2005

Effect of scroll bar and navigation menu co-location on web performance

Heather Hampton Devine
San Jose State University

Follow this and additional works at: https://scholarworks.sjsu.edu/etd_theses

Recommended Citation

Devine, Heather Hampton, "Effect of scroll bar and navigation menu co-location on web performance" (2005). *Master's Theses*. 2755.
DOI: <https://doi.org/10.31979/etd.hjgc-m4rn>
https://scholarworks.sjsu.edu/etd_theses/2755

This Thesis is brought to you for free and open access by the Master's Theses and Graduate Research at SJSU ScholarWorks. It has been accepted for inclusion in Master's Theses by an authorized administrator of SJSU ScholarWorks. For more information, please contact scholarworks@sjsu.edu.

NOTE TO USERS

This reproduction is the best copy available.

UMI[®]

EFFECT OF SCROLL BAR AND NAVIGATION MENU CO-LOCATION
ON WEB PERFORMANCE

A Thesis

Presented to

The Faculty of the Graduate Program in Human Factors / Ergonomics

Office of Graduate Studies and Research

San José State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Heather Hampton Devine

August 2005

UMI Number: 1429418

INFORMATION TO USERS

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleed-through, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

UMI Microform 1429418

Copyright 2006 by ProQuest Information and Learning Company.

All rights reserved. This microform edition is protected against unauthorized copying under Title 17, United States Code.

ProQuest Information and Learning Company
300 North Zeeb Road
P.O. Box 1346
Ann Arbor, MI 48106-1346

© 2005

Heather Hampton Devine

ALL RIGHTS RESERVED

APPROVED FOR THE PROGRAM OF
HUMAN FACTORS AND ERGONOMICS

Dr. Anthony D. Andre, Chair
Department of Industrial and Systems Engineering

Dr. Kevin C. Corker, Member
Department of Industrial and Systems Engineering

Dr. Emily H. Wughalter, Member
Department of Kinesiology

APPROVED FOR THE UNIVERSITY

ABSTRACT

EFFECT OF SCROLL BAR AND NAVIGATION MENU CO-LOCATION ON WEB PERFORMANCE

by Heather Hampton Devine

This study explored the effect of scroll bar and navigation menu co-location on web performance. Participants interacted with fictitious web sites that co-located the menu and scroll bar, or placed them opposite one another. Support was not found for the hypothesis that menu and scroll bar co-location would result in improved menu navigation performance. However, participants indicated a preference for co-location and found it easier and faster to use than non-co-location. The results show a strong advantage for the conventional right-side placement of the scroll bar and a potential benefit for the unconventional right-side placement of the menu.

ACKNOWLEDGEMENTS

Many thanks to Tony, Emily, and Kevin, for their help and support, and for making the Human Factors and Ergonomics program so great; to my friends and family, for their help and encouragement; and, last but not least, to Jamie, for being the best friend and editor a gal could want.

TABLE OF CONTENTS

	Page
LIST OF TABLES	ix
LIST OF FIGURES	x
INTRODUCTION	
World-Wide Web Usability	1
Motor Behavior in Web Browsing	2
Information Processing in Web Browsing	3
Navigation Menu Research	4
Scroll Bar Use	10
Current Study: Menu and Scroll Bar Co-Location	12
METHOD	
Experimental Design	14
Participants	15
Apparatus	15
Stimuli	16
Tasks	20
Procedure	22
Dependent Measures	24
Navigation Time	24
Cursor Movement	24

Selection Errors	24
Preference	24
RESULTS	
Navigation Time	25
Cursor Movement	31
Selection Errors	32
Usability Ratings	33
Comparative Preferences	39
DISCUSSION	
Menu Placement	43
Scroll Bar Placement	44
Scrolling Requirement	45
Web Site Design	45
Menu and Scroll Bar Co-location	45
LIMITATIONS	47
FUTURE RESEARCH	49
CONCLUSION	50
REFERENCES	51
APPENDICES	
A. Experiment Interaction Order	56
B. Screening Protocol	57

C. Participant Demographics	58
D. IRB Approval Letter	59
E. Experimental Web Site Categories and Submenus	60
F. Task List	62
G. Consent Form	67
H. Demographic Survey	68
I. Experimenter Instructions	69
J. Post-Interaction Survey	73
K. Comparative Survey	74

LIST OF TABLES

	Page
Table 1. Task conditions.....	14
Table 2. Four layouts constructed for each web site.....	20
Table 3. A sample set of tasks for the practice session.....	22
Table 4. Navigation time mean scores and standard deviation in seconds for all tasks, scrolling tasks, and non-scrolling tasks, ordered by total time ranking	27
Table 5. Mean usability ratings for left and right scroll bar placement.....	36
Table 6. Mean usability ratings for left and right menu placement.....	37
Table 7. Mean usability ratings for co-location and non-co-location	38
Table 8. Comparative ratings for left and right scroll bar placement.....	40
Table 9. Comparative ratings for co-location	41
Table 10. Comparative ratings for four menu and scroll bar comparisons	42

LIST OF FIGURES

	Page
Figure 1. An example of the bookstore web site, using the left menu, right scroll bar design	17
Figure 2. An example of the toy web site, using the right menu, right scroll bar design.....	18
Figure 3. An example of the clothing web site, using the left menu, left scroll bar design	19
Figure 4. An example of the toy web site product page, using the right menu, right scroll bar design	21
Figure 5. Mean navigation time in seconds by scrolling requirement	28
Figure 6. Mean navigation time in seconds by web site design	28
Figure 7. Mean navigation time in seconds by co-location	29
Figure 8. Mean navigation time in seconds by condition	30
Figure 9. Navigation to the wrong side by scroll bar placement.....	31
Figure 10. Navigation to the wrong side by scrolling requirement....	32
Figure 11. Target selection errors by scrolling requirement.....	33
Figure 12. Example questions from the post-interaction survey	34
Figure 13. Usability ratings by scroll bar placement	35

INTRODUCTION

Facilitating both communication between individuals and business transactions with companies, the World Wide Web (WWW) has become a common medium for the exchange of information. According to the market research and consulting firm Harris Interactive, in 1997, slightly less than one-third of adults in the United States — 59 million people — were Internet users, spending an average of eight hours a week online (Greenspan, 2002). Five years later, the number had more than doubled. World-wide, 253 million people visited a web site – just in August 2003 (Global Usage, 2003). While increases are no longer as dramatic, the number of people browsing the WWW still grows.

World-Wide Web Usability

Despite the availability of books and articles on building a usable web site (Fleming, 1998; Spool, *et al.*, 1999; Nielsen, 1999b), many sites have poor usability (Nielsen, 1998); *i.e.*, users cannot locate information or complete essential tasks. Design and layout, which affect how users complete tasks, is often cited as a critical factor in the success of a web site (Lohse & Spiller, 1998; Kim & Lee, 2002; Helander & Khalid, 2000). Studying the design of 15 large commercial web sites, Spool, *et al.* (1999) asked users to locate information, and make judgments or comparisons with it. Participant

success ranged from a low of 15 to a high of just 42 percent. Nielsen (2001) observed an average success rate of only 56% on commercial sites.

Placement of the navigation menu (Lohse & Spiller, 1998; Tilson, *et al.*, 1998) and scroll bar affects how easily and quickly users access information. The navigation menu, comprised of hyperlinks to pages within a site, is the principal control for navigating within a web site; while the scroll bar is the main control for traversing a web page. There are no clear-cut standards to direct the placement of these elements, and available design guidelines are inconsistent (Ratner, *et al.*, 1996). There is a need to determine where the navigation menu and scroll bar should be placed, and how that placement influences performance and preference.

Motor Behavior in Web Browsing

Underlying user movements, particularly, the use of hands to control the pointing device while selecting or navigating, and eyes for scanning or reading, affect web browsing performance. Motor behavior models, described by MacKenzie (2003) as simplifications of more complex behavior, can help to explain and contextualize motor behavior. He identifies two types: predictive, such as Fitts' law; and descriptive, like motor schema theory.

Fitts' law (Fitts, 1954; Fitts & Peterson, 1964) assists in understanding how users navigate within a website. It states that the time to acquire a target is a function of the size of and distance to it. The mouse is used to

move the cursor to a web browsing target, such as an item to purchase or a menu. The distance to the target is the difference between where the cursor movement begins and where the target is located. According to Fitts' law, if the target size increases or the distance to it decreases, the acquisition time decreases, and *vice versa*.

Motor schema theory (Schmidt, 1975) helps to understand the movement that occurs during web browsing. It supports a generalized motor program, controlling movement execution; and a schema, describing motor program parameters. The motor program is learned as tasks are practiced, and performed more quickly and accurately as various schemas are incorporated during learning. For example, a person who repeatedly uses the web might develop a web browsing motor program. As motor programs are practiced, they can become overlearned, resulting in automaticity (Shiffrin & Schneider, 1977), a behavior held by experts rather than novices.

Information Processing in Web Browsing

Performance is also affected by the information processing tasks associated with web browsing, such as understanding and using navigation links, scanning and reading text, and comparing information. For web shopping, the user must navigate through menus, scan for and compare products, and decide upon a purchase. This typically involves the use and

integration of information, which should be displayed to facilitate quick processing.

The proximity compatibility principle (Wickens & Carswell, 1995; Wickens & Hollands, 2000) addresses how aspects of a display should be integrated together. It differentiates between two types of proximity: display, the closeness of objects on the screen, and processing, how items are used together from an information perspective. The proximity compatibility principle states that tasks which necessitate high processing proximity should also have high display proximity, and *vice versa*. One method of increasing display proximity is co-locating objects, which, by decreasing visual search time, makes it easier to compare and integrate objects (Wickens & Carswell, 1995). Since the menu and scroll bar are used together in navigation, they have high processing proximity and should, therefore, also have high display proximity.

Navigation Menu Research

Although there are recent studies on primary navigation placement, previous menu research largely examined software applications. Menu research examined the reading of menus (Aaltonen, Hyrskykari, & Raiha, 1998; Backs, 1987; Lee & MacGregor, 1987; Hornof & Kieras, 1997), ideal ordering of items (Card, 1982; Hornof & Kieras, 1999; Teitelbaum & Granda,

1983), visual search (Byrne, *et al.*, 1999a; Hendrickson, 1989), and organization (Tsunoda *et al.*, 2001; Miller, 1981).

When considering web navigation research, the context of web browsers must be understood. While some aspects of browsers are user configurable, others, such as the scroll bar, are not. Since, by convention, the scroll bar is placed on the right of the browser window, the navigation menu is co-located only if also placed on the right.

Gathman, Lee, and Nader (1998) used performance and preference to examine the best placement for primary menu navigation. They hypothesized that a menu at the top of the browser would be best, as software applications have menus there; and it would have faster completion times, since links would be closer to task targets. The twenty-four participants were university students experienced in using web sites. The web page for each task consisted of a task frame and a navigation frame. At the beginning, the task frame contained a link, labeled "Click for a number," which provided the participant with a random number to classify into a category, while the navigation frame contained links to numerical categories. For example, if 42 was presented in the task frame, the participant would choose the "41-50" category in the navigation frame. This procedure was completed five times for each of the four navigation frame placements (top, bottom, left, and right).

Navigation time and preference were measured for each participant. The navigation time was calculated as the period between clicking the “Click for a number” link and choosing the appropriate category. Following the experiment, each participant gave information about preference. A single factor analysis of variance (ANOVA) showed no navigation time difference for menu placement, but participants preferred left navigation placement (41%) over top (29%), right (16%), or bottom (13%).

Two studies by Bernard (2001; 2002) examined user schemas for placement of web objects, such as page titles, internal links, and advertisements. Participants were asked to place cards that represented these onto a browser-like grid. Results indicated that both novice and experienced users had similar schemas for placement, expecting primary navigation to be located in the upper left of the grid. Bernard (2002) recommended placing web objects based upon expectations, to allow users to retrieve information quicker and, therefore, be more satisfied with the site. Spool (2002) tested these recommendations and found that they did not result in more purchases or higher usability ratings.

McCarthy, Sasse, and Riegelsberger (2003) conducted an eye tracking study on unexpected menu placement. As participants would expect the menu on the left, they hypothesized a slower search time for a right-placed menu. Participants interacted with three experimental web sites with the

menu placed on the top, right, or left. They visited each site three times, completing one task for each of nine menu labels held constant across layouts.

Search time was not better with left-placed menus, reinforcing Spool's (2002) finding that matching user expectation of menu placement does not result in better performance. They found that search time was faster with a left-placed menu when a participant first visited a page, but not on subsequent visits. Initially, when the menu was on the right, the number of glances on the left side of the page was large. Later visits resulted in an increase in glances to the right, suggesting that users adapted to the right-placed menu.

In a direct comparison of right and left primary navigation, Kalbach and Bosenick (2003) studied web site tasks using designs that, except for the menu location, were identical. They hypothesized that participants would perform better with left navigation but could adapt to right navigation. They found no significant difference in task times, indicating that left and right navigation were equivalent. While average task time was faster for left-hand navigation in earlier tasks, it was faster for right-hand navigation in later tasks.

Kingsburg (2004) studied the best way to construct a three-level navigation menu. A site might create this common structure by placing the

primary navigation menu across the top, with secondary and tertiary menus placed on either the same side (top) or a different side (right or left).

Examining different combinations of menu placements, she focused on whether the primary menu should be placed on the top, left, or right; as well as whether primary and secondary level menus should be together or not. A number of measures were used to compare menu placement, including navigation time, selection errors, cursor movement, and preference.

In the first experiment, Kingsburg compared menus using combinations of top and left placement to construct three-level menus. Sixteen web-experienced undergraduates emulated the process of making an online purchase, completing tasks in which they navigated through three levels of menus to locate and select a product. Each participant completed twelve navigation tasks for each of eight menu combinations. Kingsburg found a main effect of navigation time for menu placement and selection errors, with faster completion time and fewer selection errors when the primary or secondary menu placement was on the left, rather than the top. When considering both performance and preference, most measures indicated that a left primary menu was better.

In the second experiment, Kingsburg compared the best four left/top structures with four right/top structures. A main effect of navigation time for primary menu location indicated that navigation time was faster for left

menus. The numbers of selection errors for primary left and right menu placement were nearly equal, with both better than a top menu. Generally, primary left or right menus were preferred and performed better than primary top menus; and grouping secondary and tertiary menu levels together was also better. Although no structure showed both the best performance and highest preference, the two best had all three menu levels on the left or right. While this provides some guidance for menu placement, it does not provide a clear recommendation as to whether placement on the left or right is best.

According to Nielsen (1999a), navigation should be placed on the left side as it is common convention. Although this would be more efficient, requiring shorter movement between navigation and scroll bar, he argued that deviating from the left-justified standard may result in more confusion than improvement. International Business Machines (IBM) agrees, citing that the layout performs well on their site (Visual layout and elements, n.d.). The National Cancer Institute's Usability Guidelines (www.usability.gov) recommended an alternate view, suggesting placement of menu navigation on the right for efficiency. Kalbach and Bosenick (2003) found that users were not bothered by right-justified navigation. Indeed, while users generally did not notice the difference in navigation placement, more preferred right-justified placement.

Scroll Bar Use

In a survey of popular sites, Kangas (2001) gathered information about the content and layout of eighty-seven web pages. Assuming a browser window of size 800x600 pixels, he found that the average home page is about two screens in length (1127 pixels), meaning scrolling occurs regularly. Spool (1998) found that users were willing to scroll for information, and suggested that users prefer scrolling through fewer, longer pages to clicking around many, shorter pages.

In studying the day-to-day use of the web, Byrne, *et al* (1999b) confirmed that users scroll frequently. They collected five hours of verbal protocol and video data from eight volunteers, categorizing it into the types of daily browsing tasks and calculating the total time to complete each. The tasks fit into six general categories: locate on page, use information, provide information, configure browser, react to environment, and go to page. For example, a typical "go to page" task was clicking on a link to another page, and the time to complete the task measured from when the participant clicked on the link until when the new page was displayed. The most frequent user action was configuring the web browser, which included adjusting the browser window, scrolling, and adding bookmarks. Scrolling comprised eighty-nine percent of the configure tasks, consuming eleven percent of the total browsing time.

No study has directly examined the use of scroll bars during web browsing. Gathman, Lee, and Nader (1998) did not include scrolling in their study of primary frame placement, suggesting it for future work. Kingsburg (2004) cited little or no scroll bar usage as a limitation of her study. Other studies did not explicitly account for scrolling (Kalbach & Bosenick, 2003; Spool, 1999), although it may have been part of the tasks.

Kellener, Barnes, and Lingard (2001) examined scroll bars, but in the context of list boxes, which show long lists of items in a small box. User performance and preference were measured in two experiments, with researchers hypothesizing that item justification would be linked to scroll bar orientation. That is, for right-justified items, navigation time and preference would be better for a scroll bar on the right side of the list box, and *vice versa*.

In the first experiment, 28 participants were shown a colored block and then asked to select the match from a list box. Locating the matching block always required scrolling. Each participant completed 120 tasks and rated different list box styles. The hypothesized two-way interaction was found.

In a second experiment, Kellener, Barnes, and Lingard made the list boxes more realistic, using text rather than color. Participants were shown the name of a state, province, or territory; and asked to select it from a list box. Again, the two-way interaction was found. While the common practice is to present items left-justified with a scroll bar on the right, this research

indicates that performance and user preference support a design with justification consistent with scroll bar placement.

Current Study: Menu and Scroll Bar Co-Location

As performance and preference results from previous studies equivocally guide placement of the primary navigation menu on a web page, with some suggesting conforming to the convention of left navigation placement while others do not, there is a need to determine where the navigation menu should be placed and how it relates to the scroll bar. The primary reason cited for a right-placed navigation menu is efficiency (www.usability.gov; Nielsen, 1999a). By locating navigation objects closer together, users can move between them quicker. To meet Fitts' law, the navigation menu and scroll bar should be close together, which, in current browsers, means co-locating the navigation menu and scroll bar on the right. The proximity compatibility principle (Wickens & Carswell, 1995; Wickens & Hollands, 2000) supports co-location also; since the navigation menu and scroll bar have high processing proximity, they should be co-located for display proximity.

This study examined the effect of navigation menu and scroll bar co-location, to determine whether it is better to place the menu next to or opposite the scroll bar. A placement is better if a user can navigate correctly and quickly to targets, makes fewer errors when using it, and shows a

preference for it. Performance and preference data were collected during a web interaction experiment in which participants completed navigation tasks on two fictitious sites. The experiment compared combinations of menu and scroll bar placement to determine which is best.

Based upon reviewed literature and cited principles, there is a hypothesis for each of the factors. It was predicted that there would be: no difference between left and right menu placement, based upon the ambiguity of prior research (Gathman, Lee, and Nader, 1998; Kalbach & Bosenick, 2003; Kingsburg, 2004); a difference for scroll bar placement, based upon the novelty of a left-placed scroll bar; a difference for scrolling requirement, based upon tasks requiring additional time for scrolling; and a difference for navigation menu and scroll bar co-location, based upon support for it in previous research (Kellener, Barnes & Lingard 2001), greater efficiency via shorter mouse movement (Fitts' law), and easier information integration (proximity compatibility principle).

METHOD

Experimental Design

A 2 x 2 x 2 mixed design was used. The three factors were navigation menu placement (left or right), a between-subjects factor; scroll bar placement (left or right), a within-subjects factor; and scrolling requirement (yes or no), a within-subjects factor. Eight conditions resulted from the study design (Table 1). The presentation order of the navigation menu and scroll bar conditions were counterbalanced across participants (Appendix A). The scrolling and non-scrolling conditions were an aspect of the task design, with half of the tasks requiring scrolling.

Table 1

Task conditions

Condition	Menu	Scroll Bar	Scrolling
1	Right	Right	Yes
2	Right	Right	No
3	Right	Left	Yes
4	Right	Left	No
5	Left	Right	Yes
6	Left	Right	No
7	Left	Left	Yes
8	Left	Left	No

These conditions allowed several different analyses. Global menu differences were examined by comparing conditions that involved right and left navigation menu placement. Scroll bar placement was examined by comparing conditions for which the scroll bar was on the right versus the left. Scrolling was examined by comparing tasks requiring scrolling with those that did not. Co-location was examined by comparing co-located and non-co-located conditions.

Participants

Thirty-one students from San José State University participated in the study. They were recruited from a pool of undergraduate students taking General Psychology (PSYC 001) and received credit for participation. Participants were screened using the protocol in Appendix B. They were at least 18 years of age and had used the web for no less than one year. The participants considered themselves regular web users, had shopped on the web during the previous six months, and used the web at least three times a week. Complete demographics for participants are in Appendix C. Approval for the use of human subjects in this study was given by the Institutional Review Board (IRB) at San José State University (Appendix D).

Apparatus

Participants viewed locally stored web sites using Microsoft® Internet Explorer 6.0 on a workstation. The primary workstation components were a

seventeen-inch monitor and a computer running the Microsoft® Windows XP operating system. For the comfort of the participants, the chair, monitor, and mouse were adjustable. To ensure that participants used the mouse to scroll, the workstation did not have a keyboard. All participants used the mouse on their right side.

Stimuli

Three fictitious web sites, one practice and two experimental, were created using Adobe® GoLive 6.0. The practice site was based on a book store (Figure 1), and the two experimental sites were generic stores for clothing (Figure 2) and toys (Figure 3). Each web site had four layouts, corresponding to the four menu and scroll bar placement combinations (Table 2). The basic design of the sites was constant, with the name of the site across the top of each page and navigation menus down the side. Category names that can be found on similar sites were used; a full listing of the category names and submenus for each site is in Appendix E.

Product categories and links to general information were the primary navigation for each site. The category names were evenly spaced down the pages, with each site containing nine product categories and four general information links. Each category had a consistent number of submenus, with product categories having three each, and general information options having none. Products were presented at the submenu level with an associated

picture, name, and price. Product information was evenly spaced, and all pictures were similar in size (Figure 4). After participants clicked on either the picture or name of the product to choose it, a confirmation page was shown.

Figure 1. An example of the bookstore web site, using the left menu, right scroll bar design. The colors of the category images and other graphics were shades of red.

Figure 2. An example of the toy web site, using the right menu, right scroll bar design. The browser window size required scrolling to see the items of information below the “Contact Us” menu item. The colors of the category images and other graphics were shades of blue.

Figure 3. An example of the clothing web site, using the left menu, left scroll bar design. The browser window size required scrolling to see the items of information below the “Find a Store” menu item. The colors of the category images and other graphics were shades of green.

Table 2

Four layouts constructed for each web site

The gray rectangle represents the menu, and the white rectangle represents the scroll bar.

Description	Layout	Description	Layout
Left menu Right scroll bar		Left menu Left scroll bar
Right menu Left scroll bar		Right menu Right scroll bar

Tasks

Tasks included finding products, comparing prices, determining company information, and providing information about the web site. Some tasks ended with a confirmation page; while others with verbal confirmation from the researcher.

The task descriptions explicitly provided the menu or submenu name, but the order of that information did not always match the hierarchy of the site. One example is “Purchase a stuffed animal that is a tiger puppet,”

which matches the hierarchy of the menu levels by listing the menu category first. Another example is “Purchase an NFL Sports Video Game,” which does not match the hierarchy of the menu because it lists the product first, followed by the menu category. A sample set of tasks is in Table 3, with the complete list in Appendix F.

Figure 4. An example of a toy web site product page, using the right menu, right scroll bar design. The browser window size required scrolling to see the items of information below the category “Contact Us.”

Table 3

A sample set of tasks for the practice session

N	Task	Scrolling Requirement	Most Efficient Path
1	Purchase the “Tour of Duty” audiobook	None	Audiobooks Tour of Duty
2	Book returns must be completed in how many days? (Answer: 30)	None	Book Returns
3	Purchase the “Cat in the Hat” Children’s Book	Target	Children Cat in the Hat

Procedure

The participants were greeted by the experimenter and asked to complete a consent form (Appendix G) and a demographic survey (Appendix H). Then, the participant was seated at the workstation and allowed to personalize the placement of the chair, mouse, and monitor. The experimenter then began to provide instructions to the participant (Appendix I).

There were two sessions in the experiment, with a short break between. In order to control for learning effects, the web sites used in the first and second sessions were not the same. The presentation order of the site designs and the four menu and scroll bar layouts were counterbalanced across participants (Appendix A).

Four practice tasks were completed using the smaller “book store” web site. The design used for the practice tasks matched that of the experimental tasks. For example, if the participant’s experimental site had a right navigation menu with a left scroll bar, the practice web site had the same. The practice tasks helped participants become comfortable with the experimental tasks. In conditions for which the scroll bar was on the left, the practice tasks also provided a chance to become acquainted with this novel navigation method.

Following the practice, participants were asked to complete a set of 24 tasks on an experimental web site. Participants were instructed to act as if they were shopping on their own, and select the items as quickly and accurately as possible. Participants were not asked to analyze their steps or provide a verbal protocol. For each task, the experimenter read the task description to the participant, and, then, allowed the participant to begin. The task was complete when the participant chose the product or answered the question, and, then, received confirmation. After completing the experimental tasks, participants rated the usability of the experimental web site with a post-interaction survey (Appendix J).

The second session followed the same order as the first. Participants were again given practice tasks using a web site matching the layout of the experimental site. The participants then completed 24 tasks on the second

experimental web site, followed by a second post-interaction survey. After that, participants filled out a comparative survey (Appendix K).

Dependent Measures

A number of dependent measures were collected for each participant:

Navigation Time. TechSmith® Camtasia Studio 2 was used to record the participant's screen activity. The recording was used to note the total time to complete a task and the number of clicks made.

Cursor Movement. The recording was used to observe cursor movement, including the frequency of movement to the wrong side of the web site. For example, if a participant moved the cursor to the right side of the page when the scroll bar was on the left, or to the left side of the page when the menu was on the right, it was considered a cursor movement to the wrong side.

Selection Errors. Selection errors were counted for each task. This included extra clicks by participants, as well as incorrect selection of a menu, submenu, or target. Clicks in excess of the minimum number required were considered selection errors.

Preference. Comparative and usability ratings measured the preferences of the participants for the experimental web sites. These ratings and comparisons included efficiency, ease of use, layout design, and overall preference.

RESULTS

Statistical analyses were conducted on performance and preference data collected from screen recordings and surveys. Navigation time, scrolling and cursor movement, selection errors, and preferences were analyzed using ANOVA. The level of significance was defined as $\alpha \leq 0.05$. Analyses were conducted to explore possible differences between groups, comparing: right- with left- placed menus and scroll bars; tasks requiring scrolling with those that did not; interactions with the clothing site with those for the toy site; and menu and scroll bar co-location with non-co-location.

Navigation Time

Navigation time for each task was measured by recording the clicks made by the participant and the total time for task completion (Table 4). No main effect of navigation time was found for menu, $F(1, 29) = 1.369$, $p = 0.252$; or scroll bar placement, $F(1, 29) = 0.233$, $p = 0.633$. However, a main effect of navigation time was found for scrolling requirement, $F(1, 29) = 127.95$, $p < 0.01$. Navigation time was faster for tasks that did not require scrolling than for tasks that did (Figure 5). No effect of navigation time was found for co-location of menu and scroll bar, $F(1, 29) = 0.222$, $p = 0.641$.

A main effect of navigation time was found for web design, $F(1, 29) = 18.087$, $p < 0.01$. Navigation time was faster for tasks completed on the clothing web site than for the toy web site (Figure 6). No other significant

main or interaction effects were found. Separate analyses were conducted to further explore the difference by web site, and the same effect of navigation time was found for scrolling requirement for both the clothing web site, $F(1, 27) = 141.125$, $p < 0.01$, and toy web site, $F(1, 27) = 38.119$, $p < 0.01$. No other significant main or interaction effects were found for total navigation time.

Additional analyses were conducted to examine the five components of navigation time: navigation to the main menu, submenu, and scroll bar, scrolling, and navigation to the target (Figures 7 and 8). For the scrolling requirement, there was a main effect of time spent navigating to the scroll bar [$F(1, 29) = 96.304$, $p < 0.01$], time spent scrolling [$F(1, 29) = 79.485$, $p < 0.01$], and time spent navigating to the target [$F(1, 29) = 86.199$, $p < 0.01$]. The amount of time spent on each of those components was smaller for tasks that did not require scrolling than for those that did. No other significant main or interaction effects were found.

Table 4

Navigation time mean scores and standard deviation in seconds for all tasks, scrolling tasks, and non-scrolling tasks, ordered by total time ranking

Menu	Scroll Bar	All Tasks		Scrolling		Non-Scrolling	
		<i>Mean</i>	<i>St. Dev</i>	<i>Mean</i>	<i>St. Dev</i>	<i>Mean</i>	<i>St. Dev</i>
Right	Right	276.79 (1)	11.61	165.61 (1)	28.39	111.18 (1)	25.72
Right	Left	293.15 (2)	16.10	174.10 (3)	41.28	119.05 (2)	25.90
Left	Right	309.36 (3)	22.78	171.37 (2)	32.29	137.99 (4)	65.77
Left	Left	310.49 (4)	26.26	185.22 (4)	57.34	125.27 (3)	46.66

Figure 5

Mean navigation time in seconds by scrolling requirement

Figure 6

Mean navigation time in seconds by web site design

Figure 7

Mean navigation time in seconds by co-location

Figure 8

Mean navigation time in seconds by condition

Cursor Movement

The frequency of cursor movement to the wrong side was recorded for each task and totaled for each participant. Cursor movement errors were analyzed using a mixed model ANOVA. A main effect of navigation to the wrong side was found for scroll bar placement, $F(1, 29) = 5.754$, $p < 0.05$. The number of times that participants navigated to the wrong side was larger when the scroll bar was placed on the left than when it was on the right (Figure 9). A main effect of navigation to the wrong side was also found for scrolling requirement, $F(1, 29) = 7.269$, $p < 0.05$. The number of errors was larger for tasks that required scrolling than for those that did not (Figure 10). No other effects of cursor movement errors were found.

Figure 9

Navigation to the wrong side by scroll bar placement

Figure 10

Navigation to the wrong side by scrolling requirement

Selection Errors

The frequency of selection errors was recorded for each task and totaled for each participant. The errors included selection of an incorrect main menu, submenu, or target. The number of occurrences for each error was totaled for each task and then analyzed using a mixed model ANOVA. A main effect of choosing an incorrect target was found for scrolling requirement, $F(1, 29) = 13.473$, $p < 0.01$. For tasks that required scrolling, the mean number of times participants incorrectly chose a target was larger than for tasks that did not (Figure 11). No other effects of selection errors were found.

Figure 11

Target selection errors by scrolling requirement *Usability Ratings*

Participants were asked to rate each web site on a number of aspects, including efficiency of the layout, and ease of using the scroll bar, locating items on the page, and navigating the site generally, the site without error, and between the scroll bar and the menu or target item. Each aspect of the web site was rated on a scale of 1 to 5, with 1 being very easy and 5 being very difficult. That is, a lower number indicates a more positive result and a higher number indicates a less positive result. An example of two questions from the survey is shown in Figure 12; the full survey is in Appendix J.

Figure 12

Example questions from the post-interaction survey

Overall, how easy or difficult was it to navigate the web site?						
Very Easy	1	2	3	4	5	Very Hard
How efficient or inefficient do you find the layout of the web site?						
Very Efficient	1	2	3	4	5	Not efficient at all

There was a main effect of usability rating for scroll bar placement, $F(1, 29) = 51.76$, $p < 0.01$. The average rating for a right-placed scroll bar was lower than for a left-placed one (Figure 13). For all statements, a right-placed scroll bar was rated better than a left-placed scroll bar (Table 5).

There was no main effect of overall usability rating for menu placement, $F(1, 29) = 1.091$, $p > 0.05$; or for menu and scroll bar co-location, $F(1, 29) = 1.55$, $p > 0.05$. However, in all measurements except one, left-placed menus were rated easier than right-placed menus (Table 6).

No main effect of usability rating was found for menu and scroll bar co-location, $F(1, 29) = 1.550$, $p > 0.05$. Co-location was rated easier for four measurements; non-co-location was rated easier for one; and both were rated equally for two (Table 7). In comparing the four combinations of menu and scroll bar, the right menu and scroll bar combination was rated easiest in three measurements, while the left menu and right scroll bar combination

was rated easiest in four. The remaining combinations were not rated as easiest for any measurement.

Figure 13

Usability ratings by scroll bar placement. A lower value is more positive.

Table 5

Mean usability ratings for left and right scroll bar placement. A shaded cell indicates the most positive response.

Rating	Left	Right	Overall
Overall, how easy or difficult was it to navigate the web site?	2.03	1.19	1.61
How efficient or inefficient did you find the layout of the web site?	2.32	1.65	1.94
How easy or difficult was it to navigate the web site without making errors?	2.10	1.58	1.84
How easy or difficult was it to use the scroll bar?	3.16	1.48	2.32
How easy or difficult was it to navigate between the scroll bar and the menu?	2.81	1.65	2.23
How easy or difficult was it to navigate between the scroll bar and the items available for purchase?	2.55	1.71	2.13
How easy or difficult was it to locate items on the page?	2.13	1.77	1.95
Combined mean	2.44	1.56	2.00

Table 6

Mean usability ratings for left and right menu placement. A shaded cell indicates the most positive response.

Rating	Left	Right	Overall
Overall, how easy or difficult was it to navigate the web site?	1.47	1.75	1.61
How efficient or inefficient did you find the layout of the web site?	1.70	2.16	1.94
How easy or difficult was it to navigate the web site without making errors?	1.77	1.91	1.84
How easy or difficult was it to use the scroll bar?	2.27	2.38	2.32
How easy or difficult was it to navigate between the scroll bar and the menu?	2.13	2.31	2.23
How easy or difficult was it to navigate between the scroll bar and the items available for purchase?	2.17	2.09	2.13
How easy or difficult was it to locate items on the page?	1.68	2.25	1.95
Combined mean	1.88	2.12	2.00

Table 7

Mean usability ratings for co-location and non-co-location. A shaded cell indicates the most positive response.

Rating	Same	Diff	Overall
Overall, how easy or difficult was it to navigate the web site?	1.45	1.77	1.61
How efficient or inefficient did you find the layout of the web site?	1.84	2.03	1.94
How easy or difficult was it to navigate the web site without making errors?	1.87	1.81	1.84
How easy or difficult was it to use the scroll bar?	2.32	2.32	2.32
How easy or difficult was it to navigate between the scroll bar and the menu?	1.97	2.48	2.23
How easy or difficult was it to navigate between the scroll bar and the items available for purchase?	2.13	2.13	2.13
How easy or difficult was it to locate items on the page?	1.81	2.10	1.95
Combined mean	1.91	2.09	2.00

Comparative Preferences

In the comparative survey, participants decided which experimental web site, left- or right- placed scroll bar, best matched each statement. For positive statements, more responses was better, while for negative statements, fewer responses was better. The results were examined in the same groups as the usability ratings, except comparison by menu. Comparisons by menu could not be made because each participant only interacted with one menu placement, and, therefore, had no basis for comparison.

In all ratings, a right-placed scroll bar was preferred over a left-placed one (Table 8). In all but two measurements, a co-located menu and scroll bar were preferred. “Best for an experienced user” and “preferred overall” were preferred for a non-co-located menu and scroll bar. Comparing the four combinations, right menu with right scroll bar was preferred for thirteen measurements, left menu with right scroll bar was preferred for two, and they were equally preferred for three. The remaining combinations were not preferred for any measurement.

Table 8

Comparative ratings for left and right scroll bar placement. A shaded cell indicates the most positive response.

Statement	Left		Right	
	N	%	N	%
Easiest to complete tasks	3	9.68	28	90.32
Fastest to complete tasks	5	16.13	26	83.87
Hardest to navigate menus	24	80.00	6	20.00
Best for a first-time user	5	16.13	26	83.87
Best for an experienced user	3	9.68	28	90.32
Most stressful to use	29	93.55	2	6.45
Preferred Overall	1	3.33	29	96.67
Most difficult to navigate between menu and scroll bar	25	80.65	6	19.35
Most efficient	5	16.13	26	83.87
Most difficult to navigate to items for purchase	25	80.65	6	19.35
Best layout	6	19.35	25	80.65
Most intuitive	6	19.35	25	80.65
Fastest to use	3	9.68	28	90.32
Least frustrating to use	2	6.45	29	93.55
Easiest to find items for purchase	5	16.13	26	83.87
Easiest to use without making errors	3	9.68	28	90.32
Scroll bar placement most frustrating to use	29	93.55	2	6.45
Scroll bar placement easiest to navigate between the menu and scroll bar	5	16.13	26	83.87

Table 9

Comparative ratings for co-location. A shaded cell indicates the most positive response. When a participant in the right menu condition chose the right scroll bar for the statement, this was considered a co-location match, and *vice-versa*.

Statement	Co-location		No Co-location	
	N	%	N	%
Easiest to complete tasks	17	54.84	14	45.16
Fastest to complete tasks	17	54.84	14	45.16
Hardest to navigate menus	10	33.33	20	66.67
Best for a first-time user	19	61.29	12	38.71
Best for an experienced user	13	41.94	18	58.06
Most stressful to use	15	48.39	16	51.61
Preferred Overall	14	46.67	16	53.33
Most difficult to navigate between menu and scroll bar	9	29.03	22	70.97
Most efficient	19	61.29	12	38.71
Most difficult to navigate to items for purchase	15	38.39	16	51.61
Best layout	18	58.06	13	41.94
Most intuitive	18	58.06	13	41.94
Fastest to use	17	54.84	14	45.16
Least frustrating to use	16	51.61	15	48.39
Easiest to find items for purchase	19	61.29	12	38.71
Easiest to use without making errors	17	54.24	14	45.16
Scroll bar placement most frustrating to use	15	38.39	16	51.61
Scroll bar placement easiest to navigate between the menu and scroll bar	21	67.74	10	32.26

Table 10

Comparative ratings for four menu and scroll bar comparisons. A shaded cell indicates the most positive response. When a participant in the right menu condition chose the right scroll bar for the statement, this was considered a right-right match, and vice-versa.

Statement	Right Menu				Left Menu			
	Right Scroll Bar		Left Scroll Bar		Right Scroll Bar		Left Scroll Bar	
	N	%	N	%	N	%	N	%
Easiest to complete tasks	15	48.39	1	3.23	13	41.94	2	6.45
Fastest to complete tasks	15	45.16	2	6.45	12	38.71	3	9.68
Hardest to navigate menus	15	3.33	15	50.00	5	16.67	9	30.00
Best for a first-time user	15	48.39	1	3.23	11	35.48	4	12.90
Best for an experienced user	13	41.94	3	9.68	15	48.39	0	0.00
Most stressful to use	15	3.23	15	48.39	1	3.23	14	45.16
Preferred Overall	14	46.67	1	3.33	15	50.00	0	0.00
Most difficult to navigate between menu and scroll bar	16	0.00	16	51.61	6	19.35	9	29.03
Most efficient	15	48.39	1	3.23	11	35.48	4	12.90
Most difficult to navigate to items for purchase	15	9.68	13	41.94	3	9.68	12	38.71
Best layout	15	45.16	2	6.45	11	35.48	4	12.90
Most intuitive	15	45.16	2	6.45	11	35.48	4	12.90
Fastest to use	15	48.39	1	3.23	13	41.94	2	6.45
Least frustrating to use	15	48.39	1	3.23	14	45.16	1	3.23
Easiest to find items for purchase	15	48.39	1	3.23	11	35.48	4	12.90
Easiest to use without making errors	15	48.39	1	3.23	13	41.94	2	6.45
Scroll bar placement most frustrating to use	15	3.23	15	48.39	1	3.23	14	45.16
Scroll bar placement easiest to navigate between the menu and scroll bar	16	51.61	0	0.00	10	32.26	5	16.13

DISCUSSION

Menu Placement

Menu placement findings were mixed. While there was no main effect of navigation time, matching the findings of Kalbach and Bosenick (2003), placing the menu on the left produced more variance and trended toward slower navigation time. A left-placed menu matches user expectations (Bernard, 2002), but did not result in a performance difference. Higher absolute usability ratings for left-placed menus indicated a slight preference for menus on the left, although, because each participant only interacted with one menu placement, there were no direct comparative ratings by menu.

Many participants might have been unaccustomed to interacting with a right-placed menu. Kingsburg (2004) conducted a survey of web site menu structures and found that, of 69 sites using multi-level menu structures, 88% used a structure that included combinations of top and left menu placement. Of the remaining sites that had a navigation menu on the right or bottom, 5% were commerce web sites and 7% were human factors sites. Therefore, participants likely had little exposure to right-placed menus and did not expect them. However, the findings of McCarthy, Sasse, and Riegelsberger (2003) suggested that users easily adapt to this mismatch and that it does not affect long-term task performance.

Scroll Bar Placement

Findings support keeping the standard scroll bar placement. While there was no main effect of navigation time for scroll bar placement, there was a clear preference shown in usability ratings and comparisons. For scroll bar placement, there was also a significant difference in cursor movement errors, such as navigation to the wrong side. For example, if the scroll bar was located on the left and the participant navigated to the right when attempting to scroll, then it was an error. As all of the participants were experienced, they may have had an automatic motor program to navigate to the right to scroll, and the atypical location of the scroll bar likely led to increased errors with a left-placed scroll bar. Error reduction is important for improving the user experience, because users who become frustrated with a web site design will be less likely to visit again.

While participants rated a right-placed scroll bar as easier in all usability ratings and comparisons, they did not seem bothered by having it on the left. In some cases, it took participants more than a minute to discover the scroll bar on the left; but, after the placement was learned, participants became comfortable with it. Due to the practice trials, time spent discovering the location of the scroll bar on the left did not factor into the experimental sessions. However, participants always preferred the scroll bar on the right, regardless of menu placement.

Scrolling Requirement

Scrolling tasks took longer, and also induced a larger number of errors in which participants navigated to the wrong side or selected an incorrect target. The reason for this might have been because participants were likely to scroll beyond a target when scrolling was required. Since studies have shown that scrolling is a normal browsing occurrence (Byrne, *et al*, 1999b; Kangas, 2001; Spool, 1998), and scrolling introduces both longer navigation times and greater numbers of errors, it is important to optimize the placement of the menu with the scroll bar.

Web Site Design

A main effect of navigation time for web site design was found. Total time to complete tasks on the clothing web site was lower than that of the toy web site. Toy items were described by their names, such as “Chinese checkers”; while clothing items were described by their features, such as “a pair of red shorts.” Seeing a color and identifying it may have led to decreased reaction times when locating items on the clothing site.

Menu and Scroll Bar Co-location

While predicted, an effect of scroll bar and menu co-location was not found. There was no significant difference between co-location and non-co-location in total navigation time, usability rating, or errors. This contrasts with the findings of Kellener, Barnes, and Lingard (2001), although they

studied list boxes, not web browsing. It also contrasts with Fitts' law, which predicts a decrease in movement time for targets located closer together. Due to experience levels, participants likely had a motor program for web navigation that was overlearned, and a schema that included the usual layout of the menu and scroll bar on opposing sides of the browser.

Co-location was considered best in all measures except "preferred overall" and "best for an experienced user, " and rated as more usable. Despite preferring co-location, experienced users may be accustomed to having the menu and scroll bar on opposing sides and use this layout efficiently. Left co-location may be unfavorable, due to a lack of user experience with left-placed scroll bars. If the cognitive time to process the placement of the scroll bar subsumes the decrease in movement time, the novelty of the left-placed scroll bar may override the benefit of co-location. However, for standard, right-placed scroll bars, there is a potential benefit for a co-located menu, supported by preference and usability ratings. While moving the scroll bar to match the common left-placed menu would not be an improvement, moving the menu to match the standard right-placed scroll bar may.

LIMITATIONS

There are some limitations with the study, including the type and length of tasks, menu placement as a between-subject factor, novelty of a left-placed scroll bar and a right-placed menu, and demographics of study participants. While the tasks in the study are typical of those that might occur while browsing the web, in order to have participants complete the same kind and number, and to identify a start and end for each, the tasks were directed behavior. As the participant has a particular target in mind and is not browsing or scanning for something of interest, the time spent completing each task may be shorter than during normal web shopping.

To make the sessions short enough that participants would not grow tired, this study was designed with menu placement as a between-subject factor. Each participant interacted with only one menu placement, left or right. This means there were no direct comparisons for menu placement.

The novelty of the left-placed scroll bar may be another limitation. The right-placed scroll bar is the standard for web browsers and other computer applications. In some cases, it took participants quite a while to realize when the scroll bar was on the left side of the web browser. Despite practice tasks to factor out discovery time, more errors occurred when the scroll bar was on the left. Similarly, the novelty of the right-placed menu may be a limitation because it is uncommon.

The age and experience of participants may also be a limitation.

Participants were all undergraduate students and experienced users of the web. Of thirty-one participants, twenty-seven (87.1%) had used the World Wide Web for more than three years. Experienced web users were sought to avoid the need to teach participants how to use and shop on web sites; but this may have made them less adaptable to different menu and scroll bar layouts.

FUTURE RESEARCH

Additional menu research should clarify which menu and scroll bar placement is best for commercial, and personal or informational sites. Future research should determine if novice users have the same performance and preferences for menu and scroll bar placement. Novice users, with little computer and web browsing experience, may paint a different picture, as they are unaccustomed to the usual designs of web sites.

It may also be beneficial to consider how menu and scroll bar placement interacts with other navigation methods. Browser navigation tools, such as the back button (used to return to the previous web page), may impact placement. Similarly, navigation using a laptop pointing device, such as a touchpad or TrackPoint®, should be explored, as the behavior may be different from using a detached mouse.

Future research should include greater exposure to right-placed menus. In a longer study, participants could acclimate to interacting with and using menus on the right side. Users should be exposed to right menus at the same level for which they are exposed to left menus. Also, research should include further study of the co-location principle, examining right co-location by directly comparing left versus right menus with a right-placed scroll bar.

CONCLUSION

The navigation architecture of web sites is an essential aspect underlying the efficiency and satisfaction of the user experience. Usually, menus are on the left side of the browser, while the scroll bar is on the right. Navigation time and errors increase when scrolling is required, highlighting the need to optimize the placement of menus relative to the scroll bar. The findings of this study, along with those of Kingsburg (2004), suggest that, since users are wedded to a right-side scroll bar, there are potential performance and preference advantages for a corresponding right-side menu, because such a co-located arrangement would be consistent with the proximity-compatibility principle (Wickens and Carswell, 1995), in which objects that have high display and processing proximity have easier information integration; and Fitts' law (Fitts, 1954), in which closer objects provide for shorter movements and greater efficiency.

REFERENCES

- Aaltonen, Antti, Hyrskykari, Aulikki, Raiha, Kari-Jouko (1998). 101 spots, or how do users read menus? *Proceedings of the SIGCHI conference on Human factors in computing systems*, pp. 132-139.
- Backs, R. W. (1987). Comparison of Horizontal and Vertical Menu Formats. *Proceedings of the Human Factors and Ergonomics Society 31st Annual Meeting*, 715-717.
- Bernard, Michael L. (2001). Developing schemas for the location of common web objects. *Proceedings of the Human Factors and Ergonomics Society 45th Annual Meeting*, pp. 1161-1165.
- Bernard, Michael L. (2002). *Examining User Expectations for the Location of Common E-Commerce Web Objects*. Retrieved November 2003, from http://psychology.wichita.edu/surl/usabilitynews/41/web_object-ecom.htm
- Bernard, M and Hambin, C. (2003). Cascading versus Indexed Menu Design. *Usability News*, 5 (2).
- Byrne, Michael D., Anderson, John R., Douglass, Scott, and Matessa, Michael (1999a). Eye tracking the visual search of click-down menus. *Proceedings of the SIGCHI conference on Human factors in computing systems*, pp. 402-409.
- Byrne, Michael D., John, Bonnie E., Wehrle, Neil S., & Crow, David C. (1999b). The tangled Web we wove: a taskonomy of WWW use. *Proceedings of the SIGCHI conference on Human factors in computing systems*, pp. 544-551.
- Card, Stuart K (1982). User perceptual mechanisms in the search of computer command menus. *Proceedings of the 1982 conference on Human factors in computing systems*, pp. 190-196.
- Fitts P. M. (1954). The Information Capacity of the Human Motor System in Controlling Amplitude and Movement. *Journal of Experimental Psychology*, 47, 381-391.

- Fitts P. M., & Peterson J. (1964). Informational Capacity of Discrete Motor Responses. *Journal of Experimental Psychology*, 67, 103-112.
- Fleming, Jennifer (1998). *Web Navigation: Designing the User Experience*. Sebastopol, CA: O'Reilly & Associates.
- Gathman, Gregory, Lee, Wyman, and Nader, Susan (1998). *Menu Frame Placement for Optimal Web Navigation*. Retrieved November 2003, from <http://www.otal.umd.edu/SHORE98/bs25/>
- Global Usage, 2003* (August, 2003). Retrieved November 2003, from http://cyberatlas.internet.com/big_picture/traffic_patterns/print/0,,5931_3084761,00.html
- Greenspan, Robyn. (April, 2002). *Two-Thirds Hit the Net*. Retrieved November 2003, from http://cyberatlas.internet.com/big_picture/geographics/print/0,,5911_1011491,00.html
- Helander, Martin G. and Khalid, Halimahtun M. (2000). Modeling the customer in electronic commerce. *Applied Ergonomics*, 31, 609-619.
- Hendrickson, J. J. (1989). Performance, preference and visual scan patterns on a menu-based system: implications for interface design. *Proceedings of the SIGCHI conference on Human factors in computing systems*, pp. 217-222.
- Hornof, Anthony J. and Kieras, David E (1997). Cognitive modeling reveals menu search is both random and systematic. *Proceedings of the SIGCHI conference on Human factors in computing systems*, pp. 107-114.
- Hornof, Anthony J. and Kieras, David E (1999). Cognitive modeling demonstrates how people use anticipated location knowledge of menu items. *Proceedings of the SIGCHI conference on Human factors in computing systems*, pp. 410-417.
- Kalbach, James (2002). *Challenging the Status Quo: Audi Redesigned*. Retrieved November 2003, from <http://www.bboxesandarrows.com/archives/002695.php>

- Kalbach, James and Bosenick, Tim (2003). Web Page Layout: A Comparison Between Left- and Right-justified Site Navigation Menus. *Journal of Digital Information*, 4. Retrieved November 2003, from <http://jodi.ecs.soton.ac.uk/Articles/v04/i01/Kalbach/>
- Kangas, Steve. (2001). *Layout and Content of Popular Sites*. Retrieved November 2003, from <http://www.netconversions.com/layoutcontent.htm>
- Kellener, E., Barnes, G.M., & Lingard, R. (2001). Effects of Scroll Bar Orientation and Item Justification when using List Boxes. *Proceedings of the 45th Annual Meeting of the Human Factors Society*, pp. 662-666.
- Kim, Jinwoo and Lee, Jungwon (2002). Critical design factors for successful e-commerce systems. *Behaviour and Information Technology*, 21 (3): 185-199.
- Kingsburg, Jennifer. (2004). *A Comparison of Three-level Menu Navigation Structures for Web Design*. Master's thesis, University of San José, San José, California.
- Lee, Eric and MacGregor, James (1987). Menu search: random or systematic? *International Journal of Man-Machine Studies*, 26, pp. 627-631.
- Lohse, Gerald L. and Spiller, Peter (1998). Quantifying the effect of user interface design features on cyberstore traffic and sales. *Proceedings of the SIGCHI conference on Human factors in computing systems*, 211-218.
- MacKenzie, I. S. (2003). Motor behaviour models for human-computer interaction. In J. M. Carroll (Ed.) *Toward a multidisciplinary science of human-computer interaction*, 27-54. San Francisco: Morgan Kaufmann.
- McCarthy, John, Sasse, M. Angela, and Riegelsberger, John (2003). Could I have the menu please? An eye tracking study of design conventions. *Proceedings of HCI 2003*, 401-414.

- Miller, D.P. (1981). The Depth/Breadth Tradeoff in Hierarchical Computer Menus. *Proceedings of the Human Factors and Ergonomics Society 25th Annual Meeting*, 296-300.
- Nielsen, Jakob (1998). *Failure of Corporate Websites*. Retrieved November 2003, from <http://www.useit.com/alertbox/981018.html>
- Nielsen, Jakob (1999a). *When Bad Design Elements Become the Standard*. Retrieved November 2003, from <http://www.useit.com/alertbox/991114.html>
- Nielsen, Jakob (1999b). *Designing Web Usability: The Practice of Simplicity*. New Riders Press: Indianapolis, IN.
- Nielsen, Jakob (2001). *Did Poor Usability Kill E-Commerce?* Retrieved November 2003, from <http://www.useit.com/alertbox/20010819.html>
- Ratner, Julie, Grose, Eric M., and Forsythe, Chris (1996). Characterization and Assessment of HTML Style Guides. *Proceedings of the SIGCHI conference on Human factors in computing systems*. Retrieved November 2003, from http://sigchi.org/chi96/proceedings/intpost/Ratner/rj_txt.htm
- Research-Based Web Design & Usability Guidelines: Navigation*. (n.d.) Retrieved November 2003, from <http://usability.gov/guidelines/navigation.html>
- Schmidt, R. A. (1976). A schema theory of discrete motor skill learning. *Psychological Review*, 82, 225-260.
- Shiffrin, R. M., & Schneider, W. (1977). Controlled and automatic human information processing: II. Perceptual learning, automatic attending and a general theory. *Psychological Review*, 84, 127-190.
- Spool, Jared M. (1998). *As the Page Scrolls*. Retrieved November 2003, from <http://world.std.com/~uieweb/scrollin.htm>
- Spool, Jared M. (2002). *Evolution Trumps Usability Guidelines*. Retrieved November 2003, from http://www.uie.com/Articles/evolution_trumps_usability.htm

- Spool, J.M., Scanlon, T., Schroeder, W., Snyder, C., and DeAngelo, T. (1999). *Web Site Usability: A Designer's Guide*. Morgan Kaufmann Publishers: San Francisco.
- Tilson, Roger, Dong, Jianming, Martin, Shirley, and Kieke, Eric (1998). "Factors and Principles Affecting the Usability of Four E-commerce Sites." *Proceedings of the 4th Conference on Human Factors and the Web*. Retrieved November 2003, from <http://www.research.microsoft.com/users/marycz/hfweb98/tilson/index.htm>
- Teitelbaum, Richard C. and Granda, Richard E. (1983). The effects of positional constancy on searching menus for information. *Proceedings of the SIGCHI conference on Human factors in computing systems*, pp. 150-153.
- Tsunoda, T., Yamaoka, T., Yamashita, K., Matsunobe, T., Hashiya, Y., Nishiyama, Y. and Takahasi, K. (2001). Measurement of task performance times and ease of use: Comparison of various menu structures and depth on the Web. *Proceedings of the Human Factors and Ergonomics Society 45th Annual Meeting*, pp. 1225-1229.
- Visual layout and elements*. (n.d.) Retrieved November 2003, from http://www-3.ibm.com/ibm/easy/eou_ext.nsf/Publish/602
- Wickens, C.D., & Carswell, C.M. (1995). The proximity compatibility principle: Its psychological foundation and relevance to display design. *Human Factors*, 37(3), 473-494.
- Wickens, C. D. & Hollands, J.G. (2000). *Engineering Psychology and Human Performance* (3rd ed.). New Jersey: Prentice-Hall Inc.

Appendix A

Experiment Interaction Order

	Session 1				Session 2		
P	Menu	Scroll Bar	Site		Menu	Scroll Bar	Site
1	Right	Right	Toy		Right	Left	Clothing
2	Right	Right	Clothing		Right	Left	Toy
3	Right	Left	Toy		Right	Right	Clothing
4	Right	Left	Clothing		Right	Right	Toy
5	Left	Right	Toy		Left	Left	Clothing
6	Left	Right	Clothing		Left	Left	Toy
7	Left	Left	Toy		Left	Right	Clothing
8	Left	Left	Clothing		Left	Right	Toy
9	Right	Right	Toy		Right	Left	Clothing
10	Right	Right	Clothing		Right	Left	Toy
11	Right	Left	Toy		Right	Right	Clothing
12	Right	Left	Clothing		Right	Right	Toy
13	Left	Right	Toy		Left	Left	Clothing
14	Left	Right	Clothing		Left	Left	Toy
15	Left	Left	Toy		Left	Right	Clothing
16	Left	Left	Clothing		Left	Right	Toy
17	Right	Right	Toy		Right	Left	Clothing
18	Right	Right	Clothing		Right	Left	Toy
19	Right	Left	Toy		Right	Right	Clothing
20	Right	Left	Clothing		Right	Right	Toy
21	Left	Right	Toy		Left	Left	Clothing
22	Left	Right	Clothing		Left	Left	Toy
23	Left	Left	Toy		Left	Right	Clothing
24	Left	Left	Clothing		Left	Right	Toy
25	Right	Right	Toy		Right	Left	Clothing
26	Right	Right	Clothing		Right	Left	Toy
27	Right	Left	Toy		Right	Right	Clothing
28	Right	Left	Clothing		Right	Right	Toy
29	Left	Right	Toy		Left	Left	Clothing
30	Left	Left	Toy		Left	Right	Clothing
31	Left	Left	Clothing		Left	Right	Toy

Appendix B

Screening Protocol

Participants for this study should be females and males at least 18 years of age who are experienced web users. Participants will have used the web for at least one year and should be regular web users, who use the web at least 2-5 times a week. Participants should also have experience shopping on the web within the previous six months.

1. How old are you? If over 18, continue, else terminate.
2. What is your occupation? If web developers or designers, terminate, else continue.
3. Do you use the World Wide Web? If yes, continue, else terminate.
4. How long have you been using the web? If greater than 1 year, continue, else terminate.
5. How would you rate your level of experience in web usage (novice, intermediate, expert)? If not novice, continue, else terminate.
6. How often do you use the web? If greater than 2 times a week, continue, else terminate.
7. Have you ever used the web for shopping? If yes, continue, else terminate.

Appendix C
Participant Demographics

Demographic	N	Percent	Demographic	N	Percent
<u>Sex</u>			<u>Handedness</u>		
Male	11	35.48%	Right	27	87.10%
Female	20	64.52%	Left	4	12.90%
<u>Length of computer use</u>			<u>Frequency of computer use</u>		
1-2 years	1	3.23%	2-3 times a week	4	12.90%
2-3 years	2	6.45%	4-5 times a week	7	22.58%
More than 3 years	28	90.32%	6+ times a week	20	64.52%
<u>Length of web use</u>			<u>Frequency of web use</u>		
1-2 years	1	3.23%	2-3 times a week	7	22.58%
2-3 years	3	9.68%	4-5 times a week	6	19.35%
More than 3 years	27	87.10%	6+ times a week	18	58.06%
<u>Time since last online purchase</u>			<u>Frequency of online purchasing</u>		
Less than 1 week	7	22.58%	Weekly	3	9.68%
Less than 1 month	10	32.26%	Monthly	4	12.90%
1 to 6 months	10	32.26%	Every few months	18	58.06%
6 to 12 months	4	12.90%	Yearly	6	19.35%

Appendix D

IRB Approval Letter

San José State
UNIVERSITY

**Office of the Academic
Vice President
Academic Vice President
Graduate Studies and Research**

One Washington Square
San Jose, CA 95192-0025
Voice: 408-924-7500
Fax: 408-924-2477
E-mail: gradstudies@sjsu.edu
http://www.sjsu.edu

To: Heather Devine
319 E. McKinley Ave.
Sunnyvale, CA 94086

From: Pam Stacks,
Interim AVP, Graduate Studies & Research

Date: February 27, 2004

The Human Subjects-Institutional Review Board has approved your request to use human subjects in the study entitled:

"Effects of Scroll Bar and Navigation Menu Co-Location on Web
Interaction performance."

This approval is contingent upon the subjects participating in your research project being appropriately protected from risk. This includes the protection of the anonymity of the subjects' identity when they participate in your research project, and with regard to all data that may be collected from the subjects. The approval includes continued monitoring of your research by the Board to assure that the subjects are being adequately and properly protected from such risks. If at any time a subject becomes injured or complains of injury, you must notify Pam Stacks, Ph.D. immediately. Injury includes but is not limited to bodily harm, psychological trauma, and release of potentially damaging personal information. This approval for the human subjects portion of your project is in effect for one year, and data collection beyond February 27, 2005 requires an extension request.

Please also be advised that all subjects need to be fully informed and aware that their participation in your research project is voluntary, and that he or she may withdraw from the project at any time. Further, a subject's participation, refusal to participate, or withdrawal will not affect any services that the subject is receiving or will receive at the institution in which the research is being conducted.

If you have any questions, please contact me at (408) 924-2480.

cc: Anthony Andre

The California State University:
Chico, Fresno, Fullerton, Hayward, Long Beach, Los Angeles, Merced, Monterey, Monterey Bay, Northridge, Pomona, San Bernardino, San Diego, San Francisco, Sacramento, San Jose, Stanislaus, Stockton, Tulare, Ukiah, Visalia, Yuba

Appendix E

Experimental Web Site Categories and Submenus

Practice Web Site

- Audiobooks
- Fiction
- Nonfiction
- Children
- Book Club
- Book Returns

Toy Web Site

- Learning Activities
 - Science
 - Reading
 - Math
- Blocks & Legos
 - Legos
 - Blocks
 - Lincoln Logs
- Baby Dolls
 - Dolls
 - Clothing
 - Accessories
- Video Games
 - Adventure
 - Sports
 - Accessories
- Sets & Models
 - Trains
 - Planes
 - Cars
- Games & Puzzles
 - Board Games
 - Card Games
 - Puzzles
- Musical Toys
 - Guitars
 - Drums
 - Other
- Sports & Outdoors
 - Kites
 - Tents & Playhuts
 - Sports
- Stuffed Animals
 - Bears
 - Jumbo-Sized
 - Puppets
- About Us
- Contact Us
- Shipping Costs
- Store Locator

Clothing Web Site

- Women
 - Pants
 - Shirts & Tops
 - Pajamas
- Men
 - Pants
 - Shirts & Tops
 - Business
- Children
 - Boys
 - Girls
 - Outerwear
- Babies
 - One-pieces
 - Active Wear
 - Outerwear
- Teenagers
 - Girls
 - Guys
 - Outerwear
- Accessories
 - Gloves & Scarves
 - Wallets & Watches
 - Belts & Ties
- Shoes
 - Athletic
 - Boots
 - Sandals
- Purses
 - Leather
 - Fabric
 - Evening
- Maternity
 - Blouses
 - Swimwear
 - Dresses
- Shipping Rates
- Find a Store
- Locations
- Return Policy

Appendix F

Task List

The tables include the task description, scrolling requirement, and most efficient path to task completion. The scrolling information describes whether the participant must scroll to locate the category for an item, the target for a task, or both.

Practice Session 1			
N	Task	Scrolling Requirement	Most Efficient Path
1	Purchase the “Tour of Duty” audiobook	None	Audiobooks -> Tour of Duty
2	Book returns must be completed in how many days? (Answer: 30)	None	Book Returns
3	Purchase the “Cat in the Hat” Children’s Book	Target	Children -> Cat in the Hat
4	Purchase the Fiction book “Four Blind Mice”	Target	Fiction -> Four Blind Mice

Practice Session 2			
N	Task	Scrolling Requirement	Most Efficient Path
1	Purchase “Decoy”, a Fiction Novel	Target	Fiction -> Decoy
2	Please try to join the store’s book club	None	Book Club -> click here to join
3	What state are return forms mailed to? (Answer: TX)	Target	Book Returns
4	Purchase the most expensive nonfiction book.	None	Nonfiction -> Magnificent Mars

Experimental Session for Clothing Site			
N	Task	Scrolling Requirement	Most Efficient Path
1	Purchase a Pink Fleece Jacket, outerwear for a teen.	Target	Teenagers -> Outerwear -> Pink Fleece
2	Purchase the cheapest clothing item for a boy, in the children's section.	None	Children -> Boys -> Striped Rugby Shirt
3	What is the rate for domestic shipping? (Answer: 1.99/pound)	None	Shipping Rates
4	Purchase a men's shirt, the Casual Blue Tee.	Target	Men -> Shirts & Tops -> Casual Blue Tee
5	Purchase a women's shirt that costs less than \$10.	None	Women -> Shirts & Tops -> V-Neck Tee
6	Purchase a maternity dress that is tie-dyed.	Target	Maternity -> Dresses -> Tie-Dye Dress
7	Purchase a Blue Wicker Bag, a fabric purse.	None	Purses -> Fabric -> Blue Wicker Bag
8	Purchase a pair of red shorts, active wear for an infant.	Target	Infants-> Active Wear -> Red Shorts
9	What is the zip code for the address where items can be returned? (Answer: 85008)	Category and Target	Return Policy
10	Purchase the most expensive tie available from the accessories section.	Target	Accessories -> Belts & Ties -> Blue Striped Tie
11	Purchase the NBA Pajama Set, which are women's pajamas.	None	Women -> Pajamas -> NBA Pajama Set
12	Does the Clothing Boutique sell Athletic Shoes? (Answer: Yes)	None	Shoes

Experimental Session for Clothing Site (continued)			
N	Task	Scrolling Requirement	Most Efficient Path
13	Purchase a Classic Black Handbag, a leather purse.	Target	Purses -> Leather -> Classic Black Handbag
14	Purchase a Denim Dress for a girl from the children's section.	Target	Children-> Girls -> Denim Dress
15	Purchase a pair of Green Gloves, from the Gloves & Scarves accessories.	None	Accessories -> Gloves & Scarves -> Green Tech Gloves
16	In what city was the Clothing Boutique founded? (Answer: Phoenix, AZ)	Category and Target	Our History
17	Purchase a Black and White Blouse from the Maternity section.	None	Maternity -> Blouses -> White & Black Blouse
18	Purchase a pair of Suede Birkenstocks, a pair of sandals in the shoe section.	None	Shoes -> Sandals -> Suede Birkenstocks
19	Purchase a Wool Blend Suit, from the Business Section in Men's Wear.	None	Men -> Business -> Wool Blend Suit
20	Purchase a pair of Comfort Fit Jeans, which are women's pants.	Target	Women -> Pants -> Comfort Fit Jeans
21	Purchase a pair of Cargo Shorts, found in the Teenager Guys section.	Target	Teenager -> Guys -> Cargo Shorts
22	Purchase an infant one-piece that costs more than \$30.	None	Infant -> One-Pieces -> Blue Plaid Jumper
23	Purchase a pair of Men's Fleece Pants.	Target	Men -> Pants -> Fleece Pants
24	Purchase a Rain Jacket, which is outerwear for children.	None	Children -> Outerwear -> Rain Jacket

Experimental Session for Toy Site			
N	Task	Scrolling Requirement	Most Efficient Path
1	Purchase a Mini Cooper Model, a popular model car.	Target	Sets & Models -> Cars -> Mini Cooper Model
2	Purchase the cheapest doll available for purchase.	None	Baby Dolls -> Dolls -> Rock-a-Bye Chou Chou Doll
3	In what year was the Toy Superstore founded? (Answer: 1998)	None	About Us
4	Purchase some Plastic Pattern Blocks.	Target	Blocks & Legos -> Blocks -> Plastic Pattern Blocks
5	Purchase a learning toy to help with reading that costs less than \$10.	None	Learning Activities -> Reading -> Alphabet Block Wagon
6	Purchase a stuffed animal that is a tiger puppet.	Target	Stuffed Animals -> Puppets -> Tiger Puppet
7	Purchase a Find-Me Play Tent, for use in the outdoors.	None	Sports & Outdoors -> Tents & Playhuts -> Find-Me Play Tent
8	Purchase a Nascar Sports Video Game.	Target	Video Games -> Sports -> Nascar Dirt to Daytona
9	What is the zip code for the Toy SuperStore located in Portland, Oregon? (Answer: 97223)	Category and Target	Store Locator
10	Purchase the most expensive puzzle available.	Target	Games & Puzzles -> Puzzles -> New York 3-D Puzzle
11	Purchase the Magnetic Time Teacher Clock, a math learning activity.	None	Learning Activities -> Math -> Magnetic Time Teacher Clock
12	Does the Toy SuperStore sell Guitars? (Answer: Yes)	None	Musical Toys

Experimental Session for Toy Site (continued)			
N	Task	Scrolling Requirement	Most Efficient Path
13	Purchase a Pencil Kite, for use in the outdoors.	Target	Sports & Outdoors -> Kites -> Pencil Kite
14	Purchase a Ballerina Clothing set for a Baby Doll.	Target	Baby Dolls -> Clothing -> Ballerina Set
15	Purchase Chinese Checkers, a popular Board Game.	None	Games & Puzzles -> Board Games -> Chinese Checkers
16	What is the extra cost for shipping an item to Hawaii? (Answer: \$10)	Category and Target	Shipping Costs
17	Purchase a Care Bear bedtime bear, a stuffed animal.	None	Stuffed Animals -> Bears -> Care Bears Bedtime Bear
18	Purchase the TableTop Piano, a musical toy.	None	Musical Toys -> Other -> TableTop Piano
19	Purchase the Pony Express, from the Lincoln Logs Section in Blocks & Legos.	None	Blocks & Legos -> Lincoln Logs -> Pony Express
20	Purchase the Sonic FX Sphere, a science learning activity.	Target	Learning Activities -> Science -> Sonix FX Sphere
21	Purchase a Hovercraft Kit, found in the Sets & Models Planes section.	Target	Sets & Models -> Planes -> Hovercraft Kit
22	Purchase an adventure video game that costs more than \$30.	None	Video Games -> Adventure -> Metroid Prime
23	Purchase the Lego Explore Bucket.	Target	Blocks & Legos -> Legos -> Lego Explore Bucket
24	Purchase a Strawberry Shortcake Stroller, an accessory for a baby doll.	None	Baby Dolls -> Accessories -> Strawberry Shortcake Stroller

Appendix G

Consent Form

**San José State
UNIVERSITY**

**Department of Industrial
& Systems Engineering**

Room 283, Engineering Building
One Washington Square
San Jose, CA 95192-0085
Voice: 408-924-3361
Fax: 408-924-4040
E-mail: isengr@email.sjsu.edu
<http://www.engr.sjsu.edu/isengr>

Agreement to Participate in Research

Responsible Investigator: Heather H. Devine, Anthony D. Andre, PhD

Title of Protocol: Web Navigation

1. You have been asked to participate in a research study investigating web navigation.
 2. You will be asked to interact with web pages on a personal computer. The session will be followed by a paper and pencil survey and a short debriefing session.
 3. No risk to you during this session is anticipated.
 4. No discernable direct benefits to you will come from this research. However, an indirect benefit may be that similar products in the future will be easier to use if companies accept this and similar research.
 5. Although the results of this study may be published, no information that could identify you will be included.
 6. There will be no compensation for participation in this research.
 7. Questions about this research may be addressed to Heather Devine at (408) 536-6046. Complaints about the research may be presented to Dr. Kevin Corker, Director of the Graduate Program in Human Factors/Ergonomics, Industrial & Systems Engineering Department, College of Engineering, at (408) 924-3988. Questions about research subjects' rights, or research-related injury may be presented to Pam Stacks, Interim Academic Vice President, Graduate Studies and Research, at (408) 924-2480.
 8. No service of any kind, to which you are otherwise entitled, will be lost or jeopardized if you choose to "not participate" in the study.
 9. Your consent is being given voluntarily. You may refuse to participate in the entire study or in any part of the study. If you decide to participate in the study, you are free to withdraw at any time without any negative effect on your relations with San Jose State University or with any other participating institutions or agencies.
 10. At the time that you sign this consent form, you will receive a copy of it for your records, signed and dated by the investigator.
 11. You have provided a photo ID confirming that you are at least 18 years of age.
 12. I acknowledge that this session will be videotaped for the purposes of data analysis. By signing this form, I agree to have my participation recorded on videotape, and to have the videotape used for further analysis. In the event that the visual images are shared with the public, my identity will be protected (any personally identifying parts of the image will be purposely obscured). The results of the study may be published, but no information that could identify me will be included.
- The signature of a subject on this document indicates agreement to participate in the study.
 - I give my consent to participate knowing that my actions will be recorded on videotape during the experiment.
 - The signature of a researcher on this document indicates agreement to include the above named subject in the research and attestation that the subject has been fully informed of his or her rights.

The California State University:
Chico State Office
Bakersfield, Chico, Fresno, Fullerton,
Humboldt, Long Beach,
Los Angeles, Merced, Monterey,
Pomona, San Bernardino, San Diego,
San Francisco, San Jose, Santa Clara,
San Marcos, Stanislaus

Signature _____

Date _____

Investigator's Signature _____

Date _____

Appendix H

Demographic Survey

Name: _____

Phone: _____

Email: _____

Preferred Contact Method: ☐ Phone ☐ Email

Gender: ☐ Female ☐ Male

I am: ☐ Right-handed ☐ Left-handed

Computer and Web Experience

Length of computer use:

- ☐ 1-2 years
- ☐ 2-3 years
- ☐ More than 3 years

Frequency of computer use:

- ☐ 2-3 times a week
- ☐ 4-5 times a week
- ☐ 6+ times a week

Length of web use:

- ☐ 1-2 years
- ☐ 2-3 years
- ☐ More than 3 years

Frequency of web use:

- ☐ 2-3 times a week
- ☐ 4-5 times a week
- ☐ 6+ times a week

Online Shopping

How long ago was your last online purchase?

- ☐ Less than 1 week ago
- ☐ Less than 1 month ago
- ☐ 1 to 6 months ago
- ☐ 6 months to 12 months ago

How frequently do you purchase online?

- ☐ Weekly
- ☐ Monthly
- ☐ Every few months
- ☐ Yearly

Appendix I

Experimenter Instructions

Introduction

The researcher will give the participant an introduction to the study. The participant will fill out the Consent Form and Demographic Survey. The researcher will answer any questions the participant has.

Experimenter Instructions:

Introduction [paraphrase]:

“Today we are trying to learn more about web navigation. You will be doing some typical tasks with each web site, and I’d like you to perform as you normally would when using the web. Some of the web sites will have a scroll bar located on the right side and some will have a scroll bar located on the left side.

Consent Form:

Ask the participant to fill out the consent form and answer any questions the participant might have.

Demographic Survey:

Ask the participant to fill out the demographic survey and answer any questions the participant might have.

Experimenter Instructions:

Continue [paraphrase]:

During today’s session, I’ll ask you to complete some forms and answer some questions. Please try to be honest, and let us know what you think. My role today is to learn about your perspective, so please don’t answer questions based on what you think we may want to hear. While you are working, I may take notes and ask you some questions. In addition, the session will be recorded. If at any time during the study you feel you need to stop or take a break, please let me know. You may also ask questions. Also, if you have a cell phone or pager, please turn it off for the duration of the session.

Do you have any questions before we begin?

Practice Session

The participant will be seated at the workstation and allowed to make any adjustments necessary to the monitor, keyboard, mouse, and seat. The participant will perform the set of practice tasks. The experiment can be in the room with the participant during the practice session.

1. Provide task list to participant.
2. Begin recording web interaction using Camtasia.
3. At end of last task, pause recording.

Experimenter Instructions:

Introduction [paraphrase]:

“For the purpose of today’s activities, please imagine that you’re at home or work and want to visit a store online to find out more information about it and purchase some items. Use the provided list to complete this set of tasks for the store. While you are using the web site, please do not resize the browser window or navigate to anything outside of this web site.

For each task, I will read the task to you, then, you may begin the task. In order to purchase an item, you must click on it or the “Add to Cart” link for the item, then you will see a confirmation page. Once you have found the confirmation page or located the information you want, please click on the title at the top of the page to navigate back to the “home page”. Then we will continue on to the next task. Once the practice tasks are completed, we will move on to the experimental tasks. Please try to complete each task as accurately and quickly as you can. Remember, this first set of tasks is for practice.”

Session One

The participant will perform the set of tasks according to the condition matrix. The experimenter should be in the control room. Verify that the participant can hear the experimenter clearly.

1. Provide task list to participant.
2. Remind participant that they should click on the title after each task.
3. Remind participant of goal: perform accurately and quickly as s/he can.
4. Begin recording web interaction using Camtasia.
5. At end of last task, stop recording.

First Session Survey & Break

The participant will fill out a post-interaction survey for the first web site layout. Following the survey, give the participant a break.

Experimenter Instructions:

“We would like you to answer a few questions based on your interaction with the web site.”

During Break:

1. Save the Camtasia file for the first session as: participant#_session1
2. Clear the history of the web browser under the “Internet Tools” option.
3. Refresh the screen using Ctrl-R.
4. Open the web page for the second session.

Practice Session Two

The participant will perform the set of practice tasks according to the condition matrix. The experiment can be in the room with the participant during the practice session.

1. Provide task list to participant.
2. Mention that this is also a practice session.
3. Begin recording web interaction using Camtasia.
4. At end of last task, pause recording.

Session Two

The participant will perform the set of tasks according to the condition matrix. The experimenter should be in the control room. Verify that the participant can hear the experimenter clearly.

1. Provide task list to participant.
2. Remind participant that they should click on the title after each task.
3. Remind participant of goal: perform accurately and quickly as s/he can.
4. Begin recording web interaction using Camtasia.
5. At end of last task, stop recording.

Second Session Survey

The participant will fill out a post-interaction survey for the second web site layout.

Experimenter Instructions:

“We would like you to answer a few questions based on your interaction with the web site.”

Comparison Survey

The participant will fill out the comparison survey.

Experimenter Instructions:

“We would like to find out your opinion on how the two sites compare.”

Debriefing

The researcher will answer any final questions the participant has, sign the participant's credit sheet, and thank the participant for his/her time.

Experimenter Instructions:

“Thank you for all of your feedback, you've been a great help. Do you have any other questions for me?”

→ “If you know any other students who need research credit, we still have some time available on Saturday, Sunday, and Monday.”

Clean-up

Clean-up and prepare for the next participant.

1. Save the Camtasia file for the second session as: participant#_session2
2. Clear the history of the web browser under the “Internet Tools” option.
3. Refresh the screen using Ctrl-R.
4. Open the web page for the next participant's first session.

Appendix J

Post-Interaction Survey

Participant ____
Session ____

Ratings

1. Overall, how easy or difficult was it to navigate the web site?

Very Easy 1 2 3 4 5 Very Difficult

2. How efficient or inefficient did you find the layout of the web site?

Very Efficient 1 2 3 4 5 Very Inefficient

3. How easy or difficult was it to navigate the web site without making errors?

Very Easy 1 2 3 4 5 Very Difficult

4. How easy or difficult was it to use the scroll bar?

Very Easy 1 2 3 4 5 Very Difficult

5. How easy or difficult was it to navigate between the scroll bar and the menu?

Very Easy 1 2 3 4 5 Very Difficult

6. How easy or difficult was it to navigate between the scroll bar and the items available for purchase?

Very Easy 1 2 3 4 5 Very Difficult

7. How easy or difficult was it to locate items on the page?

Very Easy 1 2 3 4 5 Very Difficult

Appendix K

Comparative Survey

Participant _____

Instructions. Assuming the menu is located on the right side, as in your session today, please check the box for the web site that best matches the given statement.

Right Scroll Bar

Left Scroll Bar

	Right Scroll Bar	Left Scroll Bar
Easiest to complete tasks		
Fastest to complete tasks		
Hardest to navigate menus		
Best for a first-time user		
Best for an experienced user		
Most stressful to use		
Preferred overall		
Most difficult to navigate between menu and scroll bar		
Most efficient		
Most difficult to navigate to items for purchase		
Best layout		
Most intuitive		
Fastest to use		
Least frustrating to use		
Easiest to find items for purchase		
Easiest to use without making errors		

Instructions. Please circle your answer and write in your response.

Right Scroll Bar

Left Scroll Bar

1. Which scroll bar placement was the most frustrating to use?

Right Left

Why?

2. Which scroll bar placement made it the easiest to navigate between the menu and the scroll bar?

Right Left

Why?

3. Which web site had the layout that was easiest to use?

Toy Store Clothing Store

Why?

4. Overall, which web site did you prefer?

Toy Store Clothing Store

Why?