Web page previews: Effect on comprehension, user perceptions, and site exploration

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Abstract
Informational websites that contain pages of related hyperlinked information are often organized in a hierarchical tree, such that child-node pages contain the primary content and higher level parent-node pages link to sets of related child-node pages. In such designs, the parent-node page content can act as topic previews for the content contained in their child pages. This paper describes a 3 x 2 factorial experiment that examined the effect of preview styles (preview paragraphs with embedded child-node links, preview paragraphs with a list of child-node links below them, a list of child-node links only) and hierarchical navigation menus (present or absent) on website users’ reading comprehension, perceptions of user experience, and site exploration behaviour. Significant differences were found for inferential reading comprehension, with higher comprehension occurring when readers were exposed to previews with embedded links even though previews with embedded links negatively affected user perceptions. Presence or absence of hierarchical menus did not affect comprehension but lack of menus significantly degraded usability perceptions and site exploration. Recommendations for informational website designs are discussed based on these findings.

Keywords
previews; navigations menus; inferential comprehension; usability; site exploration

1. Introduction
The Web has become a primary means for information distribution. The non-linear hyperlinked nature of the Web requires document designers to rethink time-tested methods that have been used since the invention of the printing press in order to assist readers as they work to navigate the Internet. "When the Net absorbs a medium, it re-creates that medium in its own image. It not only dissolves the medium’s physical form; it injects the medium’s content with hyperlinks, breaks up the content into searchable chunks, and surrounds the content with the content of all the other media it has absorbed" [1, p. 95]. Unlike linearly structured print media, the Web encourages readers to explore informational sites by following a path of their own choosing. This can place a cognitive burden on website users whenever they must infer connections among related web pages while simultaneously developing a mental model of the information contained across pages in a website.

One common technique for organizing a rich body of information is to create a hierarchy of related topics and sub-topics. In linear print documents, this hierarchy is often revealed to readers through headings and sub-headings, and by including a sentence or paragraph at the beginning of sections that preview upcoming content and reveal the content relationships [2-3]. When hierarchies of information are implemented on the Web, topics and sub-topics often become individual web pages organized as a hypertext tree. While this approach can allow readers to rapidly descend a path in
the tree to the exact information they seek, readers can easily bypass potentially related sections of the website. While this approach may be fine for readers who already have high subject-area knowledge of the site’s content, or for readers who are searching for specific individual facts, readers with low subject-area knowledge may have difficulty forming a general understanding or mental model of the information in the site.

This paper reports on an experiment that investigated ways to adapt the print media tradition of using preview sentences or paragraphs to reveal content relationships and apply it to hierarchical websites such that reading comprehension across pages can be supported without negatively impacting perceptions of website usability and navigation.

2. Background

2.1. Hypertext structure and cognitive overload

Nonlinear hypertext can be both advantageous and disadvantageous for learning. In terms of advantages, cognitive flexibility theory suggests that criss-crossing a textual landscape provides the reader with multiple pathways into the information, which facilitates deeper learning [4-5]. Readers of hypertext can select their own navigation paths, which not only motivates them by offering interactive choices [6-8], but also allows them to tailor their reading paths based on their prior knowledge [9-13] and learning style [14]. Unfortunately, these advantages come at a cost: nonlinear hypertext can cause cognitive overload and disorientation, which may hinder users’ efforts to comprehend the information presented in the text [15]. Unlike printed documents that offer readers a preferred linear path through hierarchically-structured information, hypertexts force readers to make choices. Readers must divide their attentional resources between reading for comprehension and deciding what to click on next [16-19], which can impact learning and retention of the implicit underlying structure of a complex information space [20]. Numerous studies have documented the negative effects that hypertext has on comprehension [9, 16, 21, 22]; on perceptions of use [7, 9-10, 16, 22-23]; on navigational performance [24]; and on coverage of material [9, 16, 22].

Yet, some of the effects of cognitive overload can be mitigated through purposeful structuring of hypertext documents to signal content relationships—both within and between hypertexts [25]. Content representation shown through hierarchical maps, hierarchical trees, network maps, and alphabetical lists affects how high-knowledge and low-knowledge readers learn from hypertext: low-knowledge readers benefit most from hierarchical maps although these effects may be limited to a global (not local) level of text understanding [26]. For low-knowledge readers, hierarchical hypertext structures have also been shown to improve comprehension over linear structures [27]. Likewise, when hypertexts are structured with a topical hierarchical concept map, rather than a network concept map that emphasizes semantic relationships, low-knowledge readers experience improved reading comprehension [28].

2.2. Using previews and hyperlinks to signal topic structure

In order for readers to comprehend a text, they must construct a well-organized mental representation of the text’s topic structure [29]. Decades of research on print-based reading has shown that writers can enhance a text’s ability to support reading comprehension through effective representation of topic structure by using signaling devices such as headings, overviews, and summaries [30]. For example, textual previews that announce upcoming topics can lead to faster reading times, whether or not the topics are named in the same order as they appear in subsequent text [31], and enhanced comprehension for both skilled and less skilled readers [32]. Further, previews that reveal relationships between superordinate and subordinate ideas can aid inferential comprehension [2–3]. In recent years, as the web has become the primarily repository and dissemination point for information, writers have attempted to translate print-based signalling into strategies that will leverage the features of information displayed online to enhance comprehension and mitigate the cognitive burden of hypertext reading. For example, knowledge acquisition has been improved through the use of text previews that appear as pop-up windows summarizing target content [33] and link suggestions that alert readers to relevant information [19]. In addition, overviews presented to the left of a text as an “advance organizer” enhanced user perceptions and increased time spent engaging with a hypertext learning environment [34], and explicit wording of local navigational link labels encouraged wider site exploration [35]. Graphical overviews have been found to reduce disorientation and enhance factual knowledge retention, particularly for users with high prior knowledge [36], improve comprehension of difficult hypertexts [37], and enhance integration of key information between hypertext documents [25].
Hyperlinks can visually direct the reader's attention, as with annotations to embedded links that appear on mouse-over [38]. In addition, signals may be employed in multi-media sites where flashing arrows enhance learning by directing the readers to relevant information, allowing them to focus on knowledge integration over searching [39]. However, if hyperlink type and text structure are mismatched, readers' understanding can be degraded [40]. Use of redundant hyperlinks—both embedded in online documents and in lists placed to the left of the documents—resulted in more efficient searching and more positive user perceptions, compared to either configuration of links used alone [41]. In addition, shortcuts, in the form of breadcrumbs for looking back and parent-to-child links for looking forward, have been found to increase search efficiency by decreasing time on task and reducing lostness [42]. Further, menu design has been found to affect browsing and searching performance: global and local menus were more effective than pull-down menus for browsing tasks, whereas the reverse was true for search tasks [43].

3. Hypotheses
As discussed here, readers encounter an additional cognitive when the hypertext structures of a website allow them to freely select their own path through a text. Visitors with little knowledge about a site's content are likely to benefit from hierarchically structured sites that use strong structural cues for signalling a website's topic structure. Preview paragraphs are one mechanism for providing strong cues that signal the hierarchical structure of the information found in a website. Preview paragraphs introduce the main topics that are further elaborated in subordinate web pages. Preview paragraphs also introduce the relationships among these main topics.

This study hypothesizes that preview paragraphs will improve reading comprehension of websites with hierarchically structured information when the previews are placed on higher-level parent pages to reveal structural relationships among subordinate content ideas displayed on child pages beneath each parent page. It is worth noting that other common conventions already exist on websites to signal structural relationships among subordinate contents in hierarchically organized websites. On such sites, the navigation menu typically reveals the structure of the site. Likewise, parent pages often contain hyperlinks to child pages in the hierarchy.

We hypothesize that while these conventions for revealing a site’s structure may be necessary for providing a usable experience, they are not sufficient for supporting the comprehension of information that spans multiple pages. Specifically, for hierarchically organized information websites we hypothesize that:

H1: Comprehension will be highest when parent pages contain textual previews with embedded links, next highest when parent pages contain textual previews of any kind, and lowest when a list of subordinate hyperlinks is shown.

H2: Perceptions of website usability and navigation experience will be lowest when preview paragraphs contain embedded links to subordinate pages.

H3: Perceptions of usability and navigation experience will be lowest when hierarchical navigation menus and a list of subordinate hyperlinks are absent (i.e., previews with embedded links to subordinate pages are present in the absence of a hierarchical navigation menu).

H4: Site exploration will be highest when hierarchical navigation menus are present, and when previews with embedded links accompany them.

4. Methods
To test the hypotheses, we created a 3 x 2 design to assess the effect of three types of previews and hierarchical navigation menus (present, absent) on reading comprehension, perceptions of usability and navigation experience, and site exploration.

The text preview variable had three levels that represented three common ways of previewing subordinate information within the body of a web page:

1. A preview paragraph that mentions subordinate content and, below it, a list of hyperlinks to the subordinate content.
2. A preview paragraph that mentions subordinate content (the exact same paragraphs as in #1) but the hyperlinks to the subordinate content are directly embedded in the paragraph’s text (i.e., no list of hyperlinks below it).
3. No preview paragraph is displayed and, instead, only the list of hyperlinks to subordinate pages is shown on the web page.

The first and second designs are often seen in the bodies of web pages. Both of these have the potential to positively affect reading comprehension although only the second design—a preview paragraph with embedded links to subordinate content—requires readers to read the preview paragraph. A “lazy” reader could skip over the paragraph in the first design—a preview paragraph with a list of links below—and go right to the list of hyperlinks. The third design, a mere list of hyperlinks to subordinate pages, provides function that hardly differs from a navigation menu, albeit with a scope of view limited to only child pages and, as we hypothesized, this list of subordinate links would be insufficient for supporting comprehension of information across pages.

The hierarchical navigation menu variable had two levels (hierarchical tab navigation menu present at top of page and hierarchical tab navigation menu absent); it was included in this study in order to investigate the effects of a conventionally expected website element that also reveals hierarchical relationships among contents in the web pages. As stated in the hypothesis section, we suspected conventional hierarchical menus were not sufficient for supporting comprehension of information across pages but would be required for website usability and to promote exploration across the website.

This remainder of this section describes the participants recruited for this study, materials used to implement the two independent variables on a naturally occurring website, the data collection methods, and the study procedures used in our study. We administered the study remotely through the Internet by using software that automates the process of study facilitation [44].

4.1. Participants

For this study, 405 undergraduate students were recruited from engineering courses at the University of Washington to participate in the study. Participants were removed from analysis if they were under 18 years of age or if they failed to follow the study protocol as directed. Participants who identified as non-native speakers of English were also removed from analysis because they differed from native English speakers on many dependent measures.

In total, 282 participants were retained for analysis. The majority of these participants were male (76%) and between the ages of 18 and 25 years (90%). More than half of the participants reported that they were either somewhat comfortable or very comfortable with computers (18%, 49%, respectively) although slightly over one-quarter reported that they were very uncomfortable with computers (27%). Participants reported nearly identical levels of comfort with the web as with computers. The majority of the participants reported using the web for 6 or more years (92%).

4.2. Materials

The materials developed for this study included a subset of pages from a naturally occurring website that were modified to implement our two independent variables (text previews and menus), a usability perceptions survey, and a set of multiple choice questions for measuring factual and inferential reading comprehension.

4.2.1 Experimental website and variations

The experimental website was adapted from naturally occurring web pages from a U.S. National Park Service website about Big Bend National Park in Texas, USA. The materials were chosen because the articles on the website were designed for a general audience, provided interesting content, and the participants for this study were likely to be unfamiliar with the national park’s geographic region and desert environment, over 2,000 miles away from where our study was conducted. It was important for the content in the study materials to be approachable yet provide unfamiliar information in order to study the effects of structural cues in hypertext on readers’ comprehension. Reading material that is either too difficult for the readers or too familiar with the readers would create confounds with our study’s hypotheses. The experimental website consisted of a 3-level hierarchical website with 21 pages. The 3rd level contained 16 article pages (four pages x four topics: air quality, geological formations, plant life, and the Rio Grande). Each article’s text was standardized so that each page contained three embedded hyperlinks connecting to three other articles within the 16 pages. Figure 1 shows an example of one of the 3rd level article pages.
Figure 1. Example of a 3rd level article page used in the experimental website

To implement the two independent variables—text previews and menus—we wrote five preview pages that were structured as a tree with one site-wide preview page at the 1st level of the website that linked to four topic preview pages at the 2nd level. The 1st level site-wide preview paragraph introduced the general content of the site and
previewed the four topic areas. Each of the four 2nd level preview paragraphs introduced the section’s topic (e.g., air quality, geological formations, plant life, or the Rio Grande) and previewed the four topical article pages linked below it. Figure 2 shows the structure of the website. We then designed a hierarchical tab menu that reflected the structure of the website (see top of Figure 1).

Figure 2. Site map depicting the structure of the website: top row represents 1st level preview page, 2nd row represent four 2nd level topic preview pages, and four indented rows represent sixteen 3rd level article pages

For the three levels of the *preview* variable, we made the following modifications to the preview paragraphs such that either no preview paragraph was displayed and only a list of subordinate links was shown; the preview paragraph was shown with a list of subordinate links displayed below it; or the preview paragraph was shown with subordinate links embedded in the paragraph. For our two levels of *menus*, the website either displayed the hierarchical tab menu on all pages or hid it on all pages. Figure 3 provides screen captures of the six (3 x 2) versions of the website’s home page.

The preview paragraph text, when present, was identical in all conditions. Further, in all six conditions, link titles were standardized, i.e., the wording was identical in the list of links alone or after the preview paragraphs, in embedded links in the preview paragraphs that had embedded links, and in the links in the tab menus. For example, the phrase “*Air Quality*” was used consistently as the link to a 2nd level topical preview page whether the link appeared as a hyperlink in a list alone or beneath the preview text, as a hyperlink embedded in the preview text, or in the tabbed navigation menu.
Figure 3. 1st level pages of all conditions. Top row shows no preview paragraphs (link list only), second row shows preview paragraphs with link list below, and third row shows preview paragraphs with embedded links. Hierarchical tab menu is present on left and absent on right.
4.2.2 Survey materials

The post-browsing surveys consisted of usability and navigation perception questions, and reading comprehension questions. The perceptions questions consisted of the System Usability Scale [45] modified for websites [46], an additional 12-item scale measuring user experience about site navigation (e.g., questions about ease of navigation, sense of feeling lost while navigating, understanding of web page relationships, expectations regarding link content), and four questions measuring level of interest, difficulty, enjoyability, and familiarity with the website’s information.

A 32-item multiple-choice survey was developed to measure comprehension. Sixteen questions assessed factual information were drawn from the articles on the 3rd level pages and sought to measure participants’ knowledge at the level of the text base. The other 16 questions required participants to draw inferences across facts within and across the articles and sought to measure the participants’ situation models of the articles [47]. Before the comprehension questions were used in this study, the questions were tested for passage-dependence with a group of volunteers to ensure that people who had not read the website’s content would not select the correct answer slots any more frequently than by chance.

An additional set of multiple-choice questions asked participants to rate their level of familiarity with the web’s content, how difficult they felt the content was to read, and their levels of interest and enjoyment while reading. These four questions were presented on five-point scales.

4.3. Procedure

During a two-week period, participants were able to take the study on their personal computers or laptops at the time of their choosing. The study was administered remotely using a software tool called WebLabUX [44] that automates the process of randomly assigning participants to an experimental condition, delivering appropriate study materials for each experimental condition, collecting survey data and browsing behaviour from each participant, and monitoring whether participants follow study procedures.

The participants who were recruited for this study were emailed a hyperlink to the study’s introduction and informed consent web page. Participants consented to the study by clicking on an agreement button. Next, participants were presented with a demographics survey. This was followed by a web page describing their task, asking them to browse a website for at least 15 to 20 minutes with the intent to learn as much as possible about a national park in preparation for a summer job as a tour guide. Once participants were oriented to the study, they were randomly assigned to one of the six experimental conditions and allowed to browse the study website for as long as they wished. All pages on the study website contained a button on the bottom allowing them to continue to the surveys. Once participants started the surveys, they could not return to the study website. Usability perceptions surveys were presented first as a distracter task before the comprehension survey questions.

5. Results

To analyze the data collected from this study, we first confirmed participants had, on average, a low level of familiarity with the content on the experimental website and that their reaction to the articles’ content was unlikely to contain confounding factors that might affect their reading comprehension. Next, we performed an analysis of variance to determine the effects of previews and tab menus on reading comprehension and found that previews had a significant positive effect on inferential reading comprehension. An additional analysis of variance revealed that menus affected the participants’ perceptions of website usability, but not comprehension. Finally, we examined the effects of previews and menus on site exploration and found that previews with embedded links had a significant effect on increasing exploration across the topic area preview pages (the 1st and 2nd level pages) whereas previews with a list of links displayed below significantly increased site exploration at the content level (the 3rd level pages). We describe these results in detail next.

5.1. Relationship to study materials

Participants’ level of prior knowledge with the subject material in the website can interact with how a hypertext’s structure and the presence of strong structure cues affect learning. Participants in this study reported low prior familiarity with the materials on the experimental web pages ($M = 2.09$, $SD = .90$; 1 = very unfamiliar, 5 = very familiar). Further, participants found the content in the website articles relatively easy to read, rating them almost at the midline on difficulty ($M = 3.30$, $SD = 0.89$; 1 = very difficult, 5 = very easy). They rated the articles just below the
midline for interest ($M = 2.64$, $SD = 1.07$; $1$ = very uninterested, $5$ = very interested) and for enjoyability ($M = 2.57$, $SD = 0.95$; $1$ = very unenjoyable, $5$ = very enjoyable). Thus, their lack of prior familiarity coupled with their nearly neutral perceptions of content easiness/difficulty, interest, and enjoyability suggests that their reading comprehension could benefit from strong structural cues that signalled the content’s hierarchical relationships.

5.2. Reading comprehension

Our first hypothesis (H1) stated that comprehension will be highest when parent pages contain textual previews with embedded links, next highest when parent pages contain textual previews with links listed below, and lowest when only a list of subordinate hyperlinks is shown. An ANOVA revealed a significant effect for previews on inferential comprehension ($F(2, 281) = 3.128$, $p = 0.045$, partial $\eta^2 = 0.022$). A Scheffé post hoc analysis showed that previews with embedded links led to significantly higher inferential comprehension ($M = 6.93$, $SD = 2.16$) than previews with a list of links listed below them ($M = 6.09$, $SD = 2.19$). See Figure 4. This result, confirming H1, suggests that when previews contained strong structural cues in the form of embedded hyperlinks, readers were better able to form situation models of the larger hypertext. In turn, this allowed them to better comprehend content relationships across information across pages (i.e., inferential comprehension).

Surprisingly, the preview text that lacked embedded hyperlinks and instead listed subordinate hyperlinks below the paragraph appeared unable to support inferential comprehension. It is possible that participants were reading the preview texts in both cases (previews with and without embedded hyperlinks), but that the embedded hyperlinks in the preview paragraphs provided stronger signals between subordinate pages than the same text without the embedded links, and putting the hyperlinks below the paragraph either provided weak or, paradoxically, contradictory signals regarding the site’s structural relationships. Unravelling this puzzle requires investigating whether participants read the preview text in both cases.

Figure 4. Effect of previews on inferential comprehension: previews w/ embedded links led to significantly higher comprehension than previews with list of links below them
To determine whether participants read preview text in conditions where the previews had embedded links or only a list of links below, the total time spent viewing all 1st and 2nd level preview pages was calculated from navigation behavioural logs. An ANOVA revealed a significant effect for previews on time spent in preview pages ($F(2, 281) = 4.639, p = 0.010$, partial $\eta^2 = .033$). A Scheffé post hoc analysis showed that participants spent significantly more time in preview conditions with a list of links below ($M = 171.3$ seconds, $SD = 151.4$) and with embedded links ($M = 162.7$ seconds, $SD = 115.5$) than in the condition with a list of links only (i.e., no previews) ($M = 92.9$ seconds, $SD = 293.3$). See Figure 5. No significant differences were found on time in previews on menus present versus absent, and no interaction was found. This finding strongly suggests that the participants read the preview texts in all conditions that displayed previews and it lends further support to the first part of H1—preview paragraphs that contain embedded links to subordinate content provide strong structural cues that support readers’ ability to form situation models.

It is noteworthy that our results do not support text previews of any kind as better than no textual previews at all, which suggests that the inclusion of embedded links in the preview text plays a strong role in signalling structural relationships among subordinate content.

While our central argument in H1 is that textual previews will support readers’ ability to draw inferences across information presented in subordinate pages, in addition to measuring inferential reading comprehension we also measured factual reading comprehension (i.e., readers’ ability to recall an individual fact stated on a web page). An ANOVA revealed no significant differences for factual comprehension across the different conditions although inferential and factual comprehension highly correlated ($r (282) = .401, p = .000$). This would be logical; higher inferential comprehension can support fact acquisition regardless of experimental conditions.

![Figure 5. Time spent in 1st and 2nd level preview pages: significantly more time spent in both preview conditions than in the list of links only condition.](image)
5.3. Usability perceptions

Our second hypotheses (H2) stated that perceptions of website usability and navigation experience will be lowest when preview paragraphs contain embedded links to subordinate pages and our third hypothesis (H3) stated that perceptions of usability and navigation experience will be lowest when hierarchical navigation menus and a list of subordinate hyperlinks are absent (i.e., previews with embedded links to subordinate pages are present in the absence of a hierarchical navigation menu). For measuring usability, participants rated the website on the 100-point System Usability Scale (SUS). An ANOVA revealed significant main effects for previews ($F(2, 281) = 8.828, p = 0.000$, partial $\eta^2 = 0.060$) and for menus ($F(2, 281) = 34.397, p = 0.000$, partial $\eta^2 = 0.111$). For previews, Scheffé post hoc tests showed that participants rated the previews with embedded links significantly lower ($M = 69.2$, $SD = 14.9$) than the previews with a list of links listed below ($M = 75.3$, $SD = 10.8$) and list of links only (i.e., no previews) ($M = 74.6$, $SD = 11.3$), as shown in Figure 6 and in support of H2. Unsurprisingly, the participants gave significantly lower SUS ratings to conditions where navigation menus were absent ($M = 67.8$, $SD = 13.7$) than conditions where navigation menus were present ($M = 76.7$, $SD = 10.9$), as shown in Figure 7 and lending some support to H3, although support of this hypothesis requires further exploration of interactions between the kind of previews and the presence or absence of menus.

Indeed, a significant interaction was found for previews and menus ($F(2, 281) = 7.629, p = 0.001$, partial $\eta^2 = 0.052$) on SUS ratings, showing that SUS ratings were most negative for previews with embedded links when tabbed navigation menus were absent (see Figure 8). These findings suggest that even though the links embedded within preview text helped the participants build situation models of the hypertext, they found embedded hyperlinks less usable and expected to see navigational structures that look like menus. This occurred even when only a simple list of hyperlinks was shown, although participants strongly preferred tabbed navigation menus.

![Figure 6. Effect of previews on SUS ratings: ratings were significantly lowest for previews with embedded links vs. previews with links listed below and list of links only.](image-url)
Figure 7. Effect of menus on SUS ratings: ratings were significantly higher for menus present vs. absent.
Similar but more pronounced results were found for the 12-item navigational survey, normalized to a 100-point scale, lending further support to the hypotheses (i.e., H2 and H3) that users want to see familiar looking menus on informational websites. Differences in the 12-item navigational scale were significant for previews ($F(2, 281) = 10.364, p = 0.000$, partial $\eta^2 = .070$); for menus ($F(2, 281) = 83.556, p = 0.000$, partial $\eta^2 = .232$); and for the interaction between previews and menus ($F(2, 281) = 8.210, p = 0.000$, partial $\eta^2 = .056$).

Again, Scheffé post hoc analyses revealed significantly higher navigation ratings for conditions that contained previews with a list of links below ($M = 70.0, SD = 11.9$) or the list of links only ($M = 70.1, SD = 12.5$) over previews with embedded links ($M = 63.3, SD = 17.8$). Conditions with menus were rated significantly higher ($M = 74.1, SD = 11.0$) than conditions without menus ($M = 59.4, SD = 15.2$). The patterns for the preview means and the menu means were very similar to the patterns shown in Figures 6 and 7. Figure 9 shows the significant interaction between previews and menus, showing similar results to the interaction for SUS scores (Figure 8), showing that navigation ratings were most negative for previews with embedded links when tabbed navigation menus were absent. These findings suggest that even though the links embedded within preview text helped the participants build situation models of the hypertext, they found embedded hyperlinks less helpful with navigation and preferred tabbed menus.

Figure 8. SUS ratings interaction for previews x menus: ratings were most negative for previews with embedded links when tabbed navigation menus were absent
5.4. Navigation patterns

Our fourth hypothesis (H4) stated that site exploration will be highest when hierarchical navigation menus are present, and when previews with embedded links accompany them. H4 was confirmed: the presence of hierarchical tabbed menus led to significantly greater site exploration, which is consistent with the usability findings reported earlier. There were significant differences in the number of unique 1st and 2nd level preview pages visited for menus ($F(2, 281) = 25.371$, $p = 0.000$, partial $\eta^2 = .084$); participants exposed to hierarchical tab menus visited more of the five preview pages ($M = 4.8$, $SD = 0.5$) than those who did not see hierarchical tab menus ($M = 4.2$, $SD = 1.1$). See Figure 10. A significant interaction was found for previews and menus ($F(2, 281) = 4.377$, $p = 0.013$, partial $\eta^2 = .031$), showing that unique visits to the five preview pages were lowest for previews with embedded links when tabbed navigation menus were absent, and highest for previews with embedded links when tabbed navigation menus were present, further confirming H4. (See Figure 11.) This finding suggests that previews with embedded links, when paired with hierarchical tabbed navigation menus, are capable of enticing people to explore the preview-level views into subsections of a website.
Figure 10. Mean number of unique 1st and 2nd level preview pages visited: more pages visited when menus present
Figure 11. Site exploration interaction for previews and menus: unique visits to preview pages were lowest for previews with embedded links when tabbed menus were absent and highest for previews with embedded links when tabbed menus were present.

Of the sixteen 3rd level content pages, the difference in the number of unique 3rd level content pages visited was significant for previews ($F(2, 281) = 3.705, \ p = 0.026$, partial $\eta^2 = 0.026$), and a Scheffé post hoc analysis revealed that previews with a list of links below them received significantly more unique 3rd level page visits ($M = 11.9$, $SD = 4.1$) than conditions with a list of links only (no previews) ($M = 9.9$, $SD = 4.9$). See Figure 12.
6. Discussion and conclusions

All four hypotheses were either confirmed or partially confirmed. Reading comprehension at the inferential level for unfamiliar information in a hierarchical hyperlinked text was highest when parent-node pages contained preview paragraphs written with embedded links to child-node pages. This finding partially confirmed hypothesis 1. Even though page viewing times strongly suggest that participants read preview paragraphs whether or not the paragraphs contained embedded hyperlinks, the presence of hyperlinks inside preview paragraphs as embedded links appears to have successfully signalled inter-page relationships. Merely placing navigational links alongside (in our case, directly below) preview paragraphs was not enough to signal relationships between groups of page titles and the contents they contain. Likewise, neither the presence nor absence of conventional hierarchical navigation menus aided participants in forming inferences between content. Our prediction concerning textual previews of any kind leading to increased comprehension was not confirmed.

When inferential reading comprehension is a desired outcome, website content writers should not only consider writing simple preview paragraphs that show logical connections among subordinate content, but they should include embedded hyperlinks to the subordinate content in the previews. Our study used the same wording for the embedded hyperlinks in preview paragraphs, the hierarchical navigation links, and the page titles in order to consistently reinforce the central topic of each child-level content page. Additional research would be needed to determine if differences in wording among these signalling approaches would negatively affect signalling of structural relationships.

While we recommend using preview paragraphs on parent-node pages to increase inferential reading comprehension, our results also suggest, unsurprisingly, that when web designers fail to always include access to the
website’s full hierarchical navigational structure, they do so at their own peril. Website users appear to expect a conventional hierarchical navigation menu that is clear and consistent while they work their way through moderately sized informational sites devoted to a particular topic. Hypotheses 2 and 3 concerning perceptions of usability and navigation experience being influenced by the presence of preview paragraphs with embedded links and navigation menus were confirmed. Users do not particularly like previews with embedded links; however, the presence of hierarchical tabbed menus negates the dislike of previews with embedded links.

Our findings also suggest that previews can improve site exploration and support hypothesis 4, although the results tell a mixed story. Previews with embedded links appear to increase exploration of parent-level preview pages whereas previews with a list of links below them appear to increase exploration of child-level content pages. Further, the absence of hierarchical navigation menus, unsurprisingly, hinders readers’ breadth of site exploration.

The overall results from this study suggest that reading comprehension in informational websites can be improved by authoring textual previews that summarize relationships among related content. Previews are likely to be most effective at aiding comprehension when they include embedded links that name and describe subordinate content, and highlight the relationship among subordinate pages. Such previews are most effective at providing a good user experience when coupled with traditional navigational menus that remain visible at all levels of the website’s hierarchy. Web authors owe it to readers of informational websites to look for ways of reducing cognitive load as their readers navigate through web content and seek to form mental models of the content presented. This study has shown that previews with embedded link is one strategy for doing just that.

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8. References


