How Seductive Details Do Their Damage: A Theory of Cognitive Interest in Science Learning

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In 4 experiments, students who read expository passages with seductive details (i.e., interesting but irrelevant adjuncts) recalled significantly fewer main ideas and generated significantly fewer problem-solving transfer solutions than those who read passages without seductive details. In Experiments 1, 2, and 3, revising the passage to include either highlighting of the main ideas, a statement of learning objectives, or signaling, respectively, did not reduce the seductive details effect. In Experiment 4, presenting the seductive details at the beginning of the passage exacerbated the seductive details effect, whereas presenting the seductive details at the end of the passage reduced the seductive details effect. The results suggest that seductive details interfere with learning by priming inappropriate schemas around which readers organize the material, rather than by distracting the reader or by disrupting the coherence of the passage.

Textbooks are second only to lecture as the instructional medium of choice for presenting information to students (Garner, Gillingham, & White, 1989), but students often find the material boring (Harp & Mayer, 1997). One suggested technique for increasing students' interest in a text, such as the lightning formation passage in the Appendix, is to add seductive details, that is, highly interesting and entertaining information that is only tangentially related to the topic but is irrelevant to the author's intended theme (Garner, Brown, Sanders, & Menke, 1992; Garner et al., 1989). For example, we could add an entertaining lightning-related story (e.g., about a boy who was struck by lightning) and a color illustration (e.g., a photo of his lightning-scorched clothes) to each paragraph, such as those shown in the middle and right columns of Figure 1, respectively. However, adding seductive details to the lightning formation passage resulted in poorer retention and transfer performance than having no seductive details in the passage (Harp & Mayer, 1997).

This pattern of results, which can be called the seductive details effect, is consistent with earlier research findings in which adding seductive details (in the form of sentences) to a passage reduces or does not facilitate students' remembering of the main ideas in a passage (Garner, Alexander, Gillingham, Kulikowich, & Brown, 1991; Garner et al., 1992; Garner et al., 1989; Harp & Mayer, 1997; Hidi & Baird, 1986; Wade, 1992; Wade & Adams, 1990). Also consistent with the seductive details hypothesis is that readers typically remember interesting adjuncts included in a passage rather than structurally important ideas (Garner, 1992; Garner et al., 1991; Garner et al., 1992; Hidi & Anderson, 1992). Taken together, these results are consistent with Dewey's (1913) classic admonition against viewing interest as an ingredient that can be added to spice up an otherwise boring lesson. As such, the primary goal of this study is not to provide further documentation for the seductive details effect but rather to examine possible theoretical explanations for why this phenomenon occurs.

Locating the Damage Site: Three Hypotheses for How Seductive Details Do Their Damage

In order to understand how seductive details do their damage, it is first necessary to consider the processes involved in understanding textbook material. According to Mayer, Steinhoff, Bower, and Mars (1995) there are three processes that an active learner must use to construct a coherent mental representation of information contained in text and illustrations: selecting, organizing, and integrating. Selecting involves paying attention to the relevant pieces of information in the text, such as each of the steps in the formation of lightning. Organizing involves building internal connections among the selected pieces of information, such as noting that one step is the cause of the next step in a cause-and-effect chain. Integrating involves building external connections between the incoming information (such as the step in the process where warm air rises to form a cloud) and prior knowledge existing in the learner's long-term memory (such as the idea of what a cloud is).

The goal of the present study was to determine where it is within this generative model that seductive details do their damage. Seductive details may do their damage by interfering with any of the three cognitive processes that lead to effective text comprehension: selecting, organizing, or inte-
grating. On the basis of this analysis, three plausible theoretical explanations for the seductive details effect are (a) the distraction hypothesis, that is, that seductive details guide readers' selective attention away from the main ideas; (b) the disruption hypothesis, that is, that seductive details interfere with the building of an organized mental model of the causal chain; and (c) the diversion hypothesis, that is, that seductive details activate inappropriate prior knowledge.

The Distraction Hypothesis

According to the distraction hypothesis, seductive details do their damage by "seducing" the reader's selective attention away from the important information. For example, while reading about how lightning works, the reader may select and retain seductive information about golfers who were killed by lightning rather than information about the interaction of positive and negative charges within a cloud. This may be because seductive details tend to contain information that requires little attentional effort and is easily understood (Shirey & Reynolds, 1988).

If the distraction hypothesis is correct, then revising a lesson containing seductive details so as to guide students' selection processes toward structurally important ideas—such as through highlighting the major steps in lightning formation—should minimize the effects of the seductive details. Selection can also be guided verbally by simply telling students what they should be paying attention to while reading, such as telling students to pay particular attention to the steps leading to a flash of lightning. The distraction hypothesis predicts that readers who are assisted in guiding their selection processes toward structurally important ideas in a lesson should be less susceptible to the seductive details effect than those who are not guided.

The Disruption Hypothesis

The disruption hypothesis suggests that seductive details are damaging because they interrupt the transition from one main idea to the next. In order for the reader to be able to construct a coherent mental model of the chain of events leading to the formation of lightning, links between the steps in the causal chain must be constructed in working memory. Because seductive details are presented between the steps of the causal chain, the reader is not able to see how to link the steps. As a result, the reader interprets each step as a separate, independent event, rather than as part of a causal chain. In this case, the reader fails to note the relationships among the causal steps within the system explained in the lesson. According to the disruption hypothesis, seductive details serve to break the chain, so to speak, making it difficult for the reader to construct an organized text base.

If the disruption hypothesis is correct, then helping the reader to more effectively organize the important main ideas should reduce the seductive details effect. Rewriting a passage by using organizational signals such as preview sentences and number signals in a passage about how lightning works should help the reader to realize that the steps explained in the passage are related to one another. For example, using number signals such as "Step 1: Warm air rises" and "Step 2: Condenses and forms a cloud" for each of the major steps in the causal chain should make it easier for the reader to build the necessary internal connections among the causal elements. If the disruption hypothesis is correct, then students who read seductive details passages with organizational signals should be less influenced by the seductive details than those who read nonsignaled seductive details passages.

The Diversion Hypothesis

In contrast to the disruption hypothesis, in which readers are unable to build a coherently organized mental representation, the diversion hypothesis states that the reader builds a coherent mental representation but not of the structurally important ideas. According to the diversion hypothesis, the reader builds a representation of the text organized around the seductive details, rather than around the important main ideas contained in the lesson. In this case, seductive details prime the activation of inappropriate prior knowledge as the organizing schema for the lesson.

For example, again consider a student reading a passage intended to convey a lesson about the steps involved in the formation of lightning that also contains interesting descriptions of death and destruction caused by lightning. According to the diversion hypothesis, the student will be mislead into relating the passage to prior knowledge about "what lightning causes" rather than "what causes lightning." In this case, the reader attempts to make sense of the passage in terms of the seductive details and may assume that the information regarding the formation of lightning is simply supporting material.

If the diversion hypothesis is correct, then revising a lesson by presenting all of the irrelevant information at the beginning of the lightning passage should exacerbate the seductive details effect. For instance, if all of the irrelevant information about the damage lightning can cause is presented before the lesson, then the student's prior knowledge about lightning-related damage will be activated before the student begins to read about how lightning works. The reader will then use this inappropriate schema to organize the remainder of the passage. This hypothesis predicts that students who read passages with seductive details placed at the beginning of the lesson will be more susceptible to the seductive details effect than those who read the passage with seductive details interspersed throughout the passage.

Conversely, according to the diversion hypothesis, revising the passage by moving the seductive details to the end of the lesson should result in reducing the seductive details effect. By coming after the important information has been presented, the irrelevant information should have no effect on the readers' expectations concerning what the passage is about. Therefore, this hypothesis predicts that students who read passages with the seductive details moved to the end of the passage will be less influenced by the seductive details than those who read passages with seductive details interspersed throughout the passage.
Every year approximately 150 Americans are killed by lightning. Swimmers are sitting ducks for lightning, because water is an excellent conductor of this electrical discharge.

When flying through updrafts, an airplane ride can become bumpy. Metal airplanes conduct lightning very well, but they sustain little damage because the bolt, meeting no resistance, passes right through.

When lightning strikes the ground, fulgurites may form, as the heat from the lightning fuses sand into the shape of the electricity's path.

In trying to understand these processes, scientists sometimes create lightning by launching tiny rockets into overhead clouds.

Golfers are prime targets of lightning strikes because they tend to stand in open grassy fields, or to huddle under trees.

Approximately 10,000 Americans are injured by lightning every year. Eyewitnesses in Burtonsville, Maryland, watched as a bolt of lightning tore a hole in the helmet of a high school football player during practice. The bolt burned his jersey, and blew his shoes off. More than a year later, the young man still won't talk about his near death experience.
We conducted four experiments to test the predictions of these three hypotheses. In each study, we first determined whether a seductive details effect was evident and then attempted to reduce the effect by using techniques based on each hypothesis.

Experiment 1

Experiment 1 explored whether the seductive details effect is affected by techniques designed to guide the selection process during reading such as using underlining and highlighting (Golding & Fowler, 1992; Lorch, Lorch, & Klusewitz, 1995). College students read a scientific passage explaining the formation of lightning that was with or without seductive details and with or without highlighting (such as italicized bold print) of the nine links of a causal chain that leads to a flash of lightning. After reading their respective passages, the four groups were compared on measures of recall and problem solving.

According to the distraction hypothesis, the seductive details effect is due to the reader’s selection of interesting, irrelevant material rather than structurally important ideas contained in a passage. If failing to select the important parts of the text contributes to the seductive details effect, students who read the seductive details passage with the main ideas highlighted should not show as strong a seductive details effect as those who read the same passage without highlighted text. However, no prediction can be made regarding problem-solving performance, for simply selecting information does not imply an understanding of the material.

In contrast, the disruption hypothesis states that seductive details interrupt the coherence of the causal chain explained in the passage on lightning. Therefore, this hypothesis cannot make a specific prediction regarding recall performance, for taken as a separate process, an improvement in the ability to organize information does not imply improved recall of that information. However, the disruption hypothesis predicts that highlighting the important ideas should not reduce the seductive details effect on measures of problem-solving performance, because highlighting the important information should not make a passage containing seductive details any more coherent. Therefore, according to the disruption hypothesis, students who read passages containing seductive details will perform poorly on transfer tests, whether or not the passage contains typographical highlighting.

Finally, the diversion hypothesis states that seductive details activate inappropriate prior knowledge with which to integrate new material. If this hypothesis is correct, highlighting should not reduce the seductive details effect on recall performance, because highlighting does not help to activate useful prior knowledge. As well, this hypothesis predicts that the seductive details effect on problem solving should not be reduced, because highlighting should not make it easier for the reader to process and integrate the main ideas. Even if the main ideas are highlighted, the reader may still find it easier to integrate the seductive details. These predictions are summarized in the 2nd column (Highlights) of Table 1.

Method

Participants and design. The participants were 81 undergraduate students recruited from the psychology subject pool at the University of California, Santa Barbara. All participants rated their knowledge of meteorology as low on a participant questionnaire (as described in the Materials section and in the Scoring section). Each participant served in one cell of a 2 X 2 between-subjects factorial design, with seductive details (present or absent) being the first variable and highlighting (present or absent) being the second variable. There were 19 participants in the base-passage group, 24 in the base-passage-plus-highlighting group, 17 in the base-passage-plus-seductive-details group, and 21 in the base-passage-plus-seductive-details-plus-highlighting group. Comparisons were made among the four groups on measures of recall and problem-solving performance.

Materials. The materials consisted of a participant questionnaire, four instructional booklets, a recall sheet, and four problem-solving sheets. A standard stopwatch was used to time the participants.

The participant questionnaire, adapted from Mayer et al. (1995), solicited general demographic information, such as age, gender, and Scholastic Assessment Test (SAT) scores. The questionnaire also requested the participants to place a check on a 5-point scale, rating their knowledge of weather, ranging from very little to very much, and to place a check by each of six weather-related items that applied to them, including the following: “I know what a cold front is,” “I can distinguish between cumulus and nimbus clouds,” “I know what a low pressure system is,” “I can explain what makes the wind blow,” “I know what this symbol means” [symbol for warm front], and “I know what this symbol means” [symbol for cold front].

Each of the instructional booklets consisted of a four-page passage pasted inside a folder such that only two facing pages were visible at a time, mimicking the format of a textbook. All pages were typed using black text on white 8.5 X 11 in. (21.6 X 27.9 cm) paper, and the title, “The Process of Lightning,” appeared above the text on the first page of each booklet in large, bold print.

Table 1
Predicted and Actual Outcomes for Experiments 1, 2, 3, and 4: According to the Distraction, Disruption, and Diversion Hypotheses, Should Particular Treatments Result in a Reduction of the Seductive Details Effect on Recall of Structurally Important Ideas or on Transfer Performance?

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Hypothesis and measure (Experiment)</th>
<th>Highlights (Experiment 1)</th>
<th>Learning objectives (Experiment 2)</th>
<th>Signals (Experiment 3)</th>
<th>Seductive details before the passage vs. interspersed (Experiment 4)</th>
<th>Seductive details after the passage vs. interspersed (Experiment 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distraction Recall Transfer</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>no</td>
<td></td>
</tr>
<tr>
<td>Disruption Recall Transfer</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Diversion Recall Transfer</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Recall Transfer</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Actual outcomes Recall Transfer</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td></td>
</tr>
</tbody>
</table>

Note. NA = Not applicable.

The base-passage booklet, adapted from Mayer et al. (1995), consisted of 550 words and six black-and-white captioned illustrations explaining the causal chain involved in the formation of lightning. The captions included approximately 60 words repeated directly from the passage. The passage contained six paragraphs, each describing a step in the process of lightning, based on factual information taken from high school science textbooks and an excerpt from the World Book Encyclopedia (1992). The first and second pages each contained two paragraphs, whereas the third and fourth pages each contained one paragraph. To the left of each paragraph appeared its corresponding captioned illustration, depicting a step in the process of lightning. Each illustration was approximately 2.5 in.\(^2\) (16.1 cm\(^2\)).

The seductive details booklet contained the base passage described above along with 150 additional words (referred to as seductive text) and six captioned color photographs (referred to as seductive illustrations) intended to make the passage more interesting. The middle column of Figure 1 lists the sentences that were incorporated into the passage in order to add one or two seductive details into each paragraph. The sentences containing seductive details were carefully chosen for their ability to flow within the base passage and were adapted from an article on lightning in National Geographic (Newcott, 1993). The six lightning-related color photographs (seductive illustrations) were also adapted from the National Geographic article on lightning (Newcott, 1993) and are shown in the right column of Figure 1. For example, one of the photographs showed a young football player who had been struck by lightning gazing at his burned uniform. Each seductive illustration was approximately 2.5 in.\(^2\) (16.1 cm\(^2\)). The captions for these pictures were taken directly from the seductive text described above. Each seductive illustration and its caption was positioned to the right of the paragraph to which it was marginally related.

The base-passage-plus-highlighting booklet was identical to the base booklet described above, except that nine important idea units (i.e., the definition of lightning plus the eight links in the causal chain) were highlighted by being printed in a bold, italicized font. The nine highlighted idea units were the following: (a) “lightning can be defined as the difference in electrical charges between the cloud and the ground,” (b) “warm moist air rises,” (c) “water vapor condenses and forms a cloud,” (d) “raindrops and ice crystals fall,” (e) “air is dragged from the top of the cloud downward,” (f) “negatively charged particles fall to the bottom of the cloud,” (g) “two leaders meet,” (h) “negatively charged particles rush from the cloud to the ground,” and (i) “positively charged particles rush from the ground upward along the same path.”

The seductive-details-plus-highlighting booklet was identical to the seductive details booklet described above except that nine important idea units were highlighted by using bold, italicized print, also described above.

The recall sheet consisted of a single 8.5 x 11 in. (21.6 x 27.9 cm) page and had the following instruction typed at the top: “Please write down everything you can remember from the passage.” Typed at the bottom of the sheet was the instruction: “Please keep working until instructed to stop.”

Each of the four problem-solving sheets contained one of the four following questions typed at the top of a single 8.5 x 11 in. (21.6 x 27.9 cm) page: (a) “Suppose you see clouds in the sky, but no lightning. Why not?” (b) “What does air temperature have to do with lightning?” (c) “What could be done to decrease the intensity of a lightning storm?” and (d) “What causes lightning?” The following reminder was typed at the bottom of each sheet: “Please keep working until instructed to stop.”

Procedure. The participants were tested individually in groups of 1-5 per session, with each participant seated in a separate cubicle. The participants were randomly assigned to one of four treatment groups, with all participants within a session receiving the same treatment. First, the participants filled out the participant questionnaire at their own rate.

Second, they were informed that they would be reading a
four-page passage about lightning. The participants were told to read carefully and that after they had finished they would be asked a series of questions based on the reading. They were asked not to make any marks within the booklet as they read and were informed that they would be given 6.5 min to read the passage. Then, each participant was given the booklet corresponding to his or her treatment group and was told to begin reading. All students finished reading the booklet before time was called.

Third, after 6.5 min had passed, the booklets were collected and each participant was given a recall sheet. They were told that they would have 6 min to write down everything they could remember from the passage and that they need not be concerned with spelling, neatness, nor writing style. The participants were alerted when there were 30 s remaining in the 6-min period. After 6 min had passed, the recall sheets were collected.

Fourth and finally, the participants were given the four problem-solving sheets, one at a time. They were given 2.5 min to work on each sheet, along with a warning when there were 20 s remaining. The order in which the sheets were handed out was counterbalanced to minimize any order effects. As each sheet was given, the participants were instructed to write down as many solutions to the problem as possible and were reminded that they would have 2.5 min to answer the question. After the participants spent 2.5 min on one sheet, it was collected and another sheet handed out, along with a repetition of the instructions. After the fourth and final sheet had been collected, the participants were thanked and dismissed.

Results

Scoring. Each participant's knowledge of meteorology was scored by tallying the number of six weather-related items checked on the participant questionnaire and adding the participant's self-rating of weather knowledge (with 1 as very little and 5 as very high), yielding a possible score ranging from 0 to 11. Only students with weather knowledge scores of 8 or below were included in this study, because on the basis of previous studies scores above 8 are considered to indicate high knowledge of meteorology (Harp & Mayer, 1997; Mayer et al., 1995).

For the recall tasks and the problem-solving task, two independent raters scored each protocol and reached an initial interrater reliability rating of $r = .98$. In the few cases where the raters' scores were different, the raters discussed the participant's answer until an agreement was reached. In no case did the raters fail to reach an agreement. The recall performance of each participant was scored by tallying the number of causal chain idea units recalled. Using a scoring system similar to that used by Mayer et al. (1995) and Harp and Mayer (1997), the recall score for the important information task was determined by assigning 1 point for each of the nine causal chain idea units labeled (i) through (i) in the previous section. For each participant, the total number of idea units recalled was tallied, yielding a possible score ranging from 0 to 9 points.

For secondary analysis of the recall task, 1 point was assigned for each of the following 12 seductive details, in any order and not necessarily verbatim, that each participant included on their recall sheet: (a) “every year approximately 150 Americans are killed by lightning,” (b) “swimmers are sitting ducks for lightning,” (c) “water is an excellent conductor of this electrical discharge,” (d) “when flying through updrafts, an airplane ride can become bumpy,” (e) “metal airplanes conduct lightning, but sustain little damage,” (f) “when lightning strikes the ground fulgurites may form,” (g) “scientists sometimes create lightning by launching tiny rockets into overhead clouds,” (h) “golfers are prime targets of lightning strikes,” (i) “approximately 10,000 Americans are injured by lightning every year,” (j) “lightning struck a high school football player during practice,” (k) “tore a hole in his helmet, burned his jersey, and blew off his shoes,” and (l) “more than a year later, the young man still won’t talk about his near death experience.” For each participant, the number of seductive details recalled was tallied, yielding a possible score ranging from 0 to 12 points.

The problem-solving performance of each participant was scored by tallying the number of acceptable solutions generated. Using a system similar to that used by Mayer et al. (1995) and Harp and Mayer (1997), 1 point was assigned for each acceptable answer written by each participant, and the points were tallied across all four problem-solving questions. Because participants may have written more than one acceptable answer for each question, the possible problem-solving score for each participant ranged from 0 to an open-ended number of points. To aid in scoring, a list of acceptable and unacceptable answers was generated for each of the four problem-solving questions. Answers were judged as acceptable if they were hypothetically correct solutions (regardless of feasibility) that could have been inferred from the passage about lightning.

For instance, examples of acceptable answers for the question asking why there may be no lightning when there are clouds in the sky included that the tops of the clouds may not be high enough to freeze or that there may not be enough moisture in the air. An example of an unacceptable answer for this question is that there actually is lightning in the sky, but it is not bright enough to be seen. For the question asking how the intensity of a lightning storm could be decreased, acceptable answers included heating the clouds so that ice crystals cannot form or adding positive ions to the bottom of the cloud to balance out the charges within the cloud. An unacceptable answer for this question is that people should avoid lightning-prone areas. Acceptable answers for the question asking what air temperature has to do with lightning included that the air must be cooler than the ground or that the top of the cloud must be cooler than the bottom. An example of an unacceptable answer for this question is that lightning only occurs when it is cold outside. For the question asking what causes lightning, acceptable answers included a difference in charge between the positively charged top and negatively charged bottom of a cloud or a difference in charge between a negative charge in the cloud and a positive charge on the ground. An example of an unacceptable answer, albeit a popular one for this question, is that lightning is caused by clouds bumping into one another.

Issue 1: Do students reading passages with seductive details recall more or fewer important idea units than students reading passages without seductive details? Given that we were interested in reducing the seductive details...
effect, a preliminary question is whether the seductive details effect on recall was evident in this experiment. The top panel of Figure 2 shows the mean number of important idea units, out of a total possible of nine, recalled by each of the four groups. A two-way analysis of variance (ANOVA) indicated that students who read passages with seductive details recalled significantly fewer important idea units ($M = 1.73, SD = 1.36$) than those who read passages without seductive details ($M = 4.26, SD = 1.64$), $F(1, 77) = 54.33, MSE = 2.34, p < .001$. These results are consistent with the hypothesis that seductive details interfere with students' recall of important information and replicate findings of the seductive details effect (e.g., Garner et al., 1989; Harp & Mayer, 1997).

**Issue 2:** Do students who read highlighted passages recall more or fewer important idea units than students who read passages with no highlighting? If highlighting the important information helps readers to pay more attention to the main ideas, then a main effect of highlighting can be predicted. Contrary to this prediction, the top panel of Figure 2 shows that there was no significant difference in the number of important idea units recalled among students who read passages with the important material highlighted ($M = 2.90, SD = 2.12$) and those who read the passage without highlighting ($M = 3.10, SD = 1.85$), $F(1, 77) = 0.38, MSE = 2.34, ns$. There was no significant difference in the number of seductive details recalled by groups who read the seductive details passage with no highlighting ($M = 5.59, SD = 2.12$) and those who read the seductive-details-plus-highlighting passage ($M = 4.95, SD = 2.84$), $t(36) = 0.76$, ns. These results are inconsistent with those of Lorch et al. (1995) and are inconsistent with the hypothesis that highlighting important information helps readers to select and later to recall important material contained in a passage.

**Issue 3:** Does highlighting important material reduce the seductive details effect on the retention of important information? A major new issue addressed by Experiment 1 is whether or not highlighting important material reduces the seductive details effect on students' recall of important ideas. The top panel of Figure 2 shows that there was no interaction between seductive details and highlighting for recall of important idea units, $F(1, 77) = 0.86, MSE = 2.34, ns$. Students who read the highlighted seductive details passage recalled fewer structurally important ideas ($M = 2.00, SD = 1.58$) than students who read the highlighted base passage ($M = 4.21, SD = 1.41$). A similar difference in recall scores was found for students who read the seductive details passage with no highlighting ($M = 1.47, SD = 1.01$) and students who read the base passage with no highlighting ($M = 4.32, SD = 1.95$). These results are inconsistent with the distraction hypothesis and consistent with the diversion hypothesis.

**Issue 4:** Do students who read passages with seductive details generate more or fewer problem-solving solutions than those who read passages without seductive details? Before examining techniques for reducing the seductive details effect, we must first examine whether the seductive details effect on transfer was evident in this experiment. The seductive details hypothesis predicts a main effect of seductive details in that the inclusion of seductive details in a passage should result in readers performing worse on the transfer test than those reading the passage without seductive details. The bottom panel of Figure 2 shows the mean number of solutions generated across the four problem-solving questions. As predicted, a two-way ANOVA revealed that students who read passages containing seductive details generated significantly fewer solutions ($M = 1.78, SD = 1.26$) than those who read passages without seductive details ($M = 4.55, SD = 1.99$), $F(1, 77) = 52.83, MSE = 2.91, p < .001$. This finding replicates that of Harp and Mayer (1997), showing that seductive details have a damaging effect on problem-solving performance and is consistent with the seductive details hypothesis.

**Issue 5:** Do students who read highlighted passages generate more or fewer solutions on the transfer test than those who read passages without highlighting? If highlighting the main ideas contained in a passage helps readers to select and attend to the important information, then those who read highlighted passages should generate more solutions to the transfer questions than those who read the passage with no highlighting. Contrary to this prediction, there was no main effect of highlighting on the number of problem-solving solutions generated. As shown in the bottom panel of Figure 2, students who read highlighted
passages did not generate significantly more solutions \((M = 3.24, SD = 2.25)\) than those who read passages with no highlighting \((M = 3.09, SD = 2.10)\), \(F(1, 77) = 0.17, MSE = 2.91, ns\).

**Issue 6: Does highlighting main ideas reduce the seductive details effect on problem solving?** An important new question addressed in Experiment 1 is whether highlighting reduces the seductive details effect on students' transfer performance. If highlighting the main ideas reduces the seductive details effect on problem solving, then an interaction is predicted in which the difference in problem-solving performance between the seductive-details-passage-plus-highlighting group and the base-passage-plus-highlighting group should be smaller than the difference between the seductive-details-passage group and the base-passage group. Contrary to this prediction, there was no interaction between seductive details and highlighting on the number of solutions generated on the transfer test, \(F(1, 77) = 0.07, MSE = 2.91, ns\). The bottom panel of Figure 2 shows that students who read seductive-details-plus-highlighting passage performed worse \((M = 1.90, SD = 1.37)\) on the transfer test than students who read the highlighted base passage \((M = 4.58, SD = 2.15)\). A similar difference was found between the group that read the seductive details passage with no highlighting \((M = 1.65, SD = 1.11)\) and the group that read the base passage with no highlighting \((M = 4.53, SD = 1.84)\). These results do not support the distraction hypothesis but are consistent with the disruption hypothesis and the diversion hypothesis.

**Discussion**

First, the results of Experiment 1 replicated previous findings of the seductive details effect on recall (i.e., Garner et al., 1989; Harp & Mayer, 1997) and replicated findings of the seductive details effect on transfer (Harp & Mayer, 1997). Second, these results do not indicate that typographical highlighting helped students to retain or transfer the main ideas in the lightning passage. Third, these results show that highlighting structurally important ideas contained in a passage did not counter the seductive details effect. Taken together, these results cast serious doubt on the distraction hypothesis.

That typographical cues were not helpful in guiding readers' selection processes is in contrast to past research (Golding & Fowler, 1992; Lorch et al., 1995). However, it should be noted that the typographical cues used in Experiment 1, namely bold, italicized print, were different from the cue type used in past experiments, such as capitalization or underlining. Therefore, the lack of an effect obtained by highlighting in Experiment 1 may be explained in one of three ways. One explanation may be that bold, italicized print is simply not an effective typographical cue for guiding college-level readers' selection of material. Alternatively, it may be argued that bold, italicized print is an effective guidance tool but not effective enough to overcome the seductive details effect. Lastly, it may be that highlighting important text did not reduce the seductive details effect because the distraction theory is incorrect. In short, it is possible that the seductive details effect is not caused by a failure to select relevant information. To further explore whether seductive details serve to distract the reader, Experiment 2 used a stronger means to guide students' selection processes as they read.

**Experiment 2**

Experiment 2 used learning objectives in an attempt to guide students' selection of information. There is a substantial research base showing that informing students of specific learning objectives, such as providing questions they are expected to be able to answer, helps them to pay attention to the material contained in a lesson that is relevant to the learning goals (e.g., Boker, 1974; Mayer, 1975; Rothkopf, 1966; Sagaria & DiVesta, 1978).

Students in Experiment 2 read a scientific explanation about the formation of lightning that either contained or did not contain seductive details. Some students in each group were told prior to reading the passage that they should be looking for the steps involved in the formation of a flash of lightning and that they would be expected to be able to explain what causes lightning after reading the passage, whereas other students did not receive these additional instructions. After reading the passage, all students took tests of recall and problem solving.

The distraction hypothesis states that seductive details do their damage by distracting the reader's selection processes away from the important material. This hypothesis predicts that a statement of learning objectives will be helpful in reducing the seductive details effect on recall, because learning objectives should help students to select the important information contained in the passage. However, because simply selecting information does not imply that a reader understands the material, the distraction hypothesis cannot predict problem-solving performance.

The disruption hypothesis states that seductive details are damaging because they disrupt the coherence of a passage. According to this hypothesis, seductive details interfere with the building of a coherent mental representation of the text. Informing students that their goal is to be able to explain the cause of lightning should help them to overcome the disruption of the text. Telling students to look for the major steps leading to lightning should assist them in mentally organizing the important ideas, which should in turn help them to see the relations among the causal steps involved in the formation of lightning. If this hypothesis is correct, students who read a passage containing seductive details along with a statement of learning objectives should be less influenced by the seductive details and be more able to effectively organize the important material. As a result, students reading seductive details passages should perform better on the transfer test if they are given learning goals as opposed to if they are not given goals. However, the disruption hypothesis does not make a prediction regarding the recall of important ideas, because taken as a separate process, mentally rearranging the important material does not imply improved recall of that material.

Alternatively, the diversion hypothesis states that seduc-
tive details prime inappropriate prior knowledge with which to integrate new information. This hypothesis predicts that a statement of learning objectives will not reduce the seductive details effect on either recall or on transfer performance. Although providing learning objectives may help readers to select and organize the important ideas, there is no evidence that suggests that statements of learning objectives activate an appropriate base of prior knowledge. According to the diversion hypothesis, students who read seductive details passages will persist in organizing and integrating the seductive details in addition to the important information, because the seductive details within a passage will continue to activate inappropriate prior knowledge. The diversion hypothesis predicts that, whether or not a statement of learning objectives is given, students who read seductive details passages will perform more poorly on measures of recall and transfer than those reading passages without seductive details. These predictions are summarized in the 3rd column (Learning objectives) of Table 1.

Method

Participants and design. The participants were 83 undergraduate students recruited from the same population as in Experiment 1. Each participant served in one cell of a $2 \times 2$ between-subjects factorial design, with the first variable being seductive details (present or absent) and the second variable being whether or not learning objectives were given prior to reading. There were 22 participants in the base-passage group, 20 in the base-passage-plus-learning-objective group, 19 in the seductive details passage group, and 22 in the seductive-details-plus-learning-objectives group. Comparisons were made among the four groups on measures of recall and problem-solving performance.

Materials. The materials included the same participant questionnaire, base-passage booklet (with no highlighting), seductive details booklet (with no highlighting), recall sheet and four problem-solving sheets as used in Experiment 1. The learning objectives consisted of the following: "Your goal while reading is to learn about what causes lightning. While reading you should be looking for the steps involved that lead to a flash of lightning. After reading you will be asked to explain how lightning works."

Procedure. The procedure was the same as in Experiment 1, except that prior to reading the booklets, the experimenter read the learning objectives aloud for those participating in the base-passage-plus-learning-objectives group and those in the seductive-details-plus-learning-objectives group. As in Experiment 1, the base-passage group read the base passage, and the seductive details group read the seductive details passage; neither group received learning objectives prior to reading their respective passage.

Results

Scoring. Each participant's recall performance and problem-solving performance were scored as in Experiment 1. Two independent raters reached an initial agreement of $r = .97$. Any discrepancies in scoring were then discussed until an agreement was reached.

Issue 1: Do students reading passages with seductive details recall more or fewer important idea units than students reading passages without seductive details? Before examining whether learning objectives reduce the seductive details effect, it is necessary to determine whether the seductive details effect on recall occurred in this experiment. The top panel of Figure 3 shows the mean number of important idea units (out of a total possible of nine) recalled by each group. A two-way ANOVA revealed that students who read passages with seductive details recalled significantly fewer important idea units ($M = 1.95$, $SD = 1.39$) than those who read passages without seductive details ($M = 4.78$, $SD = 1.97$), $F(1, 79) = 57.05$, $MSE = 2.85$, $p < .001$. These results are consistent with the hypothesis that seductive details interfere with students' recall of important information and replicate past findings of the seductive details effect (e.g., Garner et al., 1989; Harp & Mayer, 1997).

Issue 2: Do students given learning objectives recall more or fewer important idea units than students who did not receive learning objectives? Past research and theory on learning objectives suggests that giving students specific learning objectives prior to reading should help them to pay attention to the main ideas contained in a lesson that are relevant to the learning goals (e.g., Mayer, 1975; Sagaria & DiVesta, 1978). In this experiment, the top panel of Figure 3 shows that students who received learning objectives re-
called significantly more important idea units \( (M = 3.76, SD = 2.20) \) than those who did not receive learning objectives \( (M = 2.99, SD = 2.17) \), \( F(1, 79) = 4.19, MSE = 2.85, p < .05 \). There was no significant difference in the number of seductive details recalled by groups who read the seductive details passage with no learning objectives \( (M = 5.86, SD = 2.11) \) and those who read the seductive details passage along with a statement of learning objectives \( (M = 4.41, SD = 2.89) \), \( t(39) = 1.59, ns \). These results are consistent with the hypothesis that learning objectives help readers to pay attention to material in a passage that is relevant to the learning goal.

**Issue 3: Does providing learning objectives reduce the seductive details effect on the retention of important information?** A principal new question addressed in Experiment 2 is whether giving students a learning goal reduces the seductive details effect. If giving learning objectives prior to reading successfully reduces the seductive details effect, then students who receive learning objectives before reading the seductive details passage should show a larger improvement on the retention test than those who receive learning objectives prior to reading the base passage. Contrary to this prediction, the top panel of Figure 3 shows that there was no interaction between seductive details and learning objectives for recall of important idea units, \( F(1, 79) = 0.04, MSE = 2.85, ns \). In comparing the recall performance of students who were given learning objectives, those who read passages with seductive details recalled fewer important idea units \( (M = 2.32, SD = 1.43) \) than students who read passages with no seductive details \( (M = 5.20, SD = 1.91) \). However, a similar difference in retention scores was found for students who did not receive learning objectives in that those who read the seductive details passage recalled fewer main ideas \( (M = 1.63, SD = 1.30) \) than those who read the passage with no seductive details \( (M = 4.36, SD = 1.99) \). These results are inconsistent with the distraction hypothesis but are consistent with the diversion hypothesis.

**Issue 4: Do students who read passages with seductive details generate more or fewer problem-solving solutions than those who read passages without seductive details?** Before determining whether the seductive details effect can be reduced, a preliminary issue is whether the seductive details effect on transfer was evident in this experiment. The bottom panel of Figure 3 shows the mean number of solutions generated across the four problem-solving questions. A two-way ANOVA revealed that students who read passages containing seductive details generated significantly fewer solutions \( (M = 2.39, SD = 1.36) \) than those reading passages without seductive details \( (M = 4.71, SD = 1.83) \), \( F(1, 79) = 48.56, MSE = 2.28, p < .001 \). This result replicates Harp and Mayer's (1997) finding that seductive details have a detrimental effect on problem solving and is consistent with the seductive details hypothesis.

**Issue 5: Do students given learning objectives generate more or fewer solutions on the transfer test than those who do not receive learning objectives?** If giving readers a learning goal helps students to focus on the important main ideas contained in a lesson, then those given learning objectives prior to reading should generate more solutions to transfer questions than those who are not given learning objectives. As predicted, a two-way ANOVA revealed a significant main effect for learning objectives in that there was an overall improvement in transfer scores for those who received learning objectives as opposed to those who did not. The bottom panel of Figure 3 shows that students who received learning objectives generated significantly more solutions \( (M = 4.12, SD = 2.08) \) than students who did not receive learning objectives \( (M = 2.98, SD = 1.71) \), \( F(1, 79) = 11.63, MSE = 2.28, p < .001 \). This finding is consistent with past research and theory that giving students learning goals encourages them to pay more attention to the important ideas and to better understand a science passage (e.g., Boker, 1974; Mayer, 1975; Sagaria & DiVesta, 1978).

**Issue 6: Does providing learning objectives reduce the seductive details effect on problem solving?** A major new issue explored in Experiment 2 is whether or not a statement of learning objectives helps to reduce the seductive details effect on transfer. There was no interaction between seductive details and learning objectives on the number of solutions generated on the transfer test, \( F(1, 79) = 1.90, MSE = 2.28, ns \). The bottom panel of Figure 3 shows that students who read the seductive details passages along with a statement of learning goals performed worse on the transfer test \( (M = 2.73, SD = 1.49) \) than students who were given learning objectives prior to reading the base passage \( (M = 5.50, SD = 1.64) \). Similarly, students who read the seductive details passage with no specific learning goal performed worse \( (M = 2.05, SD = 1.13) \) than students who read the base passage with no specific learning goal \( (M = 3.91, SD = 1.69) \). Thus, giving learning objectives helped students to generate equally as many more solutions whether they read the base passage or the seductive details passage. These results do not support the disruption hypothesis as an explanation for why seductive details damage problem-solving ability. However, these findings are consistent with the diversion hypothesis, which predicted that learning objectives should not reduce the seductive details effect.

**Discussion**

The results of Experiment 2 replicated past findings of the seductive details effect on recall (e.g., Garner et al., 1989). As was found in Experiment 1, students who read passages containing seductive details recalled fewer structurally important ideas than those who read passages without seductive details. These results also replicated past findings of the seductive details effect on transfer performance (Harp & Mayer, 1997). Students who read passages with seductive details were less able to generate transfer solutions than were students who read passages that did not contain seductive details. As predicted, the provision of explicit learning objectives prior to reading a scientific explanation helped students to recall a greater number of main ideas and to generate more transfer solutions than when learning objectives are not given. These results are consistent with past findings that adjunct questions can focus readers'
attention when given prior to reading a lesson (e.g., Boker, 1974; Sagaria & DiVesta, 1978).

The findings of Experiment 2 are largely inconsistent with the distraction hypothesis and consistent with the diversion hypotheses, because giving a statement of learning objectives prior to presenting the passage did not reduce the seductive details effect. Although the findings of Experiment 2 are inconsistent with the distraction hypothesis, it is not clear that a simple statement of learning goals actually helps students to understand the relations among the steps in a causal chain system. Experiment 3 addresses this issue in a more direct manner.

**Experiment 3**

Experiments 1 and 2 examined whether guiding students’ selection processes results in reducing the seductive details effect. The results obtained do not support the hypothesis that the seductive details effect is caused by a failure to select relevant information and therefore do not support the distraction hypothesis. Experiment 3 explores the distraction hypothesis by examining whether guiding students’ organization of the material reduces the seductive details effect.

For a reader to understand how a causal system works, he or she must first recognize that all the steps in the process are related. Readers encountering seductive details may have trouble noticing that a causal system’s individual steps are related in a causal chain. Seductive details may do their damage by interrupting the presentation of the steps of the causal system, thereby making it difficult for the student to build a coherent mental model of the system explained in the lesson.

One way to help students to better organize the main ideas of a lesson is to provide organizational tools such as preview outlining and signaling within the passage (Dixon & Glover, 1990; Loman & Mayer, 1983; Meyer, 1975; Meyer, Brandt, & Bluth, 1980). If seductive details are damaging because they disrupt the coherence of the passage, then it may be possible to reduce the seductive details effect by using organizational signals, such as preview sentences and number signals, within a passage that contains seductive details. Both types of signals were used in Experiment 3, because these two types of signals used in combination have been shown to result in the greatest increase in recall and transfer of material targeted by the signals (e.g., Dixon & Glover, 1990; Loman & Mayer, 1983). In Experiment 3, college students read a passage about the cause of lightning with or without seductive details and with or without organizational signals. After reading their respective passages, the four groups were tested on measures of recall and problem solving.

The distraction hypothesis states that readers attend to seductive details rather than the main ideas contained in a passage. If this is true, then explicitly signaling the steps involved in the formation of lightning should help the reader to attend to these ideas and should therefore reduce the seductive details effect on retention. As a result, students reading the text with signals should recall more main ideas than those reading text without signals. However, taken as a separate process, increased attention to main ideas does not imply that the reader has gained an understanding of the material, so the distraction hypothesis makes no prediction for problem-solving performance.

The distraction hypothesis states that seductive details interrupt the cohesive presentation of the causal chain, thereby precluding readers from building a useful mental model of the system explained in the passage. Explicit signaling of the steps in the causal chain should assist the reader in building connections among the steps. Signaling should help the reader to notice that the steps are related as well as how they fit together in the system as a whole. In addition, the students reading signaled passages may use the signals as retrieval cues when recalling the steps (Dixon & Glover, 1990). Therefore, the distraction hypothesis predicts that the seductive details effect on recall and on transfer should be reduced. According to this hypothesis, students who read the signaled seductive details passage should perform better on the retention test and on the transfer test than those who read the nonsignaled seductive details passage.

Alternatively, the diversion hypothesis states that seductive details within a passage serve to prime inappropriate prior knowledge with which to integrate new information. This hypothesis predicts that signaling the main ideas will not reduce the seductive details effect on either recall or transfer of main ideas, because organizational signals are not known to activate useful prior knowledge with which to integrate new information. These predictions are summarized in the 4th column (Signals) of Table 1.

**Method**

*Participants and design.* The participants were 96 students recruited from the same population as in Experiments 1 and 2. Each participant served in one cell of a 2 X 2 between-subjects factorial design, with seductive details (present or absent) being the first variable and organizational signaling (present or absent) as the second variable. There were 23 participants in the base-passage group, 25 in the base-passage-plus-signals group, 24 in the seductive-details-passage group, and 24 in the seductive-details-plus-signals group. Comparisons were performed among the four groups on measures of recall and problem solving.

*Materials.* The materials included the same participant questionnaire, base-passage booklet, seductive details booklet, recall sheet, and four problem-solving questions as used in Experiments 1 and 2. The materials also included two additional instructional booklets: A base-passage-plus-signals booklet and a seductive-details-plus-signals booklet.

The base-passage-plus-signals booklet was identical to the base passage used in Experiments 1 and 2, except that organizational signaling was added. To assist the reader in organizing the structure of the text, the following preview sentences were added to the first paragraph: “There are 7 main steps leading to the formation of lightning. Each of the steps is related to one another, in that one step causes the next to occur. These steps will be marked for you in the text below.” Also in the first paragraph, the word Definition was inserted preceding the sentence containing the definition of lightning. Further signaling was added throughout the remaining text by numbering the steps as they were presented. For example, the first major step was signaled as follows: “(1) moist air near the surface of the earth becomes heated and rises.” In this way the definition
and each of the eight causal chain idea units (as described in Experiment 1) was signaled, for a total of nine signals. Corresponding signaling was also inserted in the captions of the explanatory illustrations, such as Definition in the first caption and Step 1 in the second caption. The seductive-details-plus-signals booklet was the same as the seductive details passage as used in Experiments 1 and 2, with the addition of the signals as described above.

Procedure. The procedure was the same as we used in Experiments 1 and 2 except that the base-plus-signals group read the base-passage-plus-signals booklet and the seductive-details-plus-signals group read the seductive-details-plus-signals booklet. The base group read the base passage and the seductive details group read the seductive details passage, as in Experiments 1 and 2.

Results

Scoring. Each participants' recall and problem-solving performances were scored as in Experiments 1 and 2. Two independent raters scored each protocol, reaching an initial agreement of r = .98. As in Experiments 1 and 2, any scoring discrepancies between the raters were discussed until an agreement was reached.

Issue 1: Do students reading passages with seductive details recall more or fewer important idea units than students reading passages without seductive details? As in Experiments 1 and 2, a preliminary issue in Experiment 3 is to determine whether there is evidence for the seductive details effect on recall. The top panel of Figure 4 shows the mean number of important idea units recalled by the participants (out of a total possible of nine). A two-way ANOVA revealed that students who read passages with seductive details recalled significantly fewer important idea units (M = 1.69, SD = 1.59) than those who read passages without seductive details (M = 4.64, SD = 2.11), F(1, 92) = 58.77, MSE = 3.55, p < .001. These results are consistent with the hypothesis that seductive details interfere with students' recall of important information and replicate past findings of the seductive details effect (e.g., Garner et al., 1989; Harp & Mayer, 1997).

Issue 2: Do students who read signaled passages recall more or fewer important idea units than students who read nonsignaled passages? Past research has consistently shown that students who read text with target ideas signaled recall more of the target ideas than those who read nonsignaled text (e.g., Dixon & Glover, 1990; Loman & Mayer, 1983; Lorch, Lorch, & Inman, 1993). Contrary to these results, the top panel of Figure 4 shows that there was no significant difference for the recall of main ideas among students who read signaled passages (M = 3.25, SD = 2.65) and those who read nonsignaled passages (M = 3.07, SD = 2.20), F(1, 92) = 0.22, MSE = 3.55, ns. There was no significant difference in the number of seductive details recalled by groups who read the nonsignaled seductive details passage (M = 4.46, SD = 2.64) and those who read the signaled seductive details passage (M = 4.79, SD = 2.08), t(46) = 0.48, ns.

Issue 3: Does organizational signaling of the main ideas in a passage reduce the seductive details effect on the recall of main ideas? A major new question addressed in Experiment 3 is whether or not organizational signaling within a passage reduces the seductive details effect on the recall of important main ideas. A two-way ANOVA revealed no interaction between signaling and seductive details on the retention of main ideas, F(1, 92) = 0.64, MSE = 3.55, ns. The top panel of Figure 4 shows that students who read the nonsignaled seductive details passage performed worse on the retention test (M = 1.75, SD = 1.33) than those who read the nonsignaled base passage (M = 4.39, SD = 2.13). A similar difference in scores was found among students who read signaled passages. Students who read the signaled seductive details passage (M = 1.63, SD = 1.84) performed worse on the retention test than those who read the signaled base passage (M = 4.88, SD = 2.13).

Apparently, inserting organizational signals in passages with seductive details does not help students to attend to the signaled ideas, which is inconsistent with the distraction hypothesis. Also, the number signals did not seem to be useful as organizational retrieval cues, which is inconsistent with the disruption hypothesis. The results are, however, consistent with the diversion hypothesis, which predicted that the use of signals would not reduce the seductive details effect on recall of structurally important ideas.

Issue 4: Do students who read passages with seductive details generate more or fewer solutions on the transfer test than students who read passages with no seductive details? As in Experiments 1 and 2, a preliminary question in this experiment is whether the seductive details effect on transfer
was evident. The bottom panel of Figure 4 shows the mean number of solutions generated by each group across the four problem-solving questions. As predicted, a two-way ANOVA revealed a significant main effect for seductive details. Students who read seductive details passages produced significantly fewer solutions to the transfer questions ($M = 2.23$, $SD = 1.51$) than those who read the passages without seductive details ($M = 4.40$, $SD = 1.91$), $F(1, 92) = 38.16$, $MSE = 2.97, p < .001$. This finding is consistent with the seductive details hypothesis and provides replication of the seductive details effect on transfer performance (Harp & Mayer, 1997).

**Issue 5: Do students who read signaled passages generate more or fewer solutions on the transfer test than students who read nonsignaled passages?** Past research and theory on the use of signals indicates that students who read passages that include preview sentences and number signals understand the passage better than those who read the same passage without signals, as measured by their ability to solve problems on the basis of what they read (Loman & Mayer, 1983). Therefore, a main effect for signals was predicted, such that students who read signaled versions of the lightning passage should perform better on the transfer test than those who read nonsignaled versions. The bottom panel of Figure 4 shows that, contrary to this prediction, there was no significant difference in the number of problem-solving solutions generated by those who read signaled passages ($M = 3.47$, $SD = 2.19$) and those who read nonsignaled passages ($M = 3.17$, $SD = 1.86$), $F(1, 92) = 0.71$, $MSE = 2.97, ns$. This result is inconsistent with past findings (Loman & Mayer, 1983) and is inconsistent with the hypothesis that the use of organizational signals improves problem-solving performance.

**Issue 6: Does organizational signaling reduce the seductive details effect on transfer?** One of the principal new issues addressed in Experiment 3 is whether the use of signals reduces the seductive details effect on problem solving. A two-way ANOVA showed that there was no interaction between signals and seductive details on the number of solutions generated on the transfer test, $F(1, 92) = 0.92$, $MSE = 2.97, ns$. The bottom panel of Figure 4 shows that students who read the signaled seductive details passage performed significantly worse on the transfer test ($M = 2.21$, $SD = 1.47$) than those who read the signaled base passage ($M = 4.72$, $SD = 2.07$). However, a similar difference in scores was found between those who read nonsignaled passages. Students who read the nonsignaled seductive details passage performed significantly worse than those who read the nonsignaled base passage ($M = 2.25$, $SD = 1.57$) than those who read the nonsignaled base passage ($M = 4.09$, $SD = 1.70$).

The lack of an interaction is inconsistent with the hypothesis that helping students to better organize a scientific passage will help them to overcome the negative effects of seductive details. The use of explicit signaling, such as preview sentences and number signals, did not reduce the seductive details effect on student's transfer performance. Therefore, these findings contradict the predictions of the disruption hypothesis. However, as in Experiments 1 and 2, these results are consistent with the diversion hypothesis, which predicted that signals would not reduce the seductive details effect on transfer.

**Discussion**

The results of Experiment 3 replicate past findings of the seductive details effect (e.g., Garner et al., 1989; Harp & Mayer, 1997). As was found in Experiments 1 and 2, students were less able to recall structurally important ideas and were less able to generate transfer solutions after reading the lightning lesson containing seductive details as compared with students who read the same lesson without seductive details. This experiment has also shown that the use of organizational signals to foster the building of internal mental representations of a causal system was not helpful in reducing the seductive details effect on recall nor on problem solving.

The results obtained in Experiment 3 provide further evidence against the distraction hypothesis, because explicit signaling of the main ideas in passages containing seductive details failed to help readers to overcome the seductive details effect. These results are also largely inconsistent with the disruption hypothesis, because signaling the steps and their relations in the causal chain leading to a flash of lightning did not help students to better understand the relationships among the steps, as evidenced by their poor problem-solving performance.

That signaling had no effect on improving students’ recall or transfer performance is inconsistent with past research findings (e.g., Dixon & Glover, 1990; Loman & Mayer, 1983). The use of signals in the passage about lightning may have been ineffective in increasing students’ recall and transfer performance because the original text, without signals, was already written in a well-organized fashion. As noted by Lorch and Lorch (1996), organizational signals have little effect on students’ recall when the text’s topic structure is simple. However, this explanation does not account for why signaling had no effect on those who read the seductive details passage, which was not well-organized because of the seductive details. A more parsimonious explanation may be that the disruption hypothesis is incorrect.

As in Experiments 1 and 2, the results of Experiment 3 are consistent with the predictions of the diversion hypothesis. If activation of an inappropriate base of prior knowledge is indeed responsible for the seductive details effect, then it is not surprising that attempts to guide students’ selection processes to important ideas and attempts to help students to better organize the passage had no effect on reducing the damage caused by seductive details. If the diversion hypothesis is correct, then more radical alterations of the seductive details passage are needed in order to reduce the seductive details effect. Experiment 4 further explores the implications of the diversion hypothesis.

**Experiment 4**

Experiment 4 examines a technique for priming relevant and irrelevant prior knowledge in long-term memory as an
SEDUCTIVE DETAILS

Seductive details within a passage may serve to activate an inappropriate context for the reading, which can alter a reader's perspective about what they are reading. This in turn may activate readers' prior knowledge related to the information contained in the seductive details rather than in the structurally important ideas. This may be particularly true if the reader does not know much about the topic and therefore does not possess adequate prior knowledge with which to relate the structurally important information in the text. In this case, readers may be especially prone to building a representation of the text organized around the seductive details in their attempt to make sense of what they are reading.

Past research and theory on using prior knowledge has shown that context is an important cue that influences what is learned from text (e.g., Bransford & Johnson, 1972; Mannes & Hoyes, 1996; Pichert & Anderson, 1977). For example, students who were given information about the topic before reading a passage tended to rate it as much more comprehensible and recalled more of the passage than students who were given the topic after reading a passage or who were given no topic at all (Bransford & Johnson, 1972). These studies show that it is possible for text to activate readers' prior knowledge and that readers interpret what they read depending on their perspective.

If it is true that seductive details prime an inappropriate context and thus activate inappropriate prior knowledge in the reader, then varying the placement of the seductive details should have an influence on what readers learn and remember from the text. This can be tested by placing all of the seductive details either at the beginning of a passage or by presenting them at the end of a passage. If all the seductive details are presented at the beginning of the lightning passage, then, like Bransford and Johnson's (1972) presentation of the topic, they are even more likely to serve as a prime, if indeed this is their function. In keeping with past findings, placing the seductive details at the end of the passage should result in no priming effect, for by the time the reader encounters the seductive details, the structurally important ideas will have already been processed. Conversely, relevant prior knowledge should be primed in this case, for the structurally important material will have been read first.

In Experiment 4, students read the lightning passage with either no seductive details, or they read seductive details passages with the seductive details placed either at the beginning, interspersed throughout, or at the end of the passage. The four groups were then tested on measures of recall and problem solving.

Seductive Details Placed at the Beginning Versus Interspersed Throughout the Passage

According to the distraction hypothesis, seductive details do their damage by calling attention away from structurally important ideas. If it is true that seductive details are damaging because they are attention grabbing, then it should not make a difference where they are placed in the passage. Therefore, the distraction hypothesis predicts that the seductive details effect on recall will not be reduced if seductive details are placed at the beginning of the passage. As before, the distraction hypothesis makes no prediction regarding transfer performance, because as a separate process, attending to information does not necessarily lead to better problem solving.

Conversely, the disruption hypothesis suggests that as long as the cohesive flow of the causal chain explanation is not disrupted, the reader should experience little difficulty in organizing the main ideas. By removing the seductive details from the body of the passage and placing them at the beginning, the coherence of the causal explanation will be preserved, which should lead to improved internal organization of the material. Therefore, if the seductive details are placed at the beginning of the passage, the seductive details effect on problem solving should be reduced, such that students who read the passage with seductive details at the beginning should generate more transfer solutions than those who read the passage with seductive details interspersed. As before, this hypothesis makes no prediction regarding recall, because as a separate process, improved mental organization of material does not imply better recall.

Alternatively, the diversion hypothesis predicts that early placement of seductive details will exacerbate the seductive details effect on both recall and transfer. If this hypothesis is correct in stating that seductive details do their damage by priming inappropriate prior knowledge, then presenting all of the seductive details first should increase the probability that inappropriate prior knowledge will be activated. As a result, students who encounter seductive details at the beginning of the passage should perform at least as poorly, if not more so, on tests of recall and transfer than students who read the passage with seductive details interspersed throughout. These predictions are summarized in the 5th column (Seductive details before) of Table 1.

Seductive Details Placed at the End of the Passage Versus Interspersed Throughout the Passage

According to the distraction hypothesis, readers select seductive details at the expense of structurally important ideas. This hypothesis predicts that moving the seductive details from the body to the end of the passage should not reduce the seductive details effect on recall. The distraction hypothesis suggests that even though readers will not encounter the seductive details until the end of the passage, they will still allocate extra time and attention to the seductive details. Therefore, the distraction hypothesis predicts that students who read the passage with seductive details presented at the end will perform as poorly on the recall test as those who read the passage with seductive details interspersed. As before, this hypothesis makes no prediction regarding problem solving, for attention alone does not imply an understanding of the material.

The disruption hypothesis suggests that if the coherence of the causal chain explanation is not disrupted, the reader should be able to build an organized mental representation of
the main ideas. Therefore, if the seductive details are removed from the body of the passage and are placed at the end, the seductive details effect on problem solving should be reduced. Because the seductive details are no longer interrupting the presentation of the causal chain, this hypothesis predicts that students who read the passage with seductive details placed at the end will perform better on the transfer test than those who read the passage with seductive details interspersed. As before, this hypothesis makes no prediction regarding recall of main ideas.

According to the diversion hypothesis, placing the seductive details at the end of the passage should reduce the seductive details effect as compared with interspersing the details throughout the passage. The final sentences containing the seductive details should not influence the readers' interpretation of the previously read section of the passage. In this case, the seductive details cannot prime inappropriate prior knowledge as the organizing schema for the lesson, because the lesson will have already been read. Therefore, this hypothesis predicts that students who read the passage with seductive details at the end will perform better on tests of recall and transfer than those who read the passage with seductive details interspersed. These predictions are summarized in the last column (Seductive details after) of Table 1.

Method

Participants and design. The participants were 97 undergraduates recruited from the same population as in Experiments 1, 2, and 3. Using a between-subjects design with four groups, participants read a passage with either no seductive details, seductive details presented at the beginning of the passage, seductive details interspersed throughout the passage, or seductive details presented at the end of the passage. There were 24 participants in the no-seductive-details group, 25 in the seductive-details-first group, 23 in the seductive-details-interspersed group, and 25 in the seductive-details-after group. Comparisons among the four groups were performed on measures of recall and problem solving.

Materials. The materials included the same participant questionnaire, base-passage booklet, seductive details booklet, recall sheet, and four problem-solving sheets as used in Experiments 1, 2, and 3. The materials included two additional instructional booklets: A booklet containing the base-passage with seductive details presented at the beginning and a booklet containing the base-passage with seductive details presented at the end of the passage.

For the booklet with seductive details presented at the beginning of the passage, all of the seductive details described earlier appeared together on three pages immediately preceding the four-page base passage, for a combined total of seven pages. For the booklet with seductive details presented at the end of the passage, all seductive details described earlier appeared together on three pages immediately following the four-page base passage. Each of the three seductive details pages contained two paragraphs of seductive text and two seductive illustrations. Each seductive illustration and its caption appeared to the right of the seductive text paragraph to which it was related.

Procedure. The procedure was the same as the one we used in Experiments 1, 2, and 3, except that the seductive-details-first group read the booklet with all of the seductive details presented at the beginning of the passage and the seductive-details-after group read the booklet with all of the seductive details presented at the end of the passage. The no-seductive-details group read the base passage, and the seductive-details-interspersed group read the seductive details passage, as in Experiments 1, 2, and 3.

Results

Scoring. Each participant's recall and problem-solving performances were scored as in Experiments 1, 2, and 3. Two independent raters scored each protocol (r = .96). As before, after reaching this initial agreement, any scoring discrepancies were discussed until an agreement was reached.

Issue 1: Do students recall more or fewer important idea units depending on where seductive details are placed?

One of the major new questions addressed in Experiment 4 was whether the recall pattern of students who read seductive details passages would change as a result of varying the placement of the seductive details within a passage. The top panel of Figure 5 shows the mean number of main ideas recalled by each of the groups. A one-way ANOVA revealed that there was a significant difference in the number of important idea units recalled among the four groups, F(3, 93) = 16.63, MSE = 3.02, p < .001. Using Tukey's honestly significantly difference (HSD) test with alpha less than .05, it was found that students who read the seductive-details-first passage and the seductive-details-interspersed passage did not differ significantly in the number of important idea units recalled (M = 1.64, SD = 1.66 and M = 1.52, SD = 1.24, respectively). This finding supports both the distraction hypothesis and the diversion hypothesis. However, inconsistent with the distraction hypothesis and consistent with the diversion hypothesis, both of these groups recalled significantly fewer main idea units than did either the group who read the base passage (M = 4.54, SD = 1.79) or the group who read the seductive-details-after passage (M = 3.32, SD = 2.12). Additionally, a critical new finding was that students in the seductive-details-after group performed as well on the recall of main ideas as did those in the base-passage group, indicating that is inconsistent with the distraction hypothesis and consistent with the diversion hypothesis.

Placing the seductive details at the beginning of the passage resulted in poor recall of structurally important ideas. This finding is consistent with past research (e.g., Bransford & Johnson, 1972; Pichert & Anderson, 1977) showing that providing readers with a context before they begin reading can alter their perception of what a passage is about. Conversely, placing the seductive details after the lesson on lightning resulted in students recalling as many of the main ideas as those who read the base passage. This is consistent with the findings of Bransford and Johnson (1972), that providing a context after reading has little influence on what readers remember from the text. This finding supports the hypothesis that seductive details do their damage by confusing the readers as to what a passage is about, so they activate inappropriate prior knowledge. Thus, these results are consistent with the diversion hypothesis and inconsistent with the distraction hypothesis.

Issue 2: Do students recall more or fewer seductive details depending on where seductive details are placed?

The serial position hypothesis states that items read at the
beginning and at the end of a list tend to be recalled better than items in the middle of a list for immediate recall tasks (e.g., Glanzer & Cunitz, 1966). Therefore, because the recall task was immediate, it was expected that more seductive details would be recalled when they were placed at the beginning or the end of the lightning passage than when they were interspersed throughout the passage.

A one-way ANOVA revealed that there was a significant difference in the number of seductive details recalled among the three groups who read seductive details passages, $F(2, 70) = 4.32, MSE = 4.65, p < .02$. In contrast to the predicted U-shaped function, the middle panel of Figure 5 shows a decreasing pattern of recall for the seductive details, with recall being highest when the seductive details are at the beginning of the passage and lowest when the details are placed at the end of the passage. A Tukey’s HSD test (with alpha less than .05) showed that students who read the seductive-details-after passage recalled significantly fewer seductive details ($M = 4.56$, $SD = 2.71$) than those who read the seductive-details-first passage ($M = 6.28$, $SD =$...
When seductive details were interspersed throughout the passage, students' recall of seductive details \((M = 5.87, SD = 1.98)\) was not significantly different from those who read the seductive-details-first passage and was no different from the recall of those who read the seductive-details-after-passage, although this difference approached significance.

Taken together with the findings on the recall of main ideas, there was a trade-off between recall of main ideas and recall of seductive details. When the seductive details were placed at the beginning of the passage, students recalled few of the main ideas but many of the seductive details. This same pattern was evident when the seductive details were interspersed throughout the passage. However, when the seductive details were placed at the end of the passage, students recalled more main ideas and fewer seductive details than the students in the other groups.

**Issue 3: Do students generate more or fewer problemsolving solutions depending on where seductive details are placed?** A principal new issue addressed in Experiment 4 was whether the pattern of students' transfer performance would change as a result of varying the placement of the seductive details within a passage. Although, as before, the distraction hypothesis makes no prediction regarding performance on the transfer test, the disruption hypothesis predicts that the seductive details effect on transfer will be reduced if the seductive details are placed at either the beginning or the end of the passage.

Supporting the seductive details hypothesis, a one-way ANOVA revealed a significant difference in the number of solutions generated among the four groups, \(F(3, 93) = 10.98, MSE = 2.55, p < .001\). The bottom panel of Figure 5 shows that the mean number of solutions generated was highest for students who read the base passage and lowest for those who read passages containing seductive details.

Consistent with the diversion hypothesis and inconsistent with the disruption hypothesis, a Tukey's HSD test (with alpha less than .05) revealed that there was no significant difference in the number of solutions generated by students in the seductive-details-first group \((M = 2.56, SD = 1.64)\) and the seductive-details-interspersed group \((M = 1.87, SD = 1.22)\). Also, both the seductive-details-first and the seductive-details-interspersed groups generated significantly fewer solutions than did either the base-passage group \((M = 4.13, SD = 1.51)\) or the seductive-details-after group \((M = 3.92, SD = 1.91)\). In addition, a major finding was that the transfer performance of students in the seductive-details-after group did not significantly differ from the base-passage group, a finding that is consistent with the diversion hypothesis and inconsistent with the disruption hypothesis.

Overall, these findings support the diversion hypothesis but not the disruption hypothesis. If the disruption hypothesis was correct, then students in the seductive-details-first group should have generated more solutions on the transfer test than those in the seductive-details-interspersed group. However, this was not the case, so there is no evidence that seductive details do their damage by disrupting the coherence of a passage. These results provide support for the idea that seductive details do their damage by priming inappropriate knowledge as the students' organizing schema.

**Discussion**

Experiment 4 shows that when seductive details are placed early in the lightning passage, neither students' ability to recall structurally important ideas nor their ability to use the main ideas to solve problems improve over their performance when the seductive details are interspersed throughout the passage. In addition, students recalled more of the seductive details when they were placed early in the passage as compared with later placement. Apparently, early placement of the seductive details primed the readers to use the seductive details as the organizing schema for the remainder of the passage. Alternatively, placing the seductive details at the end of the passage resulted in students' performing as well on tests of retention and transfer as those who read the passage with no seductive details, suggesting that these students did not organize their understanding of their passage around the seductive details. The results of Experiment 4 are inconsistent both with the distraction hypothesis and the disruption hypothesis but support the diversion hypothesis.

**General Discussion and Conclusion**

Research on the seductive details effect has recently been criticized for failing to replicate across and within studies using adequate text manipulations and for failing to use control groups (Goetz & Sadoski, 1995). To address this criticism, separate control groups were used in each of the four studies reported in this article. It was consistently found that college students who read a passage with seductive details recalled fewer structurally important ideas and generated fewer transfer solutions than those who read the same passage without seductive details. These findings were replicated across all four experiments reported here and are consistent with previous findings of the seductive details effect (Garner et al., 1991; Garner et al., 1989; Harp & Mayer, 1997; Shirey & Reynolds, 1988; Wade & Adams, 1990). Combined with previous research on seductive details, the results reported in this article provide converging evidence that adding emotionally interesting adjuncts can hurt student learning of an explanatory science lesson.

**How Do Seductive Details Do Their Damage?**

The overarching goal of this study was to determine how seductive details affect learning. The results of the studies reported here provide provocative evidence as to how seductive details do their damage.

The distraction hypothesis. According to the distraction hypothesis, seductive details do their damage by grabbing and holding readers' selective attention. Therefore, guiding students' selection processes to the structurally important ideas in a passage should help to overcome the negative effects of seductive details on the recall of main ideas. Contrary to this expectation, helping students to select and
attend to main ideas did not reduce the seductive details effect. For example, the findings of Experiment 1 indicated that graphically highlighting the structurally important ideas in the lightning passage did not reduce the seductive details effect for recall of the steps involved in the formation of lightning. Likewise, in Experiment 2, explicitly telling students to pay attention to the steps leading to a flash of lightning did not reduce the seductive details effect on recall performance. Similarly, signaling the main ideas by using preview sentences and number signals did not reduce the seductive details effect in Experiment 3. Combined, these findings consistently contradict the hypothesis that seductive details do their damage by distracting the reader and therefore do not support the distraction hypothesis.

The disruption hypothesis. According to the disruption hypothesis, seductive details do their damage by disrupting the coherence of a passage, thereby making it difficult for readers to build a mental model of the situation explained in the text. Therefore, helping students to organize the structurally important ideas in a passage should result in a reduced seductive details effect. However, a strong seductive details effect persisted when students were told what to look for and how to organize the reading, as shown in Experiment 2. The seductive details effect also remained strong even when the lightning passage included heavy explicit signaling of the main ideas, as shown in Experiment 3. In addition, preserving the coherence of the lightning lesson by placing the seductive details together at the beginning of the passage also did not help students to understand or remember what they had read, as shown in Experiment 4. Taken together, these results are inconsistent with the hypothesis that seductive details do their damage by disrupting the coherence of a passage and therefore do not support the disruption hypothesis.

The diversion hypothesis. Each of the four experiments reported here provide at least partial support for the diversion hypothesis. This hypothesis states that seductive details do their damage by priming an inappropriate context for the reading (i.e., by activating an inappropriate base of prior knowledge in the reader). According to the diversion hypothesis, the priming effects of seductive details were expected to override any positive effects of typographical cueing, verbal learning objectives, or explicit signaling of the main points in the lightning passage. Therefore, this hypothesis predicted that attempts to guide readers' selection of or to assist readers in organizing the important information would not result in a reduction of the seductive details effect. The results of Experiments 1, 2, and 3 were consistent with the prediction that techniques for guiding readers' selecting and organizing processes would not reduce the seductive details effect.

In particular, Experiment 4 provides strong evidence that seductive details confuse readers as to what a scientific passage is actually about. According to the diversion hypothesis, seductive details activate irrelevant prior knowledge, which the reader then uses as the organizing schema for the lesson. As shown in Experiment 4, inserting all of the seductive details at the beginning of the lightning lesson resulted in especially poor student performance. This finding supports the hypothesis that seductive details serve to prime a particular context for the reading. According to the diversion hypothesis, the students who participated in this series of experiments were mislead into relating the passage to their prior knowledge about "what lightning causes" rather than "what causes lightning." These readers built a representation of the lightning passage organized around the seductive details, rather than the structurally important ideas contained in the lesson, as evidenced by their poor recall of main ideas and poor problem-solving performance.

Whereas presenting the seductive details at the beginning of the lesson resulted in poor student performance, introducing them at the end of the lesson resulted in test performance that rivaled that of students who had read the lesson with no seductive details at all. These results appear to be inconsistent with those of Garner et al. (1991), who by presenting seductive details together in a separate paragraph found that varying the placement of seductive details made no difference in students' recall patterns. However, Garner et al.'s failure to find a differing effect may have been because they placed the seductive paragraph toward the middle of their passage. Because the seductive details remained within the body of the passage, they may still have activated an inappropriate organizing schema for the passage.

Taken together with Garner et al.'s (1991) findings, the results we obtained in this study suggest that avoiding or preventing the activation of erroneous prior knowledge in the reader can reduce the seductive details effect. One way to discourage inappropriate schema activation is to delay the introduction of seductive information until after the reader has processed the important material. Another way is simply not to introduce seductive details at all.

Limitations and Future Directions

These conclusions must be taken in light of their limitations. First, our study focuses on a single text that contained a large number of seductive illustrations. Second, in order to provide experimental control, the time allowed for students to study the lightning lesson was limited to 6.5 min. However, it should be noted that all students were able to finish reading within this time period. Third, the questionnaire we used to determine students' prior knowledge required self-reports, which may not accurately reflect students' knowledge. Additionally, by focusing only on low-knowledge adults, we have restricted the focus of this study.

Other limitations include the failure to obtain significant main effects for highlighting in Experiment 1 and for signaling in Experiment 3. These manipulations may not have been effective because the base passage was already concise and well organized, with the main steps in the causal chain clearly presented (Mayer, 1989; Mayer, Bove, Bryman, Mars, & Tapangco, 1996; Mayer & Gallini, 1990). This explanation is consistent with Lorch and Lorch's (1996) conclusion that guidance tools such as these are ineffective when the text structure is simple, as was the case with the lightning passage. Further study is warranted to determine whether attempts to guide students' selection processes...
would be effective in reducing the seductive details effect for passages with more difficult structure.

Furthermore, these results should not be taken to suggest that illustrations in general are harmful for students of science. This study focuses in part on the harmful effects of seductive illustrations, such as full color photographs that were irrelevant to the theme of the lesson. However, research has consistently shown that well-designed illustrations, such as the captioned, explanatory summaries used in this present research, have a beneficial effect on students’ retention and transfer when included in science lessons (e.g., Mayer, 1989; Mayer et al., 1996; Mayer & Gallini, 1990).

In addition, these results should not be taken to controvert the value of eliciting student interest during science lessons. The results reported here do not purport that all interesting material should be avoided, for previous research has consistently shown that students learn better when the material is interesting as opposed to when it is not (Hidi & Baird, 1986; Shirey & Reynolds, 1988; Wade, 1992). Perhaps the challenge is to find a way to present science lessons in a way that is interesting, without resorting to the use of entertaining but irrelevant details.

Although the findings reported here support the seductive details hypothesis that interesting, irrelevant material interferes with learning, we have not yet explored what it is that makes seductive details “seductive.” For example, Sadoski, Goetz, and Fritz (1993) argued that the concreteness of material is a better predictor of recall than is its interestingness. To investigate this issue, future research might use seductive details of varying degrees of concreteness.

Lastly, it is worthwhile to note that our study used multiple measures of learning, including both recall and problem-solving transfer. We view the problem-solving task as a near transfer measure because students were required to use information they had learned about the formation of lightning to solve lightning-related problems that they had not seen before. Given that promoting understanding is a major goal of science instruction, it is useful to include measures of understanding like the problem-solving task used in these studies.

In Support of Cognitive Interest

The results obtained in this study provide support for a theory of cognitive interest. Cognitive interest, as opposed to emotional interest, results from the reader’s satisfaction of understanding what he or she read. Although our focus in these studies was on measures of cognitive understanding, we have measured emotional interest in previous studies (Harp & Mayer, 1997). Both types of interest can be promoted by the content and structure of the text (Harp & Mayer, 1997). Cognitively interesting adjuncts, such as summaries, explanatory illustrations, and text cohesiveness, have been shown to promote understanding (e.g., Harp & Mayer, 1997; Mayer et al., 1995). On the other hand, emotionally interesting adjuncts, such as seductive details, appear to promote affective arousal in the reader (Kintsch, 1980). Research on the seductive details effect suggests that this kind of emotional arousal does not lead to better understanding of textbook lessons (Garner et al., 1991; Garner et al., 1989; Harp & Mayer, 1997).

As proposed by Kintsch (1980), “There can be no cognitive interest without the appropriate knowledge structure” (p. 91). In particular, the findings of Experiment 4 demonstrate that an important way to promote cognitive interest is to help students to activate a relevant internal knowledge structure, that is, to activate their appropriate prior knowledge. Seductive details, as evidenced from this present series of experiments, appear to give readers an inappropriate context for the reading and thereby raise false expectations about what they are reading. In their search for ways to construct meaning from the text, readers are drawn to seductive details as an organizing context. Promoting an appropriate context for a science lesson may therefore be a crucial element in science education.

References


Appendix

A Causal Explanation of the Formation of Lightning

The Process of Lightning

Lightning can be defined as the discharge of electricity resulting from the difference in electrical charges between the cloud and the ground.

When the surface of the earth is warm, moist air near the earth's surface becomes heated and rises rapidly, producing an updraft. As the air in these updrafts cools, water vapor condenses into water droplets and forms a cloud. The cloud's top extends above the freezing level. At this altitude, the air temperature is well below freezing, so the upper portion of the cloud is composed of tiny ice crystals.

Eventually, the water droplets and ice crystals in the cloud become too large to be suspended by updrafts. As raindrops and ice crystals fall through the cloud, they drag some of the air from in the cloud downward, producing downdrafts. The rising and falling air currents within the cloud may cause hailstones to form. When downdrafts strike the ground, they spread out in all directions, producing gusts of cool wind people feel just before the start of the rain.

Within the cloud, the moving air causes electrical charges to build, although scientists do not fully understand how it occurs. Most believe that the charge results from the collision of the cloud's light, rising water droplets and tiny pieces of ice against hail and other heavier, falling particles. The negatively charged particles fall to the bottom of the cloud, and most of the positively charged particles rise to the top.

The first stroke of a cloud-to-ground lightning flash is started by a stepped leader. Many scientists believe that it is triggered by a spark between the areas of positive and negative charges within the cloud. A stepped leader moves downward in a series of steps, each of which is about 50 yards long, and lasts for about 1 millionth of a second. It pauses between steps for about 50 millionths of a second. As the stepped leader nears the ground, positively charged upward-moving leaders travel up from such objects as trees.
and buildings, to meet the negative charges. Usually, the upward moving leader from the tallest object is the first to meet the stepped leader and complete a path between the cloud and earth. The two leaders meet generally about 165 feet above the ground. Negatively charged particles then rush from the cloud to the ground along the path created by the leaders. It is not very bright and usually has many branches.

As the stepped leader nears the ground, it induces an opposite charge, so positively charged particles from the ground rush upward along the same path. This upward motion of the current is the return stroke and it reaches the cloud in about 70 microseconds. The return stroke produces the bright light that people notice in a flash of lightning, but the current moves so quickly that its upward motion cannot be perceived. The lightning flash usually consists of an electrical potential of hundreds of millions of volts. The air along the lightning channel is heated briefly to a very high temperature. Such intense heating causes the air to expand explosively, producing a sound wave we call thunder.

 Received June 30, 1997
Revision received October 27, 1997
Accepted October 27, 1997

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**Call for Nominations: Emotion**

The premiere issue of *Emotion*, the newest journal from APA, will be published in 2001. The Publications and Communications (P&C) Board has opened nominations for the editorship for the period from September 1999 through December 2006.

Candidates should be members of APA and should be available to start receiving manuscripts in the fall of 1999. The successful candidate will assist the APA P&C Board in refining the scope of coverage for *Emotion*, it is anticipated that this will be a broad-based multidisciplinary journal that includes

- articles focused on emotion representing neuroscience, developmental, clinical, social, and cultural approaches

and

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Address all nominations to:

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c/o Karen Sellman, P&C Board Search Liaison
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The first review of nominations will begin December 7, 1998.