

Heading Frequency and Comprehension: Studies of Print Versus Online Media

Jan H. Spyridakis

Laura D. Schultz

Alexandra L. Bartell

This paper describes a study that examined the effect of heading frequency on comprehension and perceptions of information presented in print versus online text. Results indicated that heading frequency did not differentially affect the comprehension of readers of print text while it did differentially affect the comprehension of readers of online texts who had considerably lower comprehension scores with text that had high frequency versus medium frequency headings.

INTRODUCTION

Empirical studies tell us that when readers encounter “signals” in print text, they are able to better comprehend new or difficult information. These signals—headings, summaries, overview sentences, and other types of cues about text content—help readers create mental roadmaps of a text’s structure. These roadmaps or schemata provide a structural and content-based context that helps readers take in new information. Readers may instantiate existing schemata with new facts or they may reject new information when it does not fit with the current schemata.

Knowing the value of signals in foreshadowing information is helpful for technical communicators. Yet even though research has shown the value of signaling in print text, very little research has examined the nuances of how to best use or design text signals. In particular, no study has investigated whether the frequency of headings in print text affects readers’ comprehension. One might wonder whether there is an optimum frequency of headings that would help readers build schemata and best understand the text.

This exact issue was investigated by Schultz and Spyridakis (1) in a study that examined the effect of heading frequency on readers’ comprehension and perceptions of new knowledge gained with online medical articles. The study discussed here investigates this same issue in print documents and compares the results with those from the online study (1).

Related Literature

Before describing our current study, we briefly review relevant literature on headings and on the processing of print versus online text.

Headings have been shown to help readers build a conceptual framework or schema for encoding text (2), thus helping them retain and retrieve information (3, 4, 5, 6, 7, 8, 9, 10). Research has also shown that headings in print-based texts seem to provide clues about information importance (11, 12, 13), which may in turn affect recall. Also, headings have been shown to be particularly helpful in helping readers understand difficult or unfamiliar information (6).

With the exception of a study by Schultz and Spyridakis (1), research has not examined how the frequency of headings might help readers create mental frameworks for reading online or print documents. Their Internet-based study assessed the effect of heading frequency on comprehension and perceptions with two reader populations: college students in undergraduate engineering classes and readers from the community at large. The results revealed that high frequency versus medium frequency headings led to significantly lower comprehension for the students and lower perceptions of new knowledge gained for the readers from the community at large. The current study investigated this issue in print text given the literature (discussed next) that reveals that readers of print and online text are not always equally affected by text design.

Many studies have examined how users process online versus print-based material. These studies, however, have focused primarily on reading speed rather than comprehension (as measured by recall or recognition of content) (14). Although studies comparing reading speed in online versus print environments have had mixed results (14, 15, 16), reading from screens appears to be slower than reading from paper (14, 16, 17, 18). In addition, research has tended to concentrate on visual presentation and ergonomic factors such as screen resolution, contrast, background color, luminance levels, and flicker (14, 17).

Fewer studies appear to have been conducted on how factors intrinsic to information design, including text signaling, might affect comprehension in online versus print media. Several studies have found that factors such as cognitive overload and disorientation in hypermedia environments may negatively impact comprehension in online reading (18). Macedo-Rouet et al. cite some studies indicating that structural organizers such as titles, headings, and tables of contents appear to have greater importance in hypertext rather than print mediums (20). The cited studies suggest that structural organizers may reduce the cognitive overload and disorientation that users experience in hypertext environments.

The current study examined whether the differences we identified for the effect of heading frequency on comprehension and perceptions of online texts would also apply to print texts.

METHODOLOGY

Study Design

The 2 x 4 x 2 experimental design comprised:

- Two types of content: rheumatoid arthritis and osteoarthritis.
- Four levels of heading frequency: no headings; low frequency (approximately 1 heading/300 words); medium frequency (approximately 1 heading/200 words); high frequency (approximately 1 heading/100 words).
- Two media: print and online [results from the print text compared to results from the students in online conditions in Schultz and Spyridakis (1)].

Subjects

Although Schultz and Spyridakis' online study (1) used participants from two reading populations (undergraduate engineering students and readers from the community at large), our print-based study used only undergraduate engineering students at the University of Washington. Results of these subjects interacting with the print-based texts are compared to the results of only the undergraduate students who participated in the online study.

The sample included 239 participants [127 in the print-based study; 112 in the online study with Schultz and Spyridakis (1)]. Subjects were on average 21 years old and 76 percent were males and 24 percent were females,

a typical distribution for engineering undergraduate classes.

Materials

The source text for the study came from two articles on arthritis from the Arthritis Source Web site (<http://www.orthop.washington.edu/arthritis/>), a medical Web site created jointly by the Washington State Chapter of the Arthritis Foundation and the Department of Orthopedics and Sports Medicine at the University of Washington. Texts on two topics were used to offset the chance that results would be content specific.

The texts for the print study contained the same content and headings as the online study. When possible, we replicated the presentation format of the online study in the print study (e.g., 11-point Verdana type face). With the online text, we used a naturally occurring Web page with all of its original design features. Hence, the online text width would adjust to the user's screen width; with a 17-inch monitor, set to 1024 x 768 pixels, the maximum line length was 97 characters. With the print-based text (presented in portrait layout), the maximum line length was 82 characters. Both articles in all heading conditions consisted of either one long Web page that required scrolling or 5 to 6 printed pages (single spaced, 1.25-inch margins).

The headings were constructed by replicating headings from the original text and adding to them to create the higher frequency heading conditions (for details on the construction and testing of the heading conditions, see Schultz and Spyridakis (1)). There were no subheadings and the headings for the print-based study were formatted with the same font size and layout as the online study.

Test instruments. Comprehension was measured with the same multiple-choice comprehension test that was used in the online experiment. The tests consisted of two sets of 15 multiple-choice questions designed for either the osteoarthritis or the rheumatoid arthritis texts. Because these questions were originally reviewed and approved by a rheumatologist, and they had been tested for passage dependency, they were not revised for the print-based study. Similarly, demographics and perceptual questions from the online study were reused in the print-based study.

Procedures

The print-based experiment was conducted in classroom settings at the University of Washington in Seattle using paper surveys and response forms. The online study was conducted through the Internet at the time and location

that participants chose (see Schultz and Spyridakis (1) for further details).

For the print-based study, at the beginning of each session, a researcher explained the study in general terms, passed out consent forms, informed the subjects that they were free to participate or not, and that they could choose to end their participation at any point. Participants were also told that once they were finished reading and progressed to the tests they could not turn back and look at the texts. Similar information and instructions were provided to online participants. As with the online study, an incentive in the form of a drawing for an amazon.com gift certificate was offered to all participants.

Each participant was randomly assigned to one of the eight study conditions. Participants in both studies were told that the study would take from 20 to 25 minutes. After reading the passage to which they were assigned, participants answered the demographic, perceptual, and comprehension questions, without turning back to the text.

RESULTS

Results discussed as significant are significant at an alpha level of .05 or less. Because preliminary statistical analyses revealed that native and nonnative speakers of English significantly differed on comprehension, our analyses focused on native speakers of English. Therefore, the sample was reduced to a total of 197 participants (83 for the online study, 114 for the print-based study).

Results from the demographic survey provide some context for the comprehension results. As expected, all participants were frequent users of the Internet who spend a lot of time weekly searching for general information on the Web and very little time looking for medical information. Similarly, a majority of participants reported being comfortable with computers and the Internet.

Other preliminary analyses confirmed our expectation that there would be no comprehension differences between participants who had read the osteoarthritis versus the rheumatoid arthritis texts. Therefore, analyses focused on assessing the effect of medium (print versus online) and heading frequency (four levels) on comprehension. We found that (across all heading frequency conditions) participants in the print condition had significantly higher comprehension overall than participants in the online conditions. We also found that across both subject groups (print and online participants analyzed together) high frequency headings (1

heading/100 words) led to significantly lower comprehension than low frequency headings (1 heading/300 words). There was also a trend for high frequency headings leading to lower comprehension than medium frequency headings (1 heading/200 words).

Of specific interest here with regard to our research question, though, is the significant interaction between display medium and heading frequency. Heading frequency did not affect the readers of the print texts nearly as much as it did the readers of the online texts. In fact, readers of the print text had relatively similar comprehension scores, regardless of heading frequency. In contrast, readers of the online texts had considerably higher comprehension with medium frequency headings, and considerably reduced comprehension with the high frequency and no heading conditions. Also, although the results were only marginally significant, online readers tended to have lower perceptions of new knowledge gained with high versus medium frequency headings.

DISCUSSION AND CONCLUSION

The findings from this study of readers of print versus online text reveal some intriguing ideas. Given the result that readers of print-based text had higher comprehension scores than readers of online text regardless of heading frequency, it appears that readers of print-based text comprehend more information regardless of text design than readers of online text. Although this finding requires more study to thoroughly understand, this result adds to the ongoing literature assessing readers of online versus print text that suggests the two media are not identical in terms of readers' interactions and understanding.

Research has shown that experienced readers have less need for signals, including headings, than inexperienced readers. Readers' familiarity with the print medium may help them comprehend more with print-based text than with online text. Online text compared with print text is still in its infancy and is less prevalent and familiar, and it may be more difficult to comprehend. Thus, signals may be able to offer more help to readers of online text, as suggested by Macedo-Rouet et al. (20).

Across the online and print conditions, we see that high frequency headings reduced comprehension overall. Yet when we examine the differential effect of heading frequency on readers of print-based readers versus online text, we further see that readers of print-based text are much less impacted by heading frequency than online readers. The online readers had significantly lower comprehension with the high frequency (i.e., a heading approximately every 100 words) versus medium frequency (i.e., a heading approximately every 200

words) heading conditions. If readers were disoriented with the online text to begin with, this feeling might have been compounded by the high frequency headings as they tried to understand the flow of text.

To elaborate, if we think about the differences in layout and legibility between print and online documents, we can further understand this idea. While readers of print-based text can foresee upcoming information and “get the lay of the land,” readers of online text cannot physically spread out the pages to get a quick overview of the text, a difference that might affect comprehension and might account for the damaging effect of too many headings with online readers. Perhaps too much chunking of text works against creating a good, accurate schema and may negatively influence comprehension. Also, although screen resolution and legibility have improved overall, some of these factors could still affect online reading.

This print study and its comparison to the online study point the way to future research. It would be interesting to see how texts other than those on medical topics might influence comprehension scores in both media, as well as the need for headings. Also, it would be informative to extend this study to readers with a personal motivation for reading the text, similar to the readers from the community at large that participated in the Schultz and Spyridakis online study (1). Future research might also measure actual time spent reading texts displayed in both media and assess whether readers spend equal amounts of time reading as well as how that would relate to comprehension scores. The toolkit that Spyridakis and her students are creating (21) would allow for the measurement of time spent reading online, a test measure easily replicated with print-based reading in research environments.

There are several implications for technical communicators. First, this study is a good reminder that although computers and online text are becoming ubiquitous in our modern 21st century world, there are indeed differences between reading text in print and reading text online. Thus, the structural cues that may help readers comprehend text in one medium may be different in another medium. Technical communicators should keep these differences in mind, especially when transferring text from one medium to the other.

As future research begins to determine the effects of text signals on different populations and media, we will continue to improve the ways we communicate in the variety of media now available to readers. For technical communicators the challenge is to keep up with both the technology itself and the best ways to communicate with that technology.

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Jan H. Spyridakis
 Professor
 14 Loew Hall, Box 352195
 Department of Technical Communication
 University of Washington
 Seattle, WA 98195-2195
 206-685-1557
 jansp@u.washington.edu

Jan H. Spyridakis is a Professor of Technical Communication at the University of Washington. Her research focuses on document and screen design variables that affect comprehension and usability, Web design, cross-cultural audiences, and the refinement of research methods. She is a Fellow of STC and she often teaches seminars in industry.

Laura D. Schultz
 Technical Editor
 The Boeing Company
 Boeing Shared Services Group
 P.O. Box 3707 M/C 7A-CH
 Seattle, WA, 98124-2207 U.S.A.
 425-294-5939
 laura.d.schultz@boeing.com

Laura D. Schultz works at The Boeing Company as a technical editor, and is a senior member of the Puget Sound chapter of the Society for Technical Communication. Laura received her Masters of Science in Technical Communication from the University of Washington. Her areas of primary research are signaling and the communication of medical information online.

Alexandra L. Bartell
 Technical Writer
 The Boeing Company
 Boeing Shared Services Group
 P.O. Box 3707 M/C 7A-CH
 Seattle, WA, 98124-2207 U.S.A.
 425-681-1508
 sandy.bartell@boeing.com

Alexandra ("Sandy") Bartell is a technical writer and web designer at The Boeing Company. She is a member of the Society for Technical Communication and recently received her Masters in Science in Technical Communication at the University of Washington where she is continuing her PhD studies. Her primary areas of interest are information design and usability applied to electronic media.