on each page are highlighted or underlined, and whether you marked the material.

Please complete all of the questions for each page called out.

Name of Text _____

Author _____

Edition _____

Condition (circle one) **New** **Used**

In the first space, write the page number that the experimenter calls out. If the page called has no complete paragraphs (e.g. chapter summaries/chapter references), turn back *four* pages and write that number in the page # space. Once you have written the page number, you can begin counting paragraphs. Write how many *complete* paragraphs are on that page in the second space. Then count how many sentences are highlighted or underlined and write that amount in the third and fourth spaces. Next, please indicate whether you were the person who did the highlighting or underlining by circling one of the options. Finally, indicate how certain you are that you did the marking on that page by circling the appropriate number on the scale.

Practice:

Let's try a practice run. Turn to page 54 of your text and answer the following:

Page# _____ **Paragraphs** _____ **Sentences Highlighted** _____ **Underlined** _____

How much of the material did YOU mark? (circle one) **All** **Some** **None**

How certain are you that YOU marked the sentences on this page?

not at all			somewhat			very
1	2	3	4	5	6	7

If you have any questions, please ask the experimenter now. If not, turn the page and wait for the experimenter to announce the first page.

Appendix D

Study Habit Survey used in Study 2.

The following survey will ask you some questions about your study habits. To indicate your response, please circle the appropriate number on the scale below the question. It is important that you be as honest as possible when answering the questions. Please feel free to ask the experimenter if you need any of the questions clarified.

1. On how many occasions, when you sit down to read a textbook, do you ***highlight*** material?

never			sometimes			always
1	2	3	4	5	6	7

2. If so, how much of the text do you ***highlight***?

very little			some of it			most of it
1	2	3	4	5	6	7

2. On how many occasions, when you sit down to read a textbook, do you ***underline*** material?

never			sometimes			always
1	2	3	4	5	6	7

4. If so, how much of the text do you ***underline***?

very little			some of it			most of it
1	2	3	4	5	6	7

5. To what degree do you prefer a used textbook that has been previously highlighted/underlined?

never			sometimes			always
1	2	3	4	5	6	7

6. **How often have you studied *only* the material that was highlighted or underlined by a previous reader in your used texts?**

never **sometimes** **always**

1 2 3 4 5 6 7

Sex (circle one): MALE FEMALE

Semester in school (write number): _____

Is your Introductory Psychology textbook (circle one): NEW USED

Appendix E

Study Habit and Read Task Survey used in Study 3.

The following survey will ask you some general questions about the passages you just read. To indicate your response, please circle the appropriate number on the scale below the question. It is important that you be as honest as possible when answering the questions. Please feel free to ask the experimenter if you need any of the questions clarified.

1. **If any of the passages that you read contained highlighted material, to what degree did you find the highlighted material distracting?**

not at all			somewhat			very
1	2	3	4	5	6	7

2. **If any of the passages that you read contained highlighted material, to what degree did you find the highlighted material helpful?**

not at all			somewhat			very
1	2	3	4	5	6	7

3. **On how many occasions, when you sit down to read a textbook, do you *highlight* material?**

never			sometimes			always
1	2	3	4	5	6	7

4. **If so, how much of the text do you *highlight*?**

very little			some of it			most of it
1	2	3	4	5	6	7

5. **To what degree do you prefer a used textbook that has been previously highlighted/underlined?**

never			sometimes			always
1	2	3	4	5	6	7

6. **How often have you studied *only* the material that was highlighted or underlined by a previous reader in your used texts?**

never			sometimes			always
1	2	3	4	5	6	7

Sex (circle one): MALE FEMALE

Semester in school (write number): _____

Appendix F

Experimental Passages (unmarked) and Comprehension Questions used in Study 3.

Easy Passage

Of the 197 million square miles making up the surface of the globe, 71 percent is covered by the interconnecting bodies of marine water; the Pacific Ocean alone covers half the Earth and averages nearly 14,000 feet in depth. The continents-Eurasia, Africa, North America, South America, Australia and Antarctica-are the portions of the continental masses rising above sea level. The submerged borders of the continental masses are the continental shelves, beyond which lie the deep sea basins.

The oceans attain their greatest depths not in their central parts, but in certain elongated furrows, or long narrow troughs, called deeps. These profound troughs have a peripheral arrangement, notably around the borders of the Pacific and Indian oceans. The position of the deeps near the continental masses suggests that the deeps, like the highest mountains, are of recent origin, since otherwise they would have been filled with waste from the lands. This suggestion is strengthened by the fact that the deeps are frequently the sites of world-shaking earthquakes. For example, the "tidal wave" that in April, 1946, caused widespread destruction along Pacific coasts resulted from a strong earthquake on the floor of the Aleutian Deep.

The topography of the ocean floors is none too well known, since in great areas the available soundings are hundreds or even thousands of miles apart. However, the floor of the Atlantic is becoming fairly well known as a result of special surveys since 1920. A broad, well-defined ridge-the Mid-Atlantic ridge-runs north and south between Africa and the two Americas, and numerous other major irregularities diversify the Atlantic floor. Closely spaced soundings show that many parts of the ocean floors are as rugged as mountainous regions of the continents. Use of the recently perfected method of echo sounding is rapidly enlarging our knowledge of submarine topography. During World War II great strides were made in mapping sub-marine surfaces, particularly in many parts of the vast Pacific basin.

The continents stand on the average 2870 feet-slightly more than half a mile-above sea level. North America averages 2300 feet; Europe averages only 1150 feet; and Asia, the highest of the larger continental subdivisions, averages 3200 feet. The highest point on the globe, Mount Everest in the Himalayas, is 29,000 feet above the sea; and as the greatest known depth in the sea is over 35,000 feet, the maximum relief (that is, the difference in altitude between the lowest and highest points) exceeds 64,000 feet, or exceeds 12 miles. The continental masses and the deep-sea basins are relief features of the first order; the deeps, ridges, and volcanic cones that diversify the sea floor, as well as the plains, plateaus, and mountains of the continents, are relief features of the second order. The lands are unendingly subject to a complex of activities summarized in the term erosion, which first sculptures them in great detail and then tends to reduce them ultimately to sea level. The modeling of the landscape by weather, running water, and other agents is apparent to the keenly observant eye and causes thinking people to speculate on what must be the final result of the ceaseless wearing down of the lands.

Long before there was a science of geology, Shakespeare wrote "the revolution of the times makes mountains level."

COMPREHENSION QUESTIONS

Place a circle around the alternative that best answers the question.

1. Which of the following would be the most appropriate title for the passage?

   a). Features of the Earth's Surface
   b). Marine Topography
   c). The Causes of Earthquakes
   d). Primary Geologic Considerations
   e). How to Prevent Erosion

2. It can be inferred from the passage that the largest ocean is the:

   a). Atlantic
   b). Pacific
   c). Indian
   d). Antarctic
   e). Arctic

3. The "revolution of the times" as used in the final sentence means:

   a). the passage of years
   b). the current rebellion
   c). the science of geology
   d). the action of the ocean floor
   e). the overthrow of natural forces

4. According to the passage, the peripheral furrows or deeps are found:

   a). only in the Pacific and Indian oceans
   b). near earthquakes
   c). near the shore
   d). in the center of the ocean
   e). to be 14,000 feet in depth in the Pacific

5. The passage contains information that would answer which of the following questions:

   I. What is the highest point in North America?
   II. Which continental subdivision is, on the average, 1150 feet above sea level?
   III. How deep is the deepest part of the ocean?

   a). I only
   b). II only
   c). III only
   d). I and II only
   e). II and III only

6. From the passage, it can be inferred that earthquakes:

   a). occur only in the peripheral furrows
   b). occur more frequently in newly formed land or sea formations
   c). are a prime cause of soil erosion
   d). will ultimately "make mountains level"
   e). are caused by the weight of the water

Moderately Difficult Passage

The notion of a tranquil abyss had been so generally held that many investigators were initially reluctant to accept the evidence for strong currents and storms in the deep sea. The first argument for the existence of such currents came from theory. Cold water is denser than warm water, and models of ocean circulation showed that the sinking of cold water near the poles should generate strong, deep and steady currents flowing toward the Equator. Subsequent observations not only confirmed the presence of deep currents but also disclosed the existence of eddies on the western side of ocean basins that can be some 300 times as energetic as the mean current. Photographs of the sea floor underlying the deep currents also revealed extensive graded beds indicative of the active transport of sediment. The final evidence for dynamic activity at great depths came from direct measurements of currents and sediments in the North Atlantic carried out in the HEBBLE program.

Before we describe the HEBBLE findings in some detail let us briefly review the sources and sinks of deep-sea sediments and the forces that activate the global patterns of ocean circulation. The sediments that end up on the ocean floor are of two main types. One component is the detritus whose source is the weathering of rocks on continents and islands. This detritus, together with decaying vegetable matter from land plants, is carried by rivers to the edge of the continent and out onto the continental shelf, where it is picked up by marine currents. Once the detritus reaches the edge of the shelf it is carried to the base of the continental rise by gravitational processes. A significant amount of terrestrial material is also blown out to sea in subtropical regions by strong desert winds.

Every year some 15 billion tons of continental material reaches the outlets of streams and rivers. Most of it is trapped there or on the continental shelves; only a few billion tons escapes into the deep sea.

The second major component arriving at the sea floor consists of the shells and skeletons of dead microscopic organisms that flourish and die in the sunlit waters of the top 100 meters of the world's oceans. Such biological material contributes to the total inventory at the bottom about three billion tons per year. Rates of accumulation are governed by rates of biological productivity, which are controlled in part by surface currents. Where surface currents meet they are said to converge, and where they part they are said to diverge. Zones of divergence of major water masses allow nutrient-rich deeper water to "outcrop" at the sunlit zone where photosynthesis and the resulting fixation of organic carbon take place. Such belts of high productivity and high rates of accumulation are normally around the major oceanic fronts (such as the region around the Antarctic) and along the edges of major currents (such as the Gulf Stream off New England and the Kuroshio currents off Japan). Nutrient-rich water also outcrops in a zone along the Equator, where there is a divergence of two major, wind-driven gyres.

COMPREHENSION QUESTIONS

1. The primary purpose of the passage is to:

   a). contrast surface currents with marine currents
   b). question the methods of earlier investigators
   c). demonstrate the benefits of the HEBBLE program
   d). describe a replicable-laboratory experiment
   e). summarize evidence supporting oceanic circulation

2. Which of the following best describes the attitude of many scientists when they first encountered the theory that strong currents are at work in the deep sea?

   a). Somber resignation
   b). Measured approbation
   c). Marked skepticism
   d). Academic detachment
   e). Active espousal

3. According to the passage, the earliest data supporting the idea that the sea depths were dynamic rather than placid came from:

   a). underwater photographic surveys
   b). the activities of the HEBBLE program
   c). analysis of North Atlantic sea-bed sediments
   d). direct measurement of undersea currents
   e). models showing how hot and cold water interact

4. The passage most likely would be of particular interest to:

   a). navigators of sailing vessels
   b). students of global weather patterns
   c). current passengers on ocean liners
   d). designers of sea-floor structures
   e). researchers into photosynthesis

5. As defined in the passage, the second type of deep-sea sediment consists of which of the following?

   I. minute particles of rock
   II. Fragmentary shells
   III. Wind-blown soil

   a). I only
   b). II only
   c). I and II only
   d). I and III only
   e). I, II and III

6. In the passage, the authors do all of the following EXCEPT:

   a). approximate an amount
   b). refer to a model
   c). give an example
   d). propose a solution
   e). support a theory

Difficult Passage

Genetic variation is also important in the evolution of lower organisms such as bacteria, and here too it arises from mutations. Bacteria only have one chromosome, however, so that different alleles or variant forms of a gene are not normally present within a single cell. The reshuffling of bacterial genes therefore ordinarily requires the introduction into a bacterium of DNA carrying an allele that originated in a different cell. One mechanism accomplishing this interbacterial transfer of genes in nature is transduction: certain viruses that can infect bacterial cells pick up fragments of the bacterial DNA and carry the DNA to other cells in the course of a later infection. In another process, known as transformation, DNA released by cell death or other natural processes simply enters a new cell from the environment by penetrating the cell wall and membrane. A third mechanism, conjugation, involves certain of the self-replicating circular segments of DNA called plasmids, which can be transferred to bacterial cells that are in direct physical contact with each other.

Whether the genetic information is introduced into a bacterial cell by transduction, transformation, or conjugation, it must be incorporated into the new host's hereditary apparatus if it is to be propagated as part of that apparatus when the cell divides. As in the case of higher organisms, this incorporation is ordinarily accomplished by the exchange of homologous DNA; the entering gene must have an allelic counterpart in the recipient DNA. Because homologous recombination requires overall similarity of the two DNA segments. And so, in bacteria as well as in higher organisms, the generation of genetic variability is limited to what can be attained by exchanges between different alleles of the same genes that have stretches of similar nucleotide sequences. This requirement imposes several constraints on the rate of evolution that can be attained through homologous recombination.

Until recently mutation and homologous recombination nevertheless appeared to be the only important mechanisms for generating biological diversity. They seemed to be able to account for the degree of diversity observed in most species, and the implicit constraints of homologous recombination - which prevent the exchange of genetic information between unrelated organisms lacking extensive DNA-sequence similarity - appeared to be consistent with both a modest rate of biological evolution and the persistence of distinct species that retain their basic identity generation after generation.

Within the past decade or so, however, it has become increasingly apparent that there are various "illegitimate" recombinational processes, which can join together DNA segments having little or no nucleotide-sequence homology, and that such processes play a significant role in the organization of genetic information and the regulation of its expression. Such recombination is often effected by transposable genetic elements: structurally and genetically discrete segments of DNA that have the ability to move around the chromosomes and the extrachromosomal DNA molecules of bacteria and higher organisms. Although transposable elements have been studied largely in bacterial cells, they were originally discovered in plants and are now known to exist in animals as well. Because illegitimate recombination can join together DNA segments that have little, if any, ancestral relationship, it can affect evolution in quantum leaps as well as in small steps.

COMPREHENSION QUESTIONS

1. The passage supplies information for answering which of the following questions?

   I. Why are interbacterial transfer mechanisms important for genetic variation in bacteria?
   II. What is the role of cell death in the interbacterial transfer of genes?
   III. How do the so-called "illegitimate" recombinational processes differ from homologous recombination?

a). I only
b). II only
c). I and II only
d). I and III only
e). I, II and III

2. The primary purpose of the passage is to:

   a). examine the evidence supporting the existence of transposable genetic elements in bacteria
   b). report on the controversy over the use of illegitimate recombinational processes in bacteria
   c). discuss evolutionary theory and some hypotheses to account for its anomalies
   d). explain established mechanisms for genetic change and introduce a newly discovered one
   e). restrict the scope of the investigation of the causes of genetic variation in bacteria

3. The authors use the term "illegitimate recombinational processes" to refer to:

   a). biological processes outlawed by federal regulation
   b). processes requiring similarity of nucleotide sequences
   c). processes that break the rules of homologous recombination
   d). processes that cannot be found among higher organisms
   e). processes exceeding the permissible amount of mutation

4. A necessary precondition for the process known as transformation to take place is that the cell wall and membrane be:

   a). contiguous
   b). pliant
   c). permeable
   d). homologous
   e). self-replicating

5. The function of viruses in the mechanism of transduction in bacteria is most like the function of:

   a). caterpillars in the process of metamorphosis
   b). bees in the process of pollination
   c). germs in the process of immunization
   d). pores in the process of perspiration
   e). atoms in the process of fission

6. It can be inferred from the passage that the paragraph immediately preceding this excerpt most likely dealt with the

   a). probability of mutations in colonies of bacteria
   b). significance of genetic diversity in higher organisms
   c). discovery of transposable genetic elements in plants
   d). relationship between bacteria and higher organisms
   e). evidence supporting the theory of evolution

Appendix G

Relevant Text-Marking Passages used in Study 3.

Easy

Of the 197 million square miles making up the surface of the globe, 71 percent is covered by the interconnecting bodies of marine water; the Pacific Ocean alone covers half the Earth and averages nearly 14,000 feet in depth. The continents-Eurasia, Africa, North America, South America, Australia and Antarctica-are the portions of the continental masses rising above sea level. The submerged borders of the continental masses are the continental shelves, beyond which lie the deep sea basins.

The oceans attain their greatest depths not in their central parts, but in certain elongated furrows, or long narrow troughs, called deeps. These profound troughs have a peripheral arrangement, notably around the borders of the Pacific and Indian oceans. The position of the deeps near the continental masses suggests that the deeps, like the highest mountains, are of recent origin, since otherwise they would have been filled with waste from the lands. This suggestion is strengthened by the fact that the deeps are frequently the sites of world-shaking earthquakes. For example, the "tidal wave" that in April, 1946, caused widespread destruction along Pacific coasts resulted from a strong earthquake on the floor of the Aleutian Deep.

The topography of the ocean floors is none too well known, since in great areas the available soundings are hundreds or even thousands of miles apart. However, the floor of the Atlantic is becoming fairly well known as a result of special surveys since 1920. A broad, well-defined ridge-the Mid-Atlantic ridge-runs north and south between Africa and the two Americas, and numerous other major irregularities diversify the Atlantic floor. Closely spaced soundings show that many parts of the ocean floors are as rugged as mountainous regions of the continents. Use of the recently perfected method of echo sounding is rapidly enlarging our knowledge of submarine topography. During World War II great strides were made in mapping sub-marine surfaces, particularly in many parts of the vast Pacific basin.

The continents stand on the average 2870 feet-slightly more than half a mile-above sea level. North America averages 2300 feet; Europe averages only 1150 feet; and Asia, the highest of the larger continental subdivisions, averages 3200 feet. The highest point on the globe, Mount Everest in the Himalayas, is 29,000 feet above the sea; and as the greatest known depth in the sea is over 35,000 feet, the maximum relief (that is, the difference in altitude between the lowest and highest points) exceeds 64,000 feet, or exceeds 12 miles. The continental masses and the deep-sea basins are relief features of the first order; the deeps, ridges, and volcanic cones that diversify the sea floor, as well as the plains, plateaus, and mountains of the continents, are relief features of the second order. The lands are unendingly subject to a complex of activities summarized in the term erosion, which first sculptures them in great detail and then tends to reduce them ultimately to sea level. The modeling of the landscape by weather, running water, and other agents is apparent to the keenly observant eye and causes thinking people to speculate on what must be the final result of the ceaseless wearing down of the lands.

Long before there was a science of geology, Shakespeare wrote "the revolution of the times makes mountains level."

Moderately Difficult

The notion of a tranquil abyss had been so generally held that many investigators were initially reluctant to accept the evidence for strong currents and storms in the deep sea. The first argument for the existence of such currents came from theory. Cold water is denser than warm water, and models of ocean circulation showed that the sinking of cold water near the poles should generate strong, deep and steady currents flowing toward the Equator. Subsequent observations not only confirmed the presence of deep currents but also disclosed the existence of eddies on the western side of ocean basins that can be some 300 times as energetic as the mean current. Photographs of the sea floor underlying the deep currents also revealed extensive graded beds indicative of the active transport of sediment. The final evidence for dynamic activity at great depths came from direct measurements of currents and sediments in the North Atlantic carried out in the HEBBLE program.

Before we describe the HEBBLE findings in some detail let us briefly review the sources and sinks of deep-sea sediments and the forces that activate the global patterns of ocean circulation. The sediments that end up on the ocean floor are of two main types. One component is the detritus whose source is the weathering of rocks on continents and islands. This detritus, together with decaying vegetable matter from land plants, is carried by rivers to the edge of the continent and out onto the continental shelf, where it is picked up by marine currents. Once the detritus reaches the edge of the shelf it is carried to the base of the continental rise by gravitational processes. A significant amount of terrestrial material is also blown out to sea in subtropical regions by strong desert winds. Every year some 15 billion tons of continental material reaches the outlets of streams and rivers. Most of it is trapped there or on the continental shelves; only a few billion tons escapes into the deep sea.

The second major component arriving at the sea floor consists of the shells and skeletons of dead microscopic organisms that flourish and die in the sunlit waters of the top 100 meters of the world's oceans. Such biological material contributes to the total inventory at the bottom about three billion tons per year. Rates of accumulation are governed by rates of biological productivity, which are controlled in part by surface currents. Where surface currents meet they are said to converge, and where they part they are said to diverge. Zones of divergence of major water masses allow nutrient-rich deeper water to "outcrop" at the sunlit zone where photosynthesis and the resulting fixation of organic carbon take place. Such belts of high productivity and high rates of accumulation are normally around the major oceanic fronts (such as the region around the Antarctic) and along the edges of major currents (such as the Gulf Stream off New England and the Kuroshio currents off Japan). Nutrient-rich water also outcrops in a zone along the Equator, where there is a divergence of two major, wind-driven gyres.

Difficult

Genetic variation is also important in the evolution of lower organisms such as bacteria, and here too it arises from mutations. Bacteria only have one chromosome, however, so that different alleles or variant forms of a gene are not normally present within a single cell. The reshuffling of bacterial genes therefore ordinarily requires the introduction into a bacterium of DNA carrying an allele that originated in a different cell. One mechanism accomplishing this interbacterial transfer of genes in nature is transduction: certain viruses that can infect bacterial cells pick up fragments of the bacterial DNA and carry the DNA to other cells in the course of a later infection. In another process, known as transformation, DNA released by cell death or other natural processes simply enters a new cell from the environment by penetrating the cell wall and membrane. A third mechanism, conjugation, involves certain of the self-replicating circular segments of DNA called plasmids, which can be transferred to bacterial cells that are in direct physical contact with each other.

Whether the genetic information is introduced into a bacterial cell by transduction, transformation, or conjugation, it must be incorporated into the new host's hereditary apparatus if it is to be propagated as part of that apparatus when the cell divides. As in the case of higher organisms, this incorporation is ordinarily accomplished by the exchange of homologous DNA; the entering gene must have an allelic counterpart in the recipient DNA. Because homologous recombination requires overall similarity of the two DNA segments. And so, in bacteria as well as in higher organisms, the generation of genetic variability is limited to what can be attained by exchanges between different alleles of the same genes that have stretches of similar nucleotide sequences. This requirement imposes several constraints on the rate of evolution that can be attained through homologous recombination.

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Appendix H

Irrelevant-Marking Passages used in Study 3.

Easy

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Appendix I

For all experiments reported in this dissertation, approval for the use of human subjects was obtained from the University of New Hampshire and Notre Dame College Institutional Review Boards. Forms demonstrating this proof of approval are included in this appendix.

UNIVERSITY OF NEW HAMPSHIRE

INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN RESEARCH SUBJECTS

PROTOCOL REVIEW FORM

Project Director: KENNETH BELL IRB#: 35

Department: PSYCHOLOGY Reviewer: _____

Project Title: READING SKILL AND HIGHLIGHTING EXPOSITORY TEXT Date: _____

Reviewer: Please write comments, if any, on the reverse side of this form. Return completed form to OSR, 107 Service Building.

EXEMPT REVIEW

PROTOCOL IS APPROVED AS EXEMPT PER SUBSECTION:

___ 46.101(b)(1) Research conducted in established educational setting using normal educational procedures
_✓_ 46.101(b)(2) Educational tests, surveys, interviews, observation of public behavior/no risk

___ 46.101(b)(3) Educational tests, surveys, interviews, observation of public behavior not exempt under Subsection 2, above, if public official or if confidentiality mandated by federal statutes
___ 46.101(b)(4) Study of existing data
___ 46.101(b)(5) Study of public benefits or service programs
___ 46.101(b)(6) Taste and food studies

___ PROTOCOL IS NOT APPROVED ___ PROTOCOL RECOMMENDED FOR FULL BOARD REVIEW

EXPEDITED REVIEW

PROTOCOL IS APPROVED AS EXPEDITED PER SUBSECTION:

___ 46.110(b)(1)(1) Collection of hair, nail, teeth in non-disfiguring manner
___ 46.110(b)(1)(2) Collection of external secretions: sweat, saliva, placenta (time of delivery), amniotic fluid

___ 46.110(b)(1)(3) Recording of data from subjects 18 years or older using non-invasive procedures routinely employed in clinical practice
___ 46.110(b)(1)(4) Collection of blood samples by venipuncture
___ 46.110(b)(1)(5) Collection of dental plaque and calculus
___ 46.110(b)(1)(6) Voice recordings such as investigations of speech defects
___ 46.110(b)(1)(7) Moderate exercise by healthy volunteers
___ 46.110(b)(1)(8) Study of existing data, documents, records, or diagnostic specimens

___ 46.110(b)(1)(9) Research on individual or group behavior or characteristics of individuals, such as studies of perception, cognition, theory, or test development
___ 46.110(b)(1)(10) Research on drugs or devices for which an investigational drug or device exemption is not required

___ PROTOCOL IS NOT APPROVED ___ PROTOCOL RECOMMENDED FOR FULL BOARD REVIEW

MODIFICATION (REVISION) REVIEW

___ Protocol approved
___ Further action recommended: (specify)

_____

CONTINUING (TIME EXTENSION) REVIEW

___ Extension approved
___ Further action recommended: (specify)

_____

Signature of IRB Reviewer _____ Date 12/1/99

UNIVERSITY OF NEW HAMPSHIRE

Institutional Review Board for the Protection of Human Research Subjects

Protocol Review Form

Project Director: KENNETH BELL IRB#: 9

Department: PSYCHOLOGY Reviewer: _____

Project Title: READING SKILL AND MICROSTRUCTURE EXPOSITORY TEXT Date: _____

Reviewer: Please write comments, if any, on the reverse side of this form. Return completed form to OSR, 107 Service Building.

EXEMPT REVIEW

PROTOCOL IS APPROVED AS EXEMPT PER SUBSECTION:

- ___ 46.101(b)(1) Research conducted in established educational setting using normal educational procedures
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___ PROTOCOL IS NOT APPROVED ___ PROTOCOL RECOMMENDED FOR FULL BOARD REVIEW

MODIFICATION (REVISION) REVIEW

- ___ Protocol approved
- ___ Further action recommended: (specify) _____

CONTINUING (TIME EXTENSION) REVIEW

- ___ Extension approved
- ___ Further action recommended: (specify) _____

Signature of IRB Reviewer _____ Date _____

UNIVERSITY OF NEW HAMPSHIRE

INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN RESEARCH SUBJECTS

PROTOCOL REVIEW FORM

6

Project Director: KENNETH ISELL IRB#: _____

Department: PSYCHOLOGY Reviewer: _____

Project Title: READING SKILL AND USE OF ADJUNCT STUDY STRATEGIES Date: _____

Reviewer: Please write comments, if any, on the reverse side of this form. Return completed form to OSR, 107 Service Building.

EXEMPT REVIEW

PROTOCOL IS APPROVED AS EXEMPT PER SUBSECTION:

___ 46.101(b)(1) Research conducted in established educational setting using normal educational procedures
___ 46.101(b)(2) Educational tests, surveys, interviews, observation of public behavior/no risk
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___ 46.101(b)(6) Taste and food studies

___ PROTOCOL IS NOT APPROVED ___ PROTOCOL RECOMMENDED FOR FULL BOARD REVIEW

EXPEDITED REVIEW

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___ PROTOCOL IS NOT APPROVED ___ PROTOCOL RECOMMENDED FOR FULL BOARD REVIEW

MODIFICATION (REVISION) REVIEW

___ Protocol approved
___ Further action recommended: (specify)

_____

CONTINUING (TIME EXTENSION) REVIEW

___ Extension approved
___ Further action recommended: (specify)

_____

Signature of IRB Chairperson _____ Date _____

Research Review Form

Project Director: Kenneth Bell
Department: Sciences
Project Title: The Effect of Highlighting on Comprehension

IRB# S-exe-1
Reviewer: S. Litch Gray
Date: 11-8-01

Reviewer: Please write comments on the reverse side of this form.

Exempt review

Protocol is approved as exempt per subsection:

____ 46.101(b)(1) Research conducted in established educational setting using normal education procedures
_XX 46.101(b)(2) Educational test, surveys, interviews, observations of public behavior/no risk
____ 46.101(b)(3) Educational tests, surveys, interviews, observation of public behavior not exempt under subsection 2, above, if public or if confidentiality is mandated by federal statutes
____ 46.101(b)(4) Study of existing data
____ 46.101(b)(5) Study of public benefits or service programs
____ 46.1011(b)(6) Taste and food studies

____ Protocol is not approved

____ Protocol recommended for Full Board Review

Expedited Review

Protocol is approved as expedited per subsection

____ 46.101(b)(1)(1) Collection of hair, nail, teeth, in non-disfiguring manner
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____ 46.101(b)(1)(8) Study of existing data, documents, records, or diagnostic specimens
____ 46.101(b)(1)(9) Research of individual or group behavior of characteristics of individual, such as studies of perceptions, cognition, theory or test development
____ 46.101(b)(1)(10) Research of drugs or devices for which an investigation drug or device exemption is not required
____ Protocol is not approved ____ Protocol recommended for full board review

Modification (Revision) Review

_XX_ Protocol approved

____ Further action recommended (specify)

Continuing (Time extension) Review

____ Extension approved
____ Further action recommended (specify)

S. Litch Gray, Ph.D.
Signature of IRB Reviewer

11-8-01
Date