The Effect of Heading Frequency on Comprehension of Print Versus Online Information

ALEXANDRA L. BARTELL, LAURA D. SCHULTZ, AND JAN H. SPYRIDAKIS

INTRODUCTION

For technical communicators, writing, editing, and designing information for different audiences is becoming an increasingly complex task. Today’s technical communicators still have the same goals as technical communicators of 10 years ago, but the media choices available are varied and more complex, and can require a variety of rhetorical strategies. Although the idea of a paperless society has almost disappeared, the Internet has become a part of standard document design practices and everyday reading experiences. The Internet often mimics the print world when print material is transferred to Web pages without much change in format or content. We believe that this direct transfer of material from one medium to another results in less than optimal reading materials and a potential challenge for readers.

At this point, empirical research about the design of print documents is one of the resources technical communicators can examine to learn more about document design in general. One area of empirical research with considerable information concerning print documents is that of “signaling.” Text signals consist of preview statements, overview sentences, headings, and other cues about the content and structure of a text. Empirical studies tell us that when readers who are “reading to learn” encounter signals in print text, they are better able to comprehend new or difficult information. These signals help readers create mental roadmaps or schemata of a text’s structure and content that in turn help them absorb new information. As readers take in new information, they instantiate existing schemata, adapt them as needed to fit the new information, and at times, even reject the new information.

We know much about print-based text signals, yet there are still gaps in the research. Further, very little research has specifically examined the nuances of how to best use or design text signals online. Schultz and Spyridakis (2004) investigated the effect of heading frequency on the comprehension and perceptions of readers of online text. However, to date, no work has explored the effect of heading frequency on readers of print documents. Thus, the current study expands on Schultz and Spyridakis’s online study to assess the effect of heading frequency in print text and also compares the print-based results with their online results (2004). Specifically, this article investigates the effect of heading frequency and display medium on readers’ comprehension and perceptions of text.

The findings should help document designers better understand the ongoing debate as to whether readers perform the same with print and online documents, and whether design features that may be helpful or harmful in one medium will elicit the same results from users in another medium.

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RELATED LITERATURE
Before describing our current study, we briefly review relevant literature on (1) schemata, (2) headings, and (3) the processing of print versus online text.

**Schemata: Information frameworks**
Schemata are mental outlines or conceptual frameworks that readers have built from past experiences. Readers instantiate schemata to help them understand and take in new information. Schemata do not have to be activated consciously; they are brought up without any direct effort on a reader’s part (Williams 1994). Also, schemata are flexible and change as new information is added to the mental outline. Readers create organizational frameworks in memory that help them to (1) encode information and (2) retrieve it from long-term memory (Anderson and Pearson 1984; Bartlett 1932; Brooks and Dansereau 1983; Kintsch and van Dijk 1978; Williams 1994).

A reader can use a well-developed schema to turn new information into useful knowledge. An effective schema can also create a “levels effect” where readers recall information that is higher or more important in the mental hierarchy than information at a lower or less important level (Britton and colleagues 1980; Kintsch and Yarbrough 1982; Kintsch and van Dijk 1978; Olhausen and Roller 1988).

**Text signaling: Headings and the retrieval of information**
The research on readers of print information has shown that the development of schemata is aided by the presence of headings. Headings facilitate the reader in encoding text and thus in retaining and retrieving information (Hartley and colleagues 1980; Hyona and Lorch 2004; Lorch and Lorch 1996a; Lorch and Lorch 1996b; Lorch and colleagues 2001; Sanchez, Lorch, and Lorch 2001; Spyridakis 1989a; Spyridakis 1989b; Spyridakis 1991).

Beyond encoding and retrieval, research has also shown that headings in print-based texts seem to provide clues about information importance (Eysenck and Keanne 1990; Hartley 1987; Waller 1982), which may in turn affect recall. Signals are embedded in the text, and they highlight the text’s structure, important points in the text, or both (Meyer 1984). Waller (1982), for example, used the phrase “text as diagram” to explain how text signals can be a sort of graphic representation of the text itself and demonstrate the relationships between parts of the text. The importance of text signals is evident when one realizes how much readers use cues in a text to help them discern a text’s meaning (Kintsch and Yarbrough 1982).

The characteristics of a text itself may interact with the effect of signals on reading comprehension. If a topic is familiar, it is probably already encoded with relevant schema, and signals in text may prove less useful (Blasko and Connine 1993; Conway and Dewhurst 1995; Niederhauser and colleagues 2000; Sadoski, Goetz, and Fritz 1993; Spyridakis 1991). However, if readers lack domain knowledge or find a text difficult to comprehend, signals that provide text coherence may help them better understand the material (Salmeron and colleagues 2005; Spyridakis 1991). In contrast, text that readers perceive to be easy does not benefit from signals—in such cases, readers have little need for the extra help that signals could provide (Lorch and Lorch 1996a; McDaniel, Einstein, and Lollis 1988). Similarly, if readers find the information enjoyable to read, they may be less likely to need headings or other signals to help them understand the content (Huhmann, Mothersbaugh, and Franke 2002; Mullen and Koester 1975). Such readers may be motivated enough to overcome any difficulties with understanding the text.

Currently, Web design experts often advocate the use of high frequency headings in online text (McAdams 1996; Nielsen 2000; Redish 2003). The general idea is that headings are helpful not only because they introduce topics and help readers create schemata, but because they orient a reader who is scrolling through Web pages. Moore (n.d.) writes,

> The biggest difference between reading online and reading printed text is that online, the text moves. You’re scrolling up and down. As you scroll, you tend to scan the document. The environment urges you to speed-read, so if you don’t see anything but plain text, you’re likely to lose interest.

Because readers tend to scan online text (Nielsen 1997; Schmar-Dobler 2003), many Web usability specialists have called for the use of more headings in online text. Although such advice may be valuable for readers who are “reading to do” and who are thereby searching online texts for specific information, it may be less appropriate for readers who are “reading to learn.”

The differences between “reading to do” and “reading to learn” were first explicated by Sticht (1985) and Redish (1989). Reading to do involves reading information that is then applied to actions. Today this might involve reading a user guide to determine how to print labels on a laser printer or reading information to fill out an online form. The important outcome of reading to do is immediate action—not recall. In contrast, with reading to learn, the goal is overall comprehension. Students who read a textbook to learn a subject, for example, are reading to learn. Patients who read medical information online to learn about their conditions and be better prepared to discuss them with their medical caretakers are also reading to learn.
Regardless of the call for more frequent headings online, little research has actually examined the issue of heading frequency in either print or online text. With the exception of the Schultz and Spyridakis study (2004), we could not find research that examined how the frequency of headings might help readers create mental frameworks for reading online or print documents. The Schultz and Spyridakis Internet-based study assessed the effect of heading frequency on comprehension and perceptions of online text with two reader populations: young adults without a personal interest in the information and middle-aged adults with a personal interest in the information.

The results revealed that medium-frequency headings led to significantly higher comprehension than high-frequency headings for participants without a personal interest in the information and significantly higher perceptions of new knowledge gained for readers with a personal interest in the information. Further, text with medium-frequency headings tended to lead to higher comprehension more than text with low-frequency headings for participants without a personal interest in the information.

The current study applies the methods of this online study to a study of heading frequency in print-based text with young adult readers who do not have a personal interest in reading the information. This population is an important population to study because its members represent readers who may be quite Web savvy but who are not necessarily interested in information about medical conditions, insurance policies, or loan terms, for example, even though they may in fact find themselves forced to read such information in response to events in their everyday lives. As mentioned before, readers who find information enjoyable to read are not as likely to use headings or other structural cues to help them comprehend information (Huhmann, Moothersbaugh, and Franke 2002). Thus, studying readers without a vested interest in the information provides a realistic indication of how heading frequency may affect the comprehension of readers who would be less willing to overcome document design obstacles.

We also compare the results of the online and print-based studies. Before a review of the study, we briefly look at some research that has compared performance with print versus online text.

**Information processing: Online versus print media**

The differences between print and online reading have been researched with regard to how factors inherent in each medium affect performance and how readers process information.

Many studies that compare the processing of online versus print-based materials focus on reading speed rather than comprehension (as measured by recall or recognition of content). Although research on the effect of presentation medium on reading speed has had mixed results (Dillon 1992; Gould and colleagues 1987; Osborne and Holton 1988), reading from screens appears to be slower than reading from paper (Dillon 1992; Gould and colleagues 1987; Mills and Weldon 1987; Nielsen 2000). In addition, research with online texts has tended to concentrate on visual presentation and human interface factors such as screen resolution, contrast, background color, luminance levels, and flicker (Gould and colleagues 1987; Mills and Weldon 1987).

Some studies have examined how information design factors, including text signaling, might affect comprehension in both online and print documents. Eveland and Dunwoody (2001) showed that traditional cues associated with print text, such as page numbers and summaries, could help improve readability in hypertext environments. Examining learning from hypertext, Dee-Lucas and Larkin (1995) discovered that readers found structured overviews easier to recall and to use than unstructured overviews. Although Wenger and Payne (1996) found no overall differences in processing demands between linear texts and hypertext, they did find that hypertext requires a greater use of relational processing.

These studies suggest that structural organizers may reduce the disorientation that users experience in hypertext environments. Disorientation for online readers has often been attributed to issues of cognitive load. Sweller (1988) defined three types of cognitive load that could help explain comprehension differences in print versus online environments:

- **Intrinsic cognitive load**, which is inherent in the material itself
- **Extraneous cognitive load**, which is imposed on the user by the format and way that the material is presented
- **Germane cognitive load**, which involves the learner’s attempts to process and understand the information

The concept of extraneous cognitive load can be illustrated by the multitasking that readers of online information engage in as they make navigation decisions, follow links, use a mouse, scroll pages, and so on. Brunken, Plass, and Leutner (2003) refer to this type of multitasking as a kind of “overhead” that does not help readers understand what they are reading because it is extraneous to the material itself. Some research has suggested that the format of hypermedia—with the possibility of overwhelming amounts of information and visual stimuli as well as deep information hierarchies spread over multiple pages—can contribute to cognitive overload and disorientation, and negatively impact comprehension in online reading (Ho and Tang 2001; Nielsen 2000).

In contrast, print-based readers are not burdened with the added overhead of navigation considerations and
human-machine interactions when they turn pages and read print texts. These reading tasks have been automated through years of experience and do not compete for cognitive capacity in normal readers. The implication is that because print-based readers have less extraneous cognitive load to deal with, they are able to free up working memory and use germane cognitive load to build and automate schemata that deepen comprehension (Bannert 2002; Brunken, Plass, and Leumer 2003).

HYPOTHESES
Drawing from what we know about how readers process print text and how the nature of online text may increase cognitive load, the review of the literature led us to the following hypotheses:

- **H1.** Text topic (rheumatoid *versus* osteoarthritis) will not affect comprehension.
- **H2.** Print readers will comprehend more than online readers.
- **H3.** High-frequency headings will most severely hinder comprehension in both print and online media.
- **H4.** Display medium and heading frequency will interact.

MATERIALS AND METHODS

**Design**
The 2 × 4 × 2 experimental design comprised:

- Two text topics: rheumatoid arthritis and osteoarthritis
- Four levels of heading frequency: no headings, low frequency, medium frequency, and high frequency
- Two media: print and online

**Participants**
Participants for the comparative study were undergraduate engineering students enrolled in two technical communication courses at the University of Washington. The sample (n = 239) included 127 participants in the print-based study and 112 in the online study (see Schultz and Spyridakis 2004). Participants in the print and online studies were recruited in a similar way. In the print study, participants were recruited by course instructors who introduced the researchers to the participants during a class session. One of the researchers read general information about the study to the students and asked for their voluntary participation during class. With the online study, the same information was handed out on flyers distributed to students in the classes; the flyers asked participants to participate by entering the study URL into their computer browser.

**Materials—Texts**
The source text for both the print and online studies came from two articles on arthritis excerpted from the Arthritis Source Web site (www.orthop.uwmedicine.org), a medical Web site created jointly by the Department of Orthopaedics and Sports Medicine at the University of Washington and the Washington State Chapter of the Arthritis Foundation. Texts on two topics were used to offset the chance that results would be content specific—that is, that results would be due to a particular text’s idiosyncrasies or even the topic itself. Thus, we were not expecting to find differences between the two texts in our results.

Four versions of each text were constructed to represent the four heading frequency conditions:

- No headings
- Low frequency headings (one heading approximately every 300 words)
- Medium frequency headings (one heading approximately every 200 words)
- High frequency headings (one heading approximately every 100 words)

The heading frequency levels were determined by reviewing medical Web sites and choosing common average heading/word count ratios. Headings were constructed by designing new headings or editing existing headings. In general, headings consisted of noun or participial phrases containing one to seven words (mean = 3.62, standard deviation = 1.38). The goal with each heading was to summarize the main point of the text that followed it.

Headings were inserted into logical spots in the text, and then they were rated by four technical writers for their accuracy in reflecting the ensuing content. Any headings deemed to be inaccurate were revised. Across the four heading conditions, the two arthritis articles were about 2,000 words long. Headings were formatted at only one hierarchical level because the online articles in their natural state on the Arthritis Source Web site were designed that way (that is, there were no subheadings).

With regard to overall document layout, our goal was to create two versions that represented typical presentations for the two media, not simply to create a print-based rendition that mimicked the original Web materials. However, whenever possible, the print study replicated the format of the online study (for example, the same type size and face: 11-point Verdana). With the print-based text, the maximum line length was 82 characters, and pages were laid out with portrait orientation, single line spacing, and 1.25-inch margins. With the online text, we used the original design features of the naturally occurring Web pages (except that we removed embedded links pointing to pages outside the arthritis articles). Hence, the online text width would adjust to the user’s screen width; with a 17-inch monitor set to 1,024 × 768 pixels, the maximum line length was 97 characters. Both articles in all heading conditions consisted of either five to six printed pages or one long Web page that required scrolling.
Materials—Test instruments
Test instruments consisted of two surveys. The first survey assessed demographics and computer/Internet experience. This survey also presented a scenario to guide reading, telling participants that if they were not researching arthritis information for themselves, they should imagine they were researching information for a friend or relative about the effects of and treatment for arthritis. (This scenario was included to help readers engage with the text.)

The second survey, presented after participants had read the arthritis information, asked perceptual questions about participants’ level of interest, familiarity, and difficulty with the arthritis texts. This survey also included 15 multiple-choice comprehension questions designed for either the osteoarthritis or the rheumatoid arthritis texts. These questions were developed following Haladyna’s guidelines for test construction (1997). The comprehension questions were approved by Dr. Fredrick Matsen (an Arthritis Source author) and tested for passage dependency with technical communication students who had not read the arthritis texts. The goal of passage dependency testing of multiple-choice questions is to refine questions and answer slots to the point that all answers have an equal likelihood of being selected by people who have not read the text. The questions were edited and retested until all questions met the passage dependency goals.

Procedures
The print-based experiment was conducted in classroom settings at the University of Washington in Seattle, WA, using paper surveys and response forms. The online study was conducted through the Internet at a time and location selected by individual participants.

At the beginning of each session for the print-based study, a researcher explained the study in general terms; passed out human subjects consent forms; and informed the subjects that they were free to participate or not, that they could end their participation at any point, and that the study would take 20 to 25 minutes. Participants were also told that once they were finished reading and progressed to the surveys, they could not turn back and look at the texts. Similar information and instructions were provided to online participants. 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 experimental conditions. After reading the passage to which they were assigned, participants answered the demographic, perceptual, and comprehension questions without turning back to the text. The data was analyzed using SPSS 11.5 on a personal computer.

RESULTS
Results discussed as significant are significant at an alpha level of .05 or less. A t test to look for the effect of native language (native English versus nonnative English speakers) on comprehension was significant in both the print-based and online studies (print t (125) = 2.187, p = .031; online t (110), t = 2.909, p = .004). Therefore, nonnative speakers were excluded from further analyses. The exclusion of nonnative speakers reduced the sample size to a total of 197 participants (114 for the print-based study, 83 for the online study).

Demographic results
The participants in both studies ranged in age from 18 to 36 (mean = 20.86, standard deviation = 2.75); 76% were males and 24% were females, a typical distribution for students in engineering undergraduate classes. In terms of class level, 37.1% were freshmen or sophomores, 39.1% were juniors, and 23.8% were seniors or fifth-year students.

Computer and Internet usage Participants in both the print and the online studies were frequent users of the Internet who spent an average of 15.49 hours per week on the Web and, as might be expected, rated themselves as somewhat comfortable with computers (mean = 3.83, standard deviation = 1.65, where 1 = very uncomfortable; 5 = very comfortable) and with the Internet (mean = 3.88, standard deviation = 1.64). The vast majority of the participants (89.9%) reported that they used the Web to search for general information a few times a week to daily; however, only 5.6% of the participants reported accessing medical information on the Web a few times a week to daily.

Enjoyability, familiarity, interest, and difficulty Participants rated their perceptions of the information they read on four five-point scales. With no significant differences in ratings between presentation media, participants rated the information they read at slightly below the midpoint for enjoyability (mean = 2.82, standard deviation = .74; where 1 = very unenjoyable, 5 = very enjoyable) and familiarity (mean = 2.40, standard deviation = .92; where 1 = very unfamiliar, 5 = very familiar), and slightly above the midpoint for interest (mean = 3.39, standard deviation = .87; where 1 = very uninteresting, 5 = very interesting).

Participants’ ratings for text difficulty did significantly differ by presentation medium (t (195) = 2.108, p = .036). Readers of print-based texts found the tests significantly easier (mean = 3.59, standard deviation = .85; where 1 = very difficult, 5 = very easy) than readers of online texts (mean = 3.34, standard deviation = .79); see Figure 1.

Comprehension results Results of t tests confirmed our expectation that there would be no comprehension differ-
ences between participants who had read the osteoarthritis versus the rheumatoid arthritis texts in the print or online conditions. Therefore, the texts were collapsed to analyze the effect of heading frequency and medium on comprehension.

A two-way ANOVA revealed a main effect for heading frequency on comprehension ($F(3, 192) = 2.805, p = .041$). A post hoc LSD revealed that the high-frequency heading condition led to significantly lower comprehension (mean = 8.85) than the medium (mean = 9.70) and low (mean = 9.84) frequency heading conditions ($p = .051$ and $p = .021$, respectively). Table 1 and Figure 2 reveal the comprehension results for the four heading-frequency conditions.

The two-way ANOVA also revealed a significant main effect for medium on comprehension ($F(1, 194) = 4.682, p = .032$). Participants in the print condition had significantly higher comprehension overall (mean = 9.70, standard deviation = 1.84) than participants in the online condition (mean = 8.88, standard deviation = 2.59).

The two-way ANOVA also revealed a significant interaction between heading frequency and display medium ($F(3, 192) = 2.935, p = .035$). Heading frequency did not affect the readers of the print texts nearly as much as it did the readers of the online texts (see Figure 3). While readers of the print text had relatively similar comprehension scores regardless of heading frequency, readers of the online texts were more strongly affected by heading frequency, showing higher scores with the medium-frequency heading condition and considerably lower scores with the high-frequency and no-heading conditions.

A two-way ANOVA to examine the effect of heading frequency and display medium on participants’ perceptions of new knowledge gained revealed no significant effects.

**DISCUSSION**

It is helpful to take a step back and interpret these results from a broader viewpoint. First, the nature of our participants informs our results. Our readers were primarily 21-year-old males, and we can attest that the paper-based participants were somewhat serious about their work, spending at least 20 minutes participating in the paper-based study. These young adults were good readers, and they are quite computer and Web savvy; however, they found the print information easier than the online texts. The readers found both texts relatively interesting and rather average in terms of enjoyability and familiarity. As discussed later, some of these reader characteristics may have influenced the comprehension results.

With regard to the overall goals of the study, our first hypothesis was confirmed: text topic did not affect comprehension.

Our second hypothesis was also confirmed: print readers comprehended more than online readers. It appears...
that readers of print-based text are able to comprehend more of the text than readers of online text regardless of heading frequency. And this may be particularly true of our reader population, readers with little prior knowledge of the topic or personal motivation for reading the information—even though our readers were extremely experienced in Web environments.

As more and more print documentation is replicated online in quasi-print formats (for example, long sections of text, few headings), this finding is especially noteworthy. With printed material, readers are better able to orient themselves in the text and build an appropriate schema to facilitate comprehension. With complex online documents, the extraneous cognitive load that online readers encounter by having to navigate Web pages may exact a cost on comprehension. While the participants in our online study did not have major navigation decisions to make beyond scrolling down the page, it does appear that they had less cognitive capacity available for comprehension due to whatever extraneous load was imposed by the tasks involved in online reading.

Our third hypothesis was also confirmed: high-frequency headings most severely hindered comprehension in both print and online media. But the results relating to our fourth hypothesis—that display medium and heading frequency would interact—complicate the simple notion that high-frequency headings impede comprehension across the board. Our results showed that readers of the print text were much more resilient to heading frequency extremes than the online readers. In comparison to the online readers, readers of the print texts had relatively similar comprehension scores regardless of heading frequency. In contrast, readers of the online texts had higher scores with the medium-frequency heading condition and considerably lower scores with the high-frequency and no-heading conditions. The significant interaction of display medium and heading frequency reveals that the comprehension of online readers is much more susceptible to weak structural cues (such as too many or too few headings) than is the comprehension of print-based readers.

Our results reveal that online readers are more negatively affected by poor structural cues and thus benefit from clear signaling. These results are particularly valid for factual comprehension—our comprehension tests had a stronger focus on factual than on inferential comprehension because the texts consisted of many factual statements (in that they were introductions to osteoarthritis and rheumatoid arthritis). In addition, the tests lost some of the inferential questions present in the initial materials as the tests were revised for passage dependency.

To summarize, because orientation in a text is crucial for developing an accurate schema, it makes sense that the differences in presentation between print and online environments could call for different signaling cues. That is, it may be easier for print-based readers than for online readers to orient themselves within a text—print-based texts are linear and readers can easily scan and compare pages to get a broad sense of where they are in the overall document. Looking at online media, one might think that more headings would be needed to help orient readers as they scroll through a text and headings disappear off the screen. However, the results from our readers who were reading to learn show that high-frequency headings were far more detrimental than helpful for online readers, while a medium number of headings was optimal.

CONCLUSION AND FUTURE RESEARCH

The massive migration of information from print to online media has introduced additional considerations for authors of technical information. Although research on information processing in print media has received attention for decades, we must continue to investigate the effect that presentation medium has on the ways in which readers approach, process, and consume information.

Taking the results of our print and online studies into consideration, we must ask what technical communicators should do when designing print versus online documents. It is vital to recognize that reading print versus online
documents is not an identical experience, even when the text is identical and the online and print versions have similar layouts. Authors should understand that readers of print documents may be more resilient when dealing with maximal or minimal orientation cues because they can see an entire page at once and acquire a sense of document structure. When dealing with lengthy topics (that is, topics that require more than a few paragraphs), online readers can be at a disadvantage when it comes to orientation and schema building. We admit that authors of online information may need to explore methods that go beyond headings to help online readers develop structural schemata to help manage incoming information.

It is important to recognize that this experiment tested a specific design scenario and a population that was reading to learn, not reading to do. Our study started with a naturally occurring online article that had been adapted from print materials by the Web site’s designers without making many changes from the print-based format. The article had only one heading level in its print form, and it was moved online with the same design. While some would argue that an online text that simply replicates a paper-based text is perhaps suboptimal, the fact remains that on a daily basis, many Web designers, for lack of design skill or time, are doing just that—moving print materials online with little change in layout or format.

We also must point out that the population that we used did not consist of readers who had a vested interest in understanding the material for personal reasons as would readers who were researching information based on their own (or a loved one’s) diagnosis of arthritis. It was important to test this scenario and audience—a text that represented the reality of the rush to get information online and readers who are reading to learn but who do not necessarily have the motivation to overcome design challenges. Our earlier study (Schultz and Spyridakis 2004) examined online readers with a vested interest in the information and found their comprehension to be less negatively affected by the challenges offered by the heading frequency conditions, even though high frequency headings reduced their perceptions of the amount of new knowledge gained.

This research lays open new and interesting avenues to continue to explore these findings. It remains to be seen whether the expert advice that suggests that the addition of more headings to online documents versus print documents will pay off for readers who are reading to do or who are searching for specific information—readers who might be quite likely to lean on headings to light the way. The results of our study show that such advice does not necessarily benefit readers who are reading to learn, in particular, readers who are not overly motivated to learn the new information.

We also need more comparative studies about the effect of design decisions on readers of online versus print documents. Our next step would be to continue the line of research we presented here and investigate the effect of heading frequency in print versus online documents using readers with a vested interest in learning from the text.

It would also be interesting to see whether a hierarchy of headings (headings with subordinate subheadings) would produce different results for online versus print-based readers; we wonder how well online readers would perceive and mentally register such a hierarchy as they scroll down a page or move across pages. As print-based readers are well aware, the reader’s sense of heading hierarchy comes from an overall view of text layout, not from small screen views where multiple heading levels would likely not be visible in one glance.

Finally, we would want to measure time spent on pages with remote online experiments, something we can now do using a toolkit we have been developing to support Internet-based research (www.depts.washington.edu/intres).

This study is one piece of the puzzle in understanding how readers perform with print versus online documents—and it reveals that we cannot continue to casually take findings from print research and construct design guidelines for online documents. But the pressure to put information online will continue to mount as consumers are forced to turn to online sources to meet their daily information needs. We are critically in need of design guidelines based on empirical research that clearly delineate how readers process print versus online information.

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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 MS 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. Contact: sandy.bartell@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 MS in technical communication from the University of Washington. Her areas of primary research are signaling and the communication of medical information online. Contact: laura.d.schultz@boeing.com.

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. Contact: jansp@u.washington.edu.