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Signaling topic structure via headings or preview sentences

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ABSTRACT

Two experiments compared the effects on text processing of headings and preview sentences that were designed to communicate the same information about the texts' topics and their organization. In Experiment 1, college students read a text for understanding then were tested on memory for the subtopics and memory for simple facts presented in the text. Memory for subtopics was better for the text with headings; there was no difference between headings and preview sentences on memory for facts. In Experiment 2, participants read a text in order to outline it. Outlining was better if the text contained signals to topic structure than if the text did not contain signals, but there were no reliable differences between previews and headings. The findings show that previews function similarly to headings in a task that emphasizes the relevance of topic structure information, but they do not elicit readers' attention to topic information as readily as headings do. These results have implications for textbook design and instruction of comprehension strategies.

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La estructura temática señalizada vía títulos u oraciones previas

RESUMEN

En dos experimentos se compararon los efectos que sobre el procesamiento de textos ejercen los títulos y oraciones previas, ambos diseñados para transmitir la misma información sobre los tópicos del texto y sobre su organización. En el experimento 1, estudiantes universitarios leyeron un texto con el objeto de comprenderlo y a los que se les evaluó mediante dos pruebas de memoria, una centrada sobre los subtópicos y otra sobre hechos aislados descritos en el texto. La prueba de memoria sobre los subtemas fue superior para la versión del texto con títulos; sin embargo, no hubo diferencias en la prueba de memoria sobre hechos aislados entre ambas versiones del texto. En el experimento 2, los participantes leyeron un texto, pero en este caso con el objeto de dar una visión general sobre su contenido. En este caso la versión del texto señalizado sobre la estructura del texto fue mejor que la no señalizada, pero no se detectaron diferencias entre las oraciones previas y los títulos. Los resultados muestran que la función de las oraciones previas son similares a los títulos en tareas que enfatizan la relevancia de la información de la estructura del tema, pero no eliciten la atención de los lectores hacia la información del tópico como lo hacen fácilmente los títulos. Estos resultados tienen implicaciones educativas para el diseño de libros de texto y también para la instrucción de estrategias de comprensión.

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Literacy entails more than the ability to read words and understand sentences. Skilled comprehension requires that readers understand the structure of a text. Textbook chapters and other types of expository texts typically present information about multiple, hierarchically-related topics (Kintsch & van Dijk, 1978). Thus,

comprehension of informational text entails, in part, the construction of a mental outline or "topic structure representation" that includes the important text topics and their organization (Lorch, Lorch, & Matthews, 1985). However, constructing a topic structure representation is a demanding task; even college students often fail to adequately monitor a text's topic structure (Hyönä, Lorch, & Kaakinen, 2002; Lorch, Lorch, & Inman, 1993; Mayer, Dyck, & Cook, 1984; Meyer, Brandt, & Bluth, 1980; Surber & Schroeder, 2007). One straightforward way to aid readers in their attempts to process a text's topic structure is to use signaling devices to explicitly identify

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text topics and their organization (Lorch & Lorch, 1995, 1996a, 1996b; Lorch et al., 1993; Mayer et al., 1984; Ritchey, Schuster, & Allen; 2008). Organizational signaling devices like headings direct readers' attention to topic structure information (Cauchard, Eyrolle, Cellier, & Hyönä, 2010a, 2010b; Hyönä & Lorch, 2004; Hyönä et al., 2002) and result in a more complete and accurate representation of a text's topics and their organization (Lorch & Lorch, 1996a, 1996b; Lorch et al., 1993; Lorch, Lorch, Ritchey, McGovern, & Coleman, 2001). The availability of a good topic structure representation, in turn, supports the retrieval of information from text memory (Lorch & Lorch, 1995; Mayer et al., 1984; Sanchez, Lorch, & Lorch, 2001).

Skilled comprehension requires that readers understand the roles of the visual and verbal signaling devices that authors use to highlight text structure (Rouet, 2006). Further, understanding how organizational signals influence text processing, in general, and processing of a text's topic structure, in particular, is relevant to educational practice in at least two respects. First, a thorough understanding of how signaling devices guide text processing would be useful in guiding textbook design (Rouet, 2006). For example, knowing how different types of headings affect readers' attention to text organization and content would be helpful to an author who writes to inform an audience about a complex topic. Second, an understanding of how mature readers use signaling devices to aid their comprehension efforts could be useful in devising and teaching effective comprehension strategies to less sophisticated readers (Goldman & Wiley, 2011; Kulikowich, 2008; Meyer, Young, & Bartlett, 1989). Given that many college students appear not to adequately process topic structure information (Mayer et al., 1984; Meyer et al., 1980; Sanchez et al., 2001), there is much to be learned about the instruction of comprehension strategies designed to aid learning from informational text.

Headings are among the most extensively researched signaling devices. They have been shown to aid readers' text processing in several ways. Headings may be used to identify text topics and thus to activate a reader's knowledge of a topic. The activation of relevant background knowledge supports the identification of referents in a text (Bransford & Johnson, 1972; Wiley & Rayner, 2000) and the integration of new information with previous knowledge (Sulin & Dooling, 1974). In addition, the presence of headings in a text facilitates the construction of an accurate topic structure representation (Lorch, Chen, & Lemarié, 2012; Lorch, Lemarié, & Grant, 2011a, 2011b; Lorch & Lorch, 1996a; Lorch et al., 2001) and guides recall of text content (Lorch & Lorch, 1995; Lorch & Lorch, 1996b; Lorch et al., 1993; Sanchez et al., 2001). Further, headings are robust in their influences on text-processing. They have been shown to aid performance on reading tasks that focus on the identification of major text topics and their organization, such as summarization (Lorch & Lorch, 1996a; Lorch et al., 2001) and outlining (Brooks, Dansereau, Spurlin, & Holley, 1983; Lorch et al., 2011a; Lorch et al., 2012). They have also been shown to influence eye movements during reading (Cauchard et al., 2010a, 2010b; Hyönä & Lorch, 2004), text search (Klusewitz & Lorch, 2000; Lorch et al., 2011a, 2011b) and memory for informational text (Lorch & Lorch, 1995; 1996b; Ritchey et al., 2008) even when the reading task does not directly implicate topic structure information (e.g., reading for understanding and/or free recall).

Headings are not the only way to signal the topic structure of a text, however. Preview sentences are section-initial sentences that identify the topic of the upcoming section and thus also signal topic structure. In fact, the same information communicated by headings may be signaled, instead, by preview sentences. The ability to construct parallel versions of headings and preview sentences that serve the same communicative functions raises the questions of why such seemingly redundant signaling devices coexist and whether, in fact, they have somewhat different functions.

Consider the example of a headed text presented in Figure 1. The example is the first page of a hierarchically-organized text that

discusses three major topics (dwindling fuel resources, environmental damage, health effects) each with multiple subtopics (e.g., hazardous production methods, air pollution, cancer). Each of the headings in this example communicates four distinguishable types of information (Lemarié, Lorch, Eyrolle, & Virbel, 2008). Specifically, each heading: identifies the topic of the upcoming subsection; provides a label that may be used to refer to the subsection; demarcates its section from the preceding subsection; and communicates the hierarchical level of the topic in the text structure (i.e., either a major topic at the top level of the hierarchy or a subtopic at the bottom level of the 2-level hierarchy). These headings could be replaced by preview sentences that communicate the same information. For example, the heading "hazardous production methods" could be replaced by the preview sentence: "In this section, we will discuss one effect of dwindling resources, hazardous production methods." Like the corresponding heading, this sentence identifies the topic of the subsection as hazardous production methods and thus also provides a label that can be used to refer to the subsection. By its section-initial position and the phrase "in this section," the statement also demarcates the start of a new section. Finally, by identifying the topic as "one effect of dwindling resources," the preview sentence indicates that the section is subordinate to the major topic of dwindling resources. Thus, headings and preview sentences can signal the same information in the same location with respect to the content that it signals. But do the two signaling devices affect text processing in the same way?

We have already established that headings influence the processing of informational texts in many ways. However, much less is known about how preview sentences influence text processing. There is recent evidence that preview sentences can effectively guide the process of constructing an outline of a text as the text is presented (Lorch et al., 2012). There is also some evidence that previews improve memory for specific text content (Spyridakis & Standal, 1986, 1987). However, there is no evidence that previews have the kinds of robust effects on processing of topic structure that we have described for headings. In particular, there has been very little investigation of the extent to which readers' processing of topic structure information is influenced by the presence of preview sentences in a text.

The fact that preview sentences can communicate the same information about topic structure as headings provides a basis for predicting that the effects of previews on processing of topic structure information may be similar to the effects found for headings. However, preview sentences differ from headings in at least one important respect: Whereas headings are typically visually contrasted with the rest of the text, preview sentences are not visually distinctive. This difference in the salience of headings and preview sentences has potential implications for their effects on text processing. Specifically, headings should elicit more attention from readers than preview sentences (Cauchard et al., 2010a; 2010b; Gaddy, Sung, & van den Broek, 2001; Hyönä & Lorch, 2004) and their greater influence on attention may cause them to have greater influence on the processing of topic structure information. In contrast, the lack of distinctiveness of preview sentences relative to the text content in which they are embedded may cause them to be overlooked as signals to topic structure in the absence of any special incentive to attend to such information.

If headings do, in fact, cause more attention to be paid to topic structure information than preview sentences, are there other respects in which preview sentences have an advantage compared to headings? One likely advantage of preview sentences relative to headings is that they communicate entirely by verbal means. This makes them a more natural way to communicate topic structure information in oral discourse (Lorch et al., 2012). However, there may also be situations where preview sentences are preferable to headings in printed texts. This possibility derives from their lesser

ENERGY PROBLEMS

Since the Industrial Revolution, developed countries have become increasingly reliant on the production of energy to maintain their economies and standards of living. Primary sources of energy have been oil, coal, natural gas and, more recently, nuclear power. We are now faced with severe problems created by our dependence on these energy sources. In this article, we will discuss some of the major problems associated with our current methods of energy production.

DWINDLING FUEL RESOURCES

Coal, oil, gas, and the minerals supplying nuclear fuel are certainly abundant natural resources. However, they are not renewable resources and therefore their supplies are limited. Given the increasing demands for energy worldwide, we are rapidly approaching the time when these fuel sources will be exhausted. We are already beginning to experience the effects of the decreasing availability of fossil fuels.

Hazardous Production Methods Although the major methods of coal production remain strip-mining and underground mining, the most accessible veins of coal have long since been exhausted and miners must dig ever deeper into the ground to recover coal reserves. The deeper and more extensive tunneling operations mean greater danger to the miners. For similar reasons, drilling for oil and gas has become increasingly dangerous. As demand increases and continental reserves decrease, the search for oil and gas has extended to remote and dangerous locations. One example is the construction of the Alaskan pipeline. Work in such harsh environments is very risky.

Increasing Costs of Fuel Sources The price of gas and other fossil fuels is rising for a couple of basic reasons. In a competitive marketplace, the decreasing availability of fossil fuels puts the seller in a powerful position. Anyone old enough to remember the Arab oil embargo in 1973 and the resulting long lines at gas stations and hikes in gas price understands this principle well. Also, the decreasing accessibility of fossil fuels results in an increase in production expense—deeper and more remote mines require sophisticated technologies for drilling and mining. These technologies are expensive and the added costs are passed on to consumers.

Decrease in Energy Available per Person The global economy and the rise of developing countries in the past decade have greatly increased energy consumption. It has been estimated that if developing countries increase their energy consumption per person to the level of the United States, it would be equivalent to increasing the earth's population to 72 billion people. This figure greatly exceeds the earth's maximum ability to sustain humans, which is estimated to be at around seven billion. This clearly implies that the energy available to each individual will drop in the near future.

ENVIRONMENTAL DAMAGE

The heavy use of fossil fuels and nuclear power threatens the ecology in many ways. We are just beginning to understand the magnitude of the problems we have created. Several related issues may be identified.

Air Pollution The side-effects of industrialization have been known for a long-time. Many factors contribute to the release of contaminants into the atmosphere, but the burning of fossil fuels—particularly motor vehicle exhaust—is the major source of toxic waste. Fossil fuels.

Figure 1. Example of headings on a page from a text with a two-level hierarchical structure.

salience relative to headings. Specifically, there may be times when it is advantageous to not devote extra attention to topic structure information. For example, if the reader is searching for specific information in a text or preparing for a multiple choice test on content details it might be preferable to not attend to topic structure information. Although headings are very effective at eliciting readers' attention and triggering processing of topic structure information (e.g., Brooks et al., 1983; Krug, George, Hannon & Glover, 1989; Lorch & Lorch, 1995; 1996a; 1996b; Lorch et al., 2001), topic processing is resource-demanding and entails a disruption of the processing of a text's content (Lorch, Lorch, & Mogan, 1987). Signaling that elicits attention to topic structure information (e.g., headings) might result in less attention to other text content. If so, then an author should be judicious in using headings, reserving them for important junctures in a text but avoiding them in favor of preview sentences at minor boundaries in a text. Related to this point, it has been shown that typographical cueing should be used parsimoniously to be effective (Lorch, Lorch, & Klusewitz, 1995); similarly, it may be that the effectiveness of headings decreases with their frequency of use.

In sum, although much is known about how headings influence the processing of topics and their relations, little is known about how preview sentences influence topic structure processing. On the one hand, the fact that preview sentences can communicate the same information as headings provides a basis for expecting previews to have similar influences on text processing. On the other hand, the lesser visual salience of preview sentences relative to headings provides a basis for expecting that previews may have less influence than headings because they are less likely to elicit a reader's attention. This combination of considerations suggests that the relative influence on topic structure processing of headings vs. preview sentences may depend on the nature of the reading task: When the purpose for reading is not specifically oriented to topic structure processing (e.g., reading for understanding), readers will be sensitive to topic signals only if they are salient; when the purpose

for reading does specifically emphasize topic structure processing (e.g., read to outline), readers will actively search for useful signals and the visual salience of the signals will have less influence. This general hypothesis was examined in two experiments. The first experiment compares the two signaling devices in a context that does not place any special emphasis on topic structure information (i.e., reading for understanding and memory). The second experiment studies effects of the two signaling devices in a task that does emphasize the processing of topic structure information (i.e., outlining). Together, the experiments illuminate some similarities and differences between preview sentences and headings with respect to how and when they influence the processing of topic structure information.

Experiment 1

Experiment 1 compared the influence of headings and preview sentences on text memory when reading an informational text for understanding. After reading, students were given two memory tests. One test was a cued recall test of memory for the subtopics of the text; the other was a cued recall test of specific text content that did not require memory for the topics and subtopics of the text. The task of reading for understanding was chosen because it requires attention to all of the text content. Although processing of a text's topics and their organization is an important component of reading for understanding, it is also important that readers understand what was said about the various text topics. Thus, the task does not allow readers to attend solely to topic structure information.

Consider how the two signaling devices might influence memory for subtopics under these conditions. Prior research has demonstrated that when students read a text for understanding, their memory for the topics of the text is better if the text contains topic-identifying headings than if the text has no signals to topic structure (Lorch & Lorch, 1996a; Sanchez et al., 2001). In the case of preview sentences,

either of two possible outcomes might be observed. If readers are alert to topic structure information as they read, then preview sentences should be well attended because they explicitly identify the text topics. If that happens, preview sentences should facilitate memory to the same extent as headings. However, previous research has consistently shown that college students do not typically attend to topic structure information unless aided by prominent signaling of the topic structure (Lorch & Lorch, 1995; Lorch et al., 1993; Mayer et al., 1984). Because preview sentences are not visually salient, readers may fail to devote as much attention to them as to headings; in that event, preview sentences will not aid memory for subtopics to the extent that headings do.

Next, consider how headings and preview sentences might affect memory for specific text content (i.e., details that are unrelated to the topic structure of the text). One possible result is that neither signaling device will influence processing of detail information because neither type of signal is directly relevant to such content. Another possibility is that if the visual salience of headings draws attention to topic structure information, the additional attention to topics may result in less attention being paid to the content of the text. Because students were allowed unlimited time to read, there is no necessary competition between the processing of the macrostructure and microstructure of the text; however, if students are not motivated to perform their best in the circumstances of the experiment, they may behave as if their time resources are limited.

Method

Participants

The participants were 134 volunteers from introductory psychology classes who received credit for experimental participation. The population of students from the introductory psychology classes is approximately 66% female and consists predominantly of students between the ages of 19 and 24. Students were excluded from participation if English was not their native language.

Materials

Two texts were created for the experiment. One text was on the topic of problems associated with conventional energy sources; the second text was on the topic of possible solutions to the problems associated with conventional energy sources. Both texts were divided into three major sections with between three and seven subsections for a total of 16 topics (i.e., 3 major topics and 13 subtopics). For example, the second major section of the Problems text was titled "Environmental Damage" and the subsections subordinated to that topic were labeled: air pollution, disruption of environmentally-sensitive areas, oil spills, storage of radioactive waste, acid rain, erosion, and greenhouse effect.

There were two versions of each printed text. One version included headings introducing each subsection of the text. Figure 1 presents the first page of the Problems text. Major headings were left-justified and typed in boldface with all letters capitalized. Each of the three major headings was preceded by one line of white space to set it off from the preceding section. The 13 minor headings were underlined and typed in boldfaced print in upper- and lower-case. These minor headings were indented and the text section they headed began immediately on the same line as the heading. Thus, the headings communicated four distinguishable types of information: They indicated section boundaries, they identified the topic of each section and provided a unique label for each section, and the hierarchical relationships of the text topics were communicated by the different formatting of the major and minor headings.

A second version of each text replaced the 16 headings with preview sentences that communicated the same information as the headings they replaced. Preview sentences that introduced major topics explicitly mentioned the label in the title and enumerated the three problems (e.g., "Yet another problem we face with our current methods of energy production is environmental damage"). Preview sentences that introduced subtopics explicitly mentioned the relevant major topic and introduced the subtopics (e.g., "One of the environmental problems is air pollution", "Another environmental problem is oil spills", etc.). Each preview sentence was always the first sentence of the first paragraph of its respective section. Thus, like headings, each preview sentence communicated the start of a new section, identified the topic of the section and provided a label for the section, and communicated information about the hierarchical relationships of the text topics. Like the headed versions of the texts, the versions with preview sentences included white space before each major text section. Unlike the headed versions, the versions with preview sentences did not visually distinguish the preview sentences from other sentences in the text (i.e., they were not underlined or printed in boldface or all caps).

All text versions were typed with single spacing. The text on energy problems was 1,440 words long in the headed version and 1,549 words long in the previews version; the text on energy solutions was 1,395 words long in the headed version and 1,517 words long in the previews version.

In addition to the texts, two cued recall tests were constructed for each text. The first test consisted of three items; each item specified one of the major topics and asked subjects to list the subtopics associated with that topic. For example, the second item of the test for the Problems text was: "List the types of environmental damage discussed in the text." Thus, this test examined memory for subtopics.

The second test consisted of 13 items testing memory for details of each of the 13 subsections of the test. These items consisted of factual questions, most of which could be answered in a word or two and none of which required an answer greater than a sentence in length. Some examples of items (and answers) for the Problems text are: "What proportion of the U.S. population lives in areas where air pollution regularly exceeds federal standards?" (almost half); "What is the most serious potential side effect of hydroelectric power plants?" (soil erosion); and "Name one of the two basic reasons that the costs of conventional energy sources are increasing." (Decreasing availability of sources puts seller in a powerful position OR Increasing production costs passed on to consumers). The items on this test were intended to assess memory for content details without requiring memory for topics and subtopics. Both texts and both tests were typed single-spaced on 8.5" x 11" pages.

Procedure

Participants were tested in groups of up to 12 in sessions that lasted approximately 30 minutes. All four combinations of text (Problems or Solutions) and signaling condition (Headings or Previews) were represented in every session. Participants were assigned at random to the four conditions of the experiment. All sessions were conducted during daytime hours in a small classroom that could accommodate up to 25 students.

Each participant received one version of one text, an envelope labeled "Test 1" and an envelope labeled "Test 2." Participants were instructed to read the text for understanding and were told that they would be tested on their memory after reading. Participants were allowed to read at their own pace. When they were ready to begin the testing procedure, they were instructed to put the text in a provided envelope then take the test from the envelope labeled "Test 1." This test was always the test of subtopics. Participants completed the test of subtopics at their own pace, then put the test back in the envelope and took the test of details from the envelope labeled "Test

2.” They completed this test at their own pace, then replaced the test in the envelope and turned in their materials. The test of details was given second to all participants because it contained information about the text’s subtopics that might have influenced performance on the test of subtopics.

Scoring

Each response on each of the two tests was evaluated against a scoring key. The key for the test of subtopics consisted of the labels for the 13 subtopics of the text. The key for the test of details consisted of the answers from the text. Although the keys contained the verbatim wording from the text, verbatim reproduction of an answer was not required. Three judges independently scored 10 randomly-selected protocols, 5 for each text. Agreement was very good with only 9 disagreements in 702 judgments (98.7%), so the remaining protocols were divided among the four judges for scoring.

Results and Discussion

The results for the two tests were analyzed in two separate ANOVAs with two between-subjects factors of Signal (headings or previews) and Text (problems or solutions). All reported tests are significant beyond the .05 level unless noted otherwise.

The first test compared the effects of headings and previews on memory for subtopics. Although both signaling devices identified the text topics and their organization, recall of subtopics was better for the text with headings than for the text with preview sentences; $F(1, 130) = 10.07$, $MSe = 4.65$, partial $\eta^2 = .07$. Mean recall for the text with headings was 4.33 topics ($SD = 2.50$) compared to a mean of 3.15 topics ($SD = 1.73$) for the text with previews. The effect of signaling did not depend upon the text; $F(1, 130) = 1.30$, $MSe = 4.65$, $p = .26$, partial $\eta^2 = .01$ for the test of the interaction.

The second test examined memory for detailed, factual information in the text. It was speculated that the predicted additional processing of topic structure information in the headings condition might occur at a cost of less attention to the text’s content. If so, memory for the details of the text content should be better in the previews sentence condition than in the headings condition. In fact, there was no support for this prediction. Memory for details did not differ reliably for the previews condition ($M = 5.21$, $SD = 2.76$) and the headings condition ($M = 5.51$, $SD = 3.40$); $F(1, 130) < 1$, $p > .5$, partial $\eta^2 = .00$. Again, the effect of signaling did not vary across texts; $F(1, 130) < 1$, $p > .9$, partial $\eta^2 = .00$ for the test of the interaction.

In sum, headings produced better memory for subtopics relative to preview sentences but the two signaling devices did not differ in their influence on memory for content details. We attribute the advantage of headings on memory for subtopics to the greater salience of headings. In a task that did not target topic information as specifically relevant information, the visual prominence of headings elicited readers’ attention, resulting in better memory for the subtopics relative to preview sentences condition. What we do not know from this experiment is whether preview sentences confer any memory advantage for subtopics relative to a text that omits signals to topic information.

Experiment 2

Experiment 1 examined the effects of headings and previews in a task that did not emphasize topic processing whereas Experiment 2 compares the signaling devices in a task that does emphasize topic processing. An outlining task was chosen as the purpose for reading because the identification of text topics and their relations is necessary and sufficient for the task of constructing an outline. Further, outlining is a task that is familiar to college students so they should be specifically tuned to such information as they read. Under

these circumstances, readers should search for information about text topics and their organization and these top-down influences on processing should compensate for the attention-eliciting effects of visually salient headings. Thus, headings and previews should facilitate performance to a similar extent because both headings and previews communicate the same information about topic structure. To test this hypothesis, we presented participants with an informational text that contained headings or preview sentences or no signals to topic structure. We predict better outlining performance in the headings and previews conditions than the no signals condition.

We examined outlining performance under two conditions; participants outlined with the text available to them or with the text removed. When the text is available, memory factors influencing outlining are minimized and we anticipate that outlining performance will be equally good in the headings and preview sentences conditions. When the text is removed, participants must outline from memory. Because they are aware that their task will be to outline, they can adapt their reading strategy to that purpose and we may still find equivalent outlining performance for the headings and preview sentence conditions. However, it is also possible that the visual emphasis provided by headings will cause the representation of heading-communicated information to be more salient in memory than the representation of previews-communicated information. If that is the case, headings may produce better outlining performance than preview sentences in the text absent condition.

Method

Participants

The participants were 120 volunteers from introductory psychology classes who received credit for experimental participation. The characteristics of the population of participants were the same as described for Experiment 1. Participants were assigned at random to experimental conditions.

Materials

The Problems and Solutions texts used in Experiment 2 were slightly revised to add one new subtopic to one of the major sections of each text. Heading and preview sentence versions of each text were created that were completely analogous to the headings and preview sentence versions of the texts in Experiment 2. In addition, a no signals version of each text was created by omitting the headings and preview sentences of each text. The no signals version of the Problems text was 1,388 words long; the no signals version of the Solutions text was 1,335 words long. Thus, both the Problems and Solutions text had a 2-level hierarchical structure with three major topics and 14 subtopics. The texts were typed single-spaced on 8.5" x 11" pages.

Procedure

The basic task was to outline the presented text. Participants were provided with instructions about how to outline. They were told that they did not need to worry about conventional outline formatting with roman numerals, etc.; rather, they could use simple bulleting with a two-level structure distinguishing major topics and their subtopics. An example of such an outline from an unrelated domain was provided and explained. Any questions that the participants had were answered before the text was presented. Half of the participants were allowed to take notes as they read and to construct their outlines with the text present. The other half of the participants were required to construct their outlines with the text absent and they were not allowed to take notes or write on the article as they

read. Thus, they understood that their purpose was to read to prepare to write an outline, but they had to depend on their memories during outline construction.

Participants were tested in groups of up to 12 people in sessions that required approximately 30 minutes. All of the participants in a given session received the same task conditions (i.e., text present or text absent). All sessions were conducted in the same classroom, which could comfortably accommodate up to 25 people.

Scoring

Each entry in a participant's outline was evaluated to determine which of the 17 text of the topics it communicated; verbatim reproduction of a topic was not required. The dependent variable of interest was the number of text topics included in an outline (maximum score = 17). Two judges independently scored 12 randomly-selected protocols, 6 from each text. The agreement was good ($k = .835$), so the remaining protocols were divided between the judges to complete the scoring.

For each participant's outline, we also computed a measure of outline organization. Specifically, we correlated the order of topics in a participant's outline with the order of the same topics in the text. A correlation of 1 indicated that the participant replicated the order of topics from the text; scores less than 1 indicated different degrees of misordering of the topics.

Results and Discussion

The questions of interest in Experiment 2 concern (1) how outlining performance compares for headings and preview sentences, and (2) whether the magnitude of the difference between the two signaling devices differs depending on whether outlining is done with the text present vs. absent. Separate ANOVAs were conducted on the two dependent variables of: (1) the number of topics accurately included in the outline (Topics); and (2) the correlation between the order of topics in a participant's outline with the order of the corresponding topics in the text (Correlation). The between-subjects factors in each analysis were: Text (problems or solutions), Task (text present vs. absent during outlining), and Signaling (headings, preview sentences, no signals). The results for both dependent variables are presented in Table 1.

There was no evidence of a Task \times Signals interaction in any of the analyses; largest $F(2, 108) = 1.45$, $MSe = 10.81$, $p = .24$, for the Topics measure. There were, however, main effects of Task and Signals. With respect to Task, more topics were correctly included in the outline if outlining was done with the text present than if it was

done with the text absent; $F(1, 108) = 41.16$, $MSe = 10.81$, $partial \eta^2 = .28$. In addition, the mean correlation between the order of topics correctly included in the outline was higher if outlining was done with the text present rather than absent; $F(1, 108) = 9.58$, $MSe = .086$, $partial \eta^2 = .08$.

Consider next the effect of Signals. For the Topics measure, the main effect of Signals was reliable; $F(2, 108) = 13.97$, $MSe = 10.81$, $partial \eta^2 = .21$. Tukey HSD comparisons demonstrated that more topics were included in outlines in the headings condition than in the no signals condition; $t(108) = 5.20$, Cohen's $d = 1.16$. In addition, more topics were included in outlines in the previews condition than in the no signals condition; $t(108) = 3.40$, Cohen's $d = 0.76$. There was no reliable difference between the headings and previews condition; $t(108) = 1.80$, $p = .17$, Cohen's $d = 0.40$. With respect to the Correlation measure, there were no reliable effects of signaling; $F(2, 108) = 2.62$, $MSe = .086$, $p = .08$, $partial \eta^2 = .05$.

In sum, the critical results from Experiment 2 concern the effects of the signaling manipulation. Under conditions where topic structure information is clearly relevant to the purpose for reading, participants do a better job of identifying topics for inclusion in their outlines if the text includes either headings or preview sentences than if there are no signals to topic structure. However, in contrast to Experiment 1, there is no advantage of headings over preview sentences. We interpret the lack of difference between headings and preview sentences in Experiment 2 to be due to the fact that (a) the headings and preview sentences communicated the same information about topic structure and (b) the clear relevance of the preview sentences to the outlining task resulted in readers giving more attention to them and thus compensating for the difference in visual salience between the headings and the preview sentences.

General Discussion

The results of Experiments 1 and 2 replicate previous findings with respect to the effects of headings on text processing. Headings have consistently been shown to improve memory for text topics when students read to understand and recall or summarize a text (Hyönä et al., 2002; Lorch & Lorch, 1996a; Lorch et al., 2001; Lorch et al., 2011b). Headings have also been shown to facilitate outlining (Lorch et al., 2011a; Lorch et al., 2012).

The new empirical findings concern the effects of preview sentences and how they compare to the effects of headings. Despite the fact that the preview sentences and headings in Experiment 1 provided the same information about topic structure, preview sentences were not as effective as headings in supporting memory for text topics when students read to understand and recall a text. In contrast, previews and headings aided outlining performance in Experiment 2 to approximately the same extent, and both signaling devices produced better outlining than a no signaling control condition. This result is consistent with recent findings that outlining is equally good for texts with headings and preview sentences when access to the text is limited by a paced, line-by-line presentation of the text. (Lorch et al., 2012).

The overall pattern of results from Experiments 1 and 2 supports the hypothesis of a tradeoff between bottom-up and top-down influences on processing involving signaling devices. Headings and preview sentences communicate the same information about a text's topic structure, but headings are more visually salient because they are typographically contrasted with the rest of the text. The visual salience of headings elicits readers' attention; in contrast, no corresponding bottom-up influence on attention exists for preview sentences. As a result, headings produce better memory for text subtopics when the reading task does not confer any special status on topic information (Experiment 1). However, when the reading task singles out topic information as specifically relevant (Experiment

Table 1
Summary of Mean Performance on Two Measures of Outlining Performance in Experiment 2 as a Function of Signaling Condition and Task (standard deviations in parentheses)

DV	Condition	No Signals	Previews	Headings	Mean
Topics	Text Present	11.75 (4.05)	15.50 (3.17)	16.20 (1.51)	14.48
	Text Absent	9.15 (3.39)	10.40 (3.60)	12.35 (3.70)	10.63
	Mean	10.45	12.95	14.28	
Correlation	Text Present	.889 (.287)	.989 (.045)	.999 (.005)	.959
	Text Absent	.726 (.405)	.742 (.481)	.913 (.133)	.794
	Mean	.808	.865	.956	

2), readers become alert to such information and this top-down influence on attention compensates for the lack of visual salience of preview sentences. Both previews and headings are explicit in their communication of topic information so readers have no difficulty identifying and processing such information when they were specifically searching for it.

Our hypothesis of a tradeoff between task demands (topic specific or not) and signaling properties (visually salient or not) requires further testing. First, we must test the generality of the hypothesis that visually distinctive signals have bottom-up influences on text processing that visually indistinct signals do not have. The comparison investigated in this study confounds the signaling device with the presence vs. absence of typographical contrast. However, it is possible to test whether the difference between headings and previews found in Experiment 1 is specifically due to their difference in visual contrast by orthogonally manipulating the presence/absence of contrast with the type of signaling device.

Second, the generality of the hypothesis we are proposing should also be tested by comparing other pairs of signaling devices that communicate the same information in different ways (e.g., advanced outlines vs. headings) and by comparing other tasks that vary in the degree to which topic information is specifically relevant to the reading task.

Finally, it is important to construct a direct test of the hypothesized tradeoff between bottom-up and top-down influences during processing of signaling devices. This requires a single experiment in which there is an orthogonal manipulation of a variable hypothesized to influence attention in a bottom-up fashion (e.g., presence/absence of typographical contrast) and a variable hypothesized to influence attention in a top-down fashion (e.g., reading tasks that differ in whether they exclusively emphasize topic information).

Our findings may have two important implications for educational practice. First and most immediately, our findings are relevant to textbook design. The organization of expository text is often complicated so authors routinely use organizational signals to guide readers in their attempts to comprehend text. Headings are among the most commonly used organizational devices (Ho-Dac, Fabre, Péry-Woodley, Rebeyrolle, & Tanguy, 2012) and for good reason, given the extensive evidence that headings facilitate many aspects of text processing (for reviews: Lorch, 1989; Lemarié, Lorch, & Péry-Woodley, 2012). The findings of the current study provide further support for the use of headings, but also suggest a role for preview sentences in signalling topic structure. Given the attention-eliciting properties of headings, we hypothesize that they are particularly well-suited for communicating transition points that are captured by the overall organizational plan of a text. For example, if a text is built around a 3-level hierarchical plan, headings are a good choice for signaling all three levels of structure. However, if a fourth level of hierarchy occurs for some parts of a text but not others, preview sentences may then be the better choice to communicate these more minor and less systematic transition points. These suggestions are highly speculative at this point, but merit further investigation.

Finally, the study of signaling devices has potential relevance to the instruction of strategies for understanding expository text. Because the structure of a text reflects the important distinctions and relationships that the author is attempting to communicate, comprehension requires sensitivity to a text's organizational structure. Therefore, many researchers have developed comprehension strategies that attempt to teach readers to detect and use a text's organizational structure (Meyer et al., 1989; Paris & Oka, 1989; Richgels, McGee, Lomax & Sheard, 1987; Samuels, Tennyson, Sax, Mulcahy, Schermer, & Hajovy, 1988; Sanchez et al., 2001). Signaling devices can be an important component of this approach because of their explicit cueing of organizational structure (Meyer et al., 1989; Sanchez et al., 2001).

Conflict of interest

The authors of this article declare no conflicts of interest.

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