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Posture and internet navigation : an observational study

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POSTURE AND INTERNET NAVIGATION: AN OBSERVATIONAL STUDY

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ABSTRACT

POSTURE AND INTERNET NAVIGATION: AN OBSERVATIONAL STUDY

By Jeffrey Dale English

This study was designed to identify and compare the range of postures achieved during Internet (Web) use to those observed during a conventional typing exercise. The postures of 24 participants were recorded throughout their completion of three fundamental Web tasks (searching, learning and browsing) and a text entry task. There were differences observed between Web use and text entry in the position of the torso, position of the upper limbs, mousing hand location and non-mousing hand location. Postures were observed during the course of the Web tasks that can be classified as both beneficial and detrimental towards the development of cumulative trauma disorders and repetitive stress injuries.

ACKNOWLEDGMENTS

This study was conducted in the usability laboratory of Interface Analysis Associates, San Jose, CA (http://www.interface-analysis.com). Special thanks go to Dr. Anthony Andre for his guidance and patience in support of this research and to my thesis committee members Dr. Louis Freund and Dr. Soha Sadek for their contributions to this project. Thanks to Jules Orr for his assistance in conducting the study and subsequent data analysis. Finally, my deepest appreciation goes to Diane, Tyler and Cameron English. Without the support of my family, I would not have been able to undertake this project.

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INTRODUCTION

Recent Developments in Computer Use

Traditional activities of computer users over the past 15 years have primarily involved keyboard-centric data input and manipulation. Those activities are rapidly broadening to include the mouse-centric, read-only information search and entertainment-based browsing activities associated with the Internet and specifically the World Wide Web. As of February, 1998, more than half of all computer users browse the Web and online services, up from 40% in 1997 (IntelliQuest, 1998). Throughout the world, Web usage nearly doubled to 107 million people between February, 1997 and February, 1998 (Nua, 1998).

The inclusion of Web activities into mainstream computer use provides the opportunity for not only changes in what computer tasks people perform, but also changes in how people perform these tasks. Our interest here lies in the physical aspects of human-computer interaction. For example, Andre (1998) illustrated an extreme rearward-leaning posture that could be maintained while browsing the Web that would be an unlikely data-entry posture. As changes in the constraints, functionality and user involvement with a computer interface evolve over time it is reasonable to expect that the behavior of users would evolve as well, influenced by the constraints and opportunities provided by the developing computer interaction. Understanding whether there is indeed a change in behavior could occur by examining the postures that users assume when performing both data entry and Web browsing tasks. The next sections provide an overview of data-entry posture research, contextual differences between data entry and Web use, and previous posture research while using the mouse.

An Overview of Computer Workstation Posture Research

Scientific research of user postures at computer workstations has focused on various aspects of wrist, arm, shoulder, neck and back positions during keyboard input activities (For reviews, see Andersson, 1987; Carter & Banister, 1994; Greico, 1986; and Sauter, Schleifer, & Knutson, 1991). These research studies have reported the postural elements suspected of contributing to user discomfort, pain and injury from the prevalent use of the keyboard and mouse. These researchers have identified many risk factors and recommendations to mitigate physical impacts to computer users while performing data entry tasks.

The U.S. Government and professional organizations have established guidelines to minimize repetitive motion injuries and cumulative trauma disorders of the upper extremities related to keyboard and mouse use in workstations (American National Standards Institute, 1988; U.S. Department of Labor, 1997). These recommendations address health issues related to the data entry tasks that have been historically associated with computer use. Because Web browsing is such a recent development in computer use, popular guidelines do not recognize that there are or may be differences between Web browsing postures and data entry postures.

Differences between Data Entry and Web Browsing

Locating and retrieving information via the Web occurs through the use of software informally referred to as "browsers." While conventional data input is performed primarily via a keyboard, with occasional mouse use for intermittent navigation and cursor placement, "browsing" is primarily mouse-based navigation via hypertext, icons and graphics. Pointing the cursor at an icon, hypertext, scroll bar or other graphic on the display, and then pressing the appropriate function button on the mouse typically activates Web browser software functions.

Changes in the physical behavior of computer users may be discerned by observing the activities and postures of computer users during both data input and Web browsing activities. The postures of individuals browsing the Web may be influenced by the context of use that is particular to Web activities. The next sections describe the 3 contextual differences between data entry and Web browsing. Then, posture research with regard to mouse use is reviewed.

#1 - the user is de-coupled from the keyboard. Because Web browsing is primarily a mouse-intensive read-only activity, requiring relatively few keyboard inputs, the posture of the participant is not constrained by the need to continually position one or both hands over the keyboard. The low frequency of keyboard interaction de-couples the user from the traditional need to assume an upright, centered position directly in front of the keyboard. Consequently, the participant's usual posture that is optimized for comfortable use of the keyboard can be abandoned for nearly any posture that provides physical control over the mouse.

The position of the mouse is typically to one side of the centered keyboard. Karlqvist, Hagberg, & Selen (1994) found that participants performing mouse-based tasks after keyboard-based tasks kept the mouse lateral to the keyboard. Even though the nature of the task had changed, participants did not change the location of the mouse. Accordingly, it is not anticipated that participants browsing the Web would relocate the mouse during these activities. As a result, the location of the mouse lateral to the keyboard is the anchor point about which the participants' whole-body posture could be expected to vary.

#2 - the user is de-coupled from the desktop. For data entry tasks, participants must position themselves in postures that allow both visual and physical access to desktop materials that support their work. These tasks usually require people to read paper-based source documents on the desktop, input information into the computer, and then error-check those inputs shown on the display against the source document. Because of the read-only nature of Web browsing, the display is the "source document" of interest, not materials on the desktop. Consequently, Web users may assume nearly any posture that maintains an acceptable viewing distance and viewing angle to the display.

#3 – the user must often wait for sites to load on the display. The time required for graphical Web page content to load onto the display creates periods of non-productive interaction between the user and the display. Many variables affect the loading ("waiting") time, including the bandwidth and quality of the Web connection, data transfer rate of the modem, video display hardware, and the computer processing speed. These waiting periods are not inherent in data entry tasks, and allow participants to assume a variety of postures and exhibit behaviors that are not conducive to optimal keyboard or mouse use.

Posture Issues During Mouse Use

Karlqvist et al. (1994) investigated the differences in upper-limb posture between keyboard users and mouse users during word processing tasks, and found that the postures differ significantly. Differences were noted between wrist deviation, elbow flexion, shoulder flexion, shoulder abduction, and shoulder rotation. The operating upper-limb of mouse users was characterized by a flexed and outward rotated shoulder, and the elbow was less flexed and the wrist more ulnar deviated than keyboard-only operators. The observed working postures of mouse users can result in a risk of discomfort in the shoulder, elbow and wrist.

Dowell and Gscheidle (1997) compared the effects of three separate mouse locations on participant postures during mousing tasks. The three mouse locations tested were all to the right side of the participant - next to the monitor, the keyboard, and in front of the keyboard, close to the participant. Reach angle of the upper arm during mouse use was found to be reduced to nearly vertical as the mouse location moved toward the torso. Dowell and Gscheidle observed that the participant's preferential torso posture was maintained without regard to mouse location. It was concluded that the participant's preferential whole-body posture was the most influential factor in determining the overall expected torso posture over mouse location. Participants that preferred to be in a reclined position or an upright position assumed these postures without regard to mouse location.

In a field study to determine the effects of VDT location in the vertical plane on posture and comfort, Psihogios, Sommerich, Mirka, & Moon (1998) found that head tilt and working viewing angle were affected by monitor location, but that other body postures were not affected. When the monitor was raised or lowered, participants compensated by tilting the head forward or back, not the torso. While Web users were not specified in the study, the results indicate that the vertical location of the display may have minimal influence on the whole-body postures of people using the Web.

Summary

Previous research results regarding postures during mouse-based activities have supported the concept that there are significant postural differences between keyboard and mouse use because of workstation design and preferential posture. During Web use, these postures may also differ from data entry postures because the user is de-coupled from the keyboard, de-coupled from the desktop, and because of time delays between activities. These three contextual differences may encourage variable postures that contribute to reduced fatigue, static loading of the muscles and joints, and physiological stress on the user (Andersson, 1987). On the other hand, the contextual freedoms associated with Web browsing may allow extreme postures that could be problematic for the comfort and health of users. Differences and/or similarities between Web browsing postures and data entry postures have not yet been identified in the literature.

THE PRESENT STUDY

This study was designed to identify the behaviors and postures of Web users during various tasks. This study sought to identify if there was a difference between participant postures when performing searching, learning and browsing Web tasks and a typing task. The null hypothesis was that there were no differences between the postures observed during the Web browsing tasks and data-entry.

METHOD

Participants

Twenty-four participants were observed in a usability laboratory. The participants consisted of 15 females and 9 males, ranging from 18 to 42 years old. Nearly all of the participants were San Jose State University psychology students who received class credit for their participation in the study. The participants were familiar with using Microsoft Windows 95 and Web browsing. Participants did not have any medical conditions that may have affected their postures during the session.

Equipment

Participants were seated at a bi-level personal computer workstation. A Pentium-class personal computer with Microsoft Windows 95 and Netscape Navigator version 3.0 was used in this study. The search engine provided to participants was Yahoo! at http://www.yahoo.com. The computer modem was capable of up to 33,600 bits per second transfer rate. The viewing angle of the 20" monitor and horizontal placement of the 2-button Logitech mouse and 101-key keyboard were adjustable. An office chair was used that allowed adjustments in the height of the seat pan and chair back. The workstation was located in a test room adjacent to an observation room on the opposite side of a one-way mirror.

Experimental Design

A single factor, 4-level within-subjects design was employed. Each level was defined by a different task: (a) focused Web searching, (b) learning on-screen Web content, (c) free-form Web browsing and (d) data-entry typing. The order of the Web tasks was counterbalanced between participants, while the typing task was always the final task performed. The Web tasks preceded the typing task to avoid any directional bias of typing postures into the browsing postures. It was assumed that the suspected postural variability of the Web browsing activities would not interfere with the participants' standard data entry postures. The dependent measure was posture of the participant.

Participants were videotaped from cameras above and to each side of the workstation. Data, drawings, supporting notes and contextual observations were recorded real-time for each participant using custom data collection logs. The videotapes were subsequently analyzed to identify representative postures from each task per participant. Representative postures identified on the videotapes were placed into a matrix to aid in identifying postural differences between tasks. Variations from the representative posture were also noted.

Dependent Measures

Distance between the body and keyboard. The distance between the body and keyboard was determined by identifying the relative distance of the participant from the keyboard between tasks. The measures are relative to each other within participants. "Near" positions occurred when the participant leaned toward the keyboard, with the torso forward of neutral. The near position was identified when the elbow angle was less than 90° from horizontal when typing, suggesting that the body was close to the keyboard. "Mid" positions were identified by body positions that resulted in the elbow angle being nearly perpendicular to the horizontal plane. "Far" positions generally describe leaning back away from the keyboard, and were identified when the elbow angle was open approximately 135° from the horizontal plane. This measure was noted because it may be an indicator of the degree of engagement between the participants and the desktop, keyboard and display. The pictures in Figure 1 demonstrate the differences between the three measures.

Near Mid Far

Figure 1. Examples of near, mid and far distances between the body and the keyboard.

Position of the head and neck. The position of the head and neck is a subjective, relative measure describing the position of the head and neck relative to the torso. Forward positions were recognized when the participant tilted the head forward, often occurring when referencing content on the desktop and when leaning forward to read content on the display. Results are reported as either "centered" or "forward" of the torso; "rearward" positions were not maintained by any of the participants.

Pictures demonstrating the difference between these two measures are presented in Figure 2.

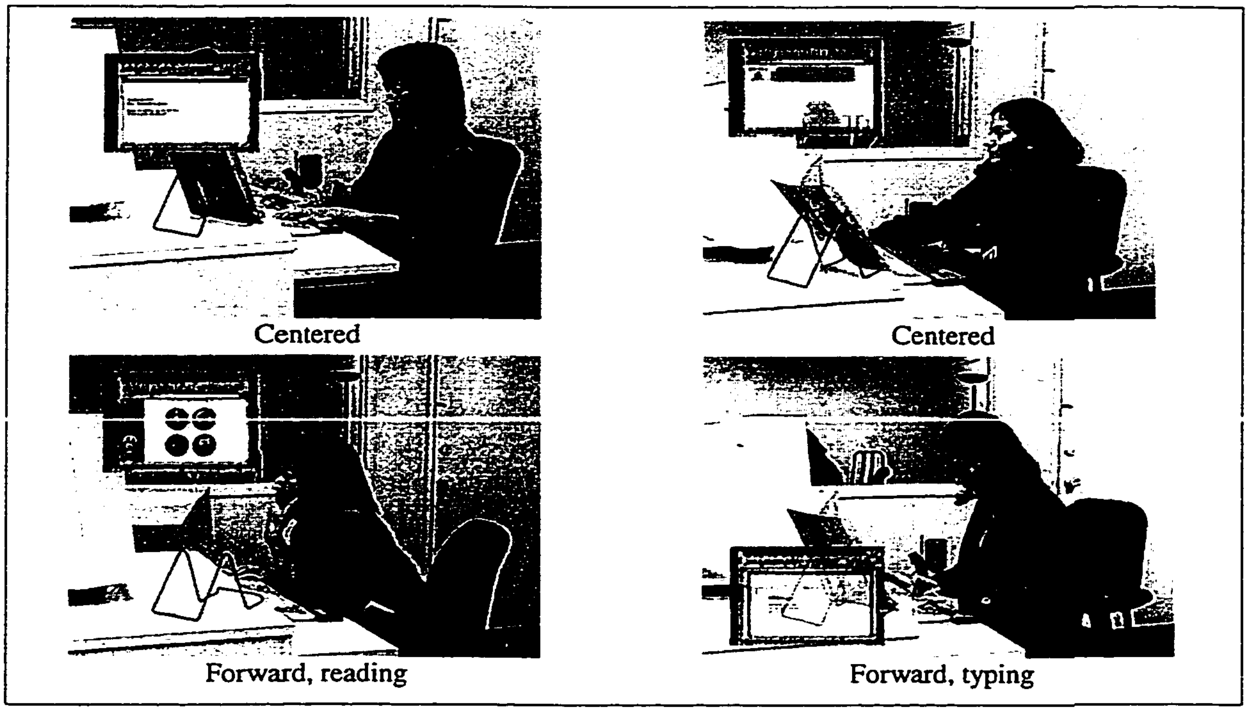
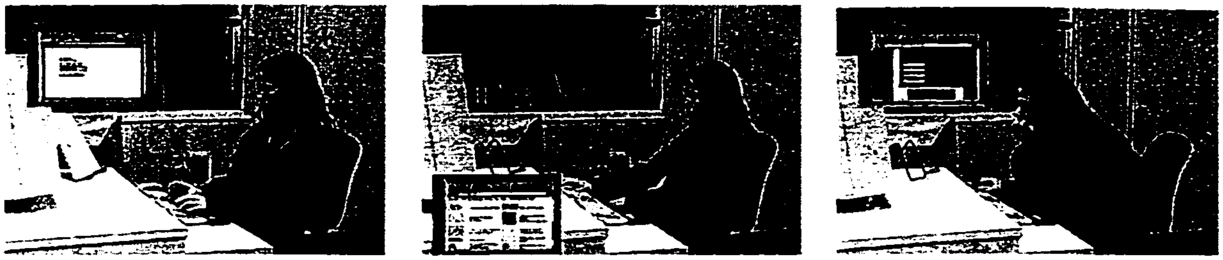


Figure 2. Examples of centered and forward head and neck positions.

Typing accommodation and whole body posture. Whole body posture was classified by whether or not each participant could type when in his/her representative posture. The posture was categorized as "typing is not possible without repositioning" if the position of the torso would have to be changed in order to type. Conversely, the posture was categorized as "typing is possible without repositioning" if an effective typing posture was being employed or was only a minor adjustment away. Pictures demonstrating the difference between these two measures are presented in Figure 3.



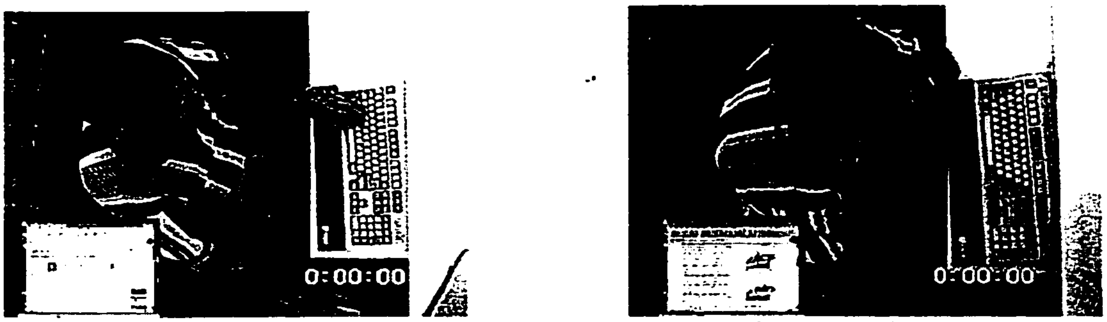
Posture during the Typing task

Posture during the Learning task – whole body posture is nearly the same as the typing posture – typing is possible

Posture during the Browsing task – whole body posture must be repositioned in order to type.

Figure 3. Example of differences between typing and non-typing postures based on whole body posture.

Typing accommodation and the position of the upper limbs. Upper limb positions were classified by whether or not the participant could type when in his/her representative posture. The posture was categorized as "typing is not possible without repositioning" if the upper limbs had to be repositioned in order to type. Conversely, the posture was categorized as "typing is possible without repositioning" if an effective typing posture required only a minor adjustment in the position of the upper limbs. A minor adjustment was recognized if the hands were lateral or near the keyboard and the elbows were at the side of the participant. Examples of these postures are presented in Figure 4.



Typing is possible with only a minor adjustment of the upper limbs

Typing not possible without repositioning the upper limbs

Figure 4. Example of differences between typing and non-typing postures based on upper limb posture.

Location of the mousing hand. The location of the mousing hand was recorded from the representative posture of each participant. The mousing hand of all participants was the right hand.

Contact of the non-mousing elbow with a surface. The elbow location of the non-mousing arm was recorded from the representative posture of each participant. If the elbow was in contact with a surface such as the tabletop, the results are shown as either "contact" or "no contact." This measure was noted because it may be an indicator of the postural variation possible due to the reduced constraints of the Web tasks.

Location of the non-mousing hand. The location of the non-mousing hand was recorded from the representative posture of each participant. The non-mousing hand of all participants was the left hand.

Procedure

Participants were told that the study was concerned with learning about the usability of the Web. Participants were not told specifically that their posture was being observed so that natural changes to their posture would not be affected. After reading and signing the consent form, participants had the opportunity to adjust the chair, mouse location, keyboard location, and monitor angle to acceptable locations prior to the session. During each of the tasks, the participant was left alone in the room to allow postural variations to occur without influence from the presence of the investigator. Participants were brought away from the workstation after each task to avoid the transfer of postural positions across tasks. At the conclusion of the session, the participants were told of the posture observations during the study, and any questions were answered during the debrief session. The tasks included a 15-minute Web search task, a 10-minute Web learning task, a 15-minute free-form Web browsing task and a 5-minute typing task.

Web search task. The search task involved finding 9 web pages of specific content and to bookmark the results. The content was provided to the participants. Some of the web pages to search for were very specific (i.e., the San Jose Sharks homepage), while other pages to locate could have been any page that contained specific content (i.e., a pasta recipe). Participants were told that the purpose of the search task for the investigator was to understand the amount of effort required to find specific information on the Web. Participants were instructed to search at a relaxed pace, and to move on to the next search if they were having difficulty finding the subject requested. This activity was designed to allow the identification of the postures associated with active searching that require both keyboard and mouse inputs.

Web learning task. Participants were to search the Web to find information about a specific topic provided to them by the investigator, then to learn as much as possible about that topic. Participants were told that the purpose of the learning task was to allow the investigator to understand how well the Web supports learning. Participants could view multiple pages briefly, or could spend all of the time reading a single page. This task was designed to require the participant to primarily perform reading activities rather than navigating, waiting or using the keyboarding, thus allowing observations of reading postures to be identified. The motivation for the participant to perform this task with some effort was that a true/false quiz would be administered at the conclusion of the task.

Web browsing task. Participants were instructed to browse the Web for any sites that were of personal interest. Participants were told that purpose of the task was to understand how well the Web supports the participant's ability to find desired information. At the conclusion of the task, participants were given a brief Web usability survey.

Typing task. Preceding the typing task, participants were given a 5-minute break. Participants were then provided with a text document to enter into the computer via the keyboard. The typing task required participants to edit any mistakes that they made to impart a degree of similarity to actual data entry tasks that they may perform. This task was included in the protocol so that any postural differences of participants between data entry postures and Web browsing postures could be observed. Following the data entry task, participants were given a short usability and ergonomics survey at the end of the session.

RESULTS

During the tasks, participants assumed various postures. In order to catalog and then analyze these postures, data were collected by first identifying a single representative posture for each participant in each task. Then, digital pictures of each representative posture were printed and analyzed for each of the 7 dependent measures. Frequencies were tabulated across subjects for each of the dependent measures. The observed frequencies are presented in Table 1. Finally, a chi-squared log-linear model was performed to identify the statistical significance of relationships between observed qualitative results and the tasks performed. The chi-squared test was performed for 3 groupings of the results, as follows.

1. Between all four of the tasks to identify associations between the results and each of the tasks.
2. Between the three Web tasks only, to identify associations between the results and the three Web tasks.
3. Between task categories, "Web" vs. typing. The results of the three Web tasks were combined into a single "Web" category for comparison to the typing task to identify categorical associations between the results and Web use and typing.

The surveys and quiz that were given throughout the session were intended to reinforce the described "Internet usability" focus of the trials, and were not subsequently analyzed. The chi-squared results are presented in the following sections by each dependent measure.

Table 1

Summary of results by task. The numbers represent the total frequency of the observed posture across all participants.

	Task			
Measure	Searching	Learning	Browsing	Typing
Body to keyboard distance				
Near	2	3	4	3
Mid	11	9	9	11
Far	11	12	11	10
Head and neck position				
Centered	18	18	14	13
Forward	6	6	10	11
Typing and whole body position				
Typing	17	15	13	24
Non-typing	7	9	11	0
Typing and upper limb position				
Typing	4	2	3	24
Non-typing	20	22	21	0
Mousing hand location				
On Mouse	23	18	22.5	0
Lap	1	5	1.5	0
Keyboard	0	1	0	24
Left elbow surface contact				
Contact	19.5	19.5	20	15
No contact	4.5	4.5	4	9
Non-mousing hand location				
On Lap	11	9.5	8.5	0
Touch Face	5.5	6.5	9.5	0
On Keyboard	2.5	0	0.5	24
On Table	2.5	4	2.5	0
Suspended from Armrest	1.5	1.5	1	0
On Armrest	0	1	0	0
Under Leg	1	1	1	0
Side of Seat Pan	0	0.5	0	0
On Chair	0	0	1	0

Distance between the Body and Keyboard

The distance between the body and keyboard was determined by identifying the relative distance of the participant from the keyboard between tasks. The pictures in Figure 5 are presented again for convenience to demonstrate the differences between the three measures.

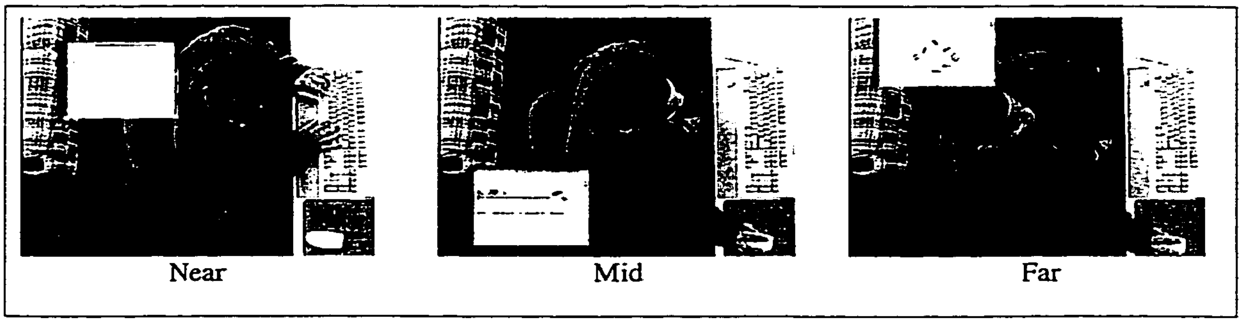


Figure 5. Examples of near, mid and far distances between the body and the keyboard.

All tasks. The relationship between the four tasks and the distance between the body and keyboard did not reach statistical significance ($\chi^2 = 1.25$, $p > 0.05$), although the data suggest that participants in the typing task were more likely to be at a mid distance as compared to Web users who were more likely to be at nearer or farther distances from the keyboard. Across all tasks, 13% of the participants positioned their body near the keyboard, 42% at a mid/neutral position and 46% far from the keyboard. The results across all tasks are presented in Figure 6.

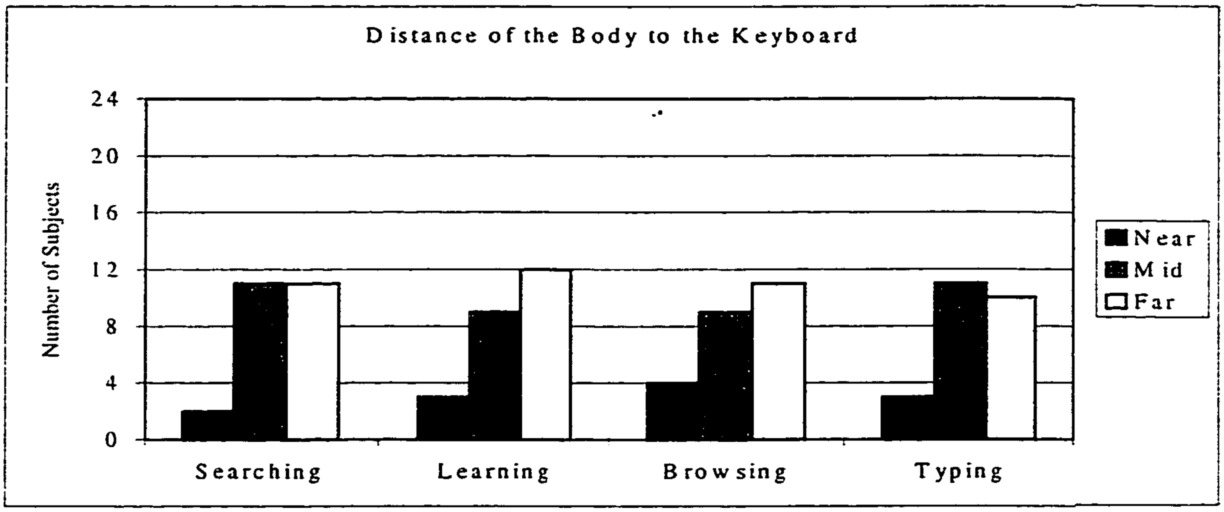


Figure 6. Distance of the body from the keyboard as a function of task performed.

Web tasks. The relationship between the three Web tasks and the distance between the body and keyboard did not reach statistical significance (χ^2 = 1.00, p > 0.05). Web users were more likely to engage in positions nearer the keyboard when performing the browsing task than when performing the searching or learning tasks. When performing the searching task, participants were more likely to be at mid or far distances from the keyboard than the other Web tasks.

Web vs. typing. The relationship between the categorical tasks and the distance of the body to the keyboard did not reach statistical significance (χ^2 = 0.17, p > 0.05). Across both task categories, 13% of the participants positioned their body near the keyboard. Participants were at mid distances while typing slightly more often than when performing Web tasks, while Web users were at far distances from the keyboard slightly more often than when performing the typing task. The results between the task categories are presented in Figure 7.

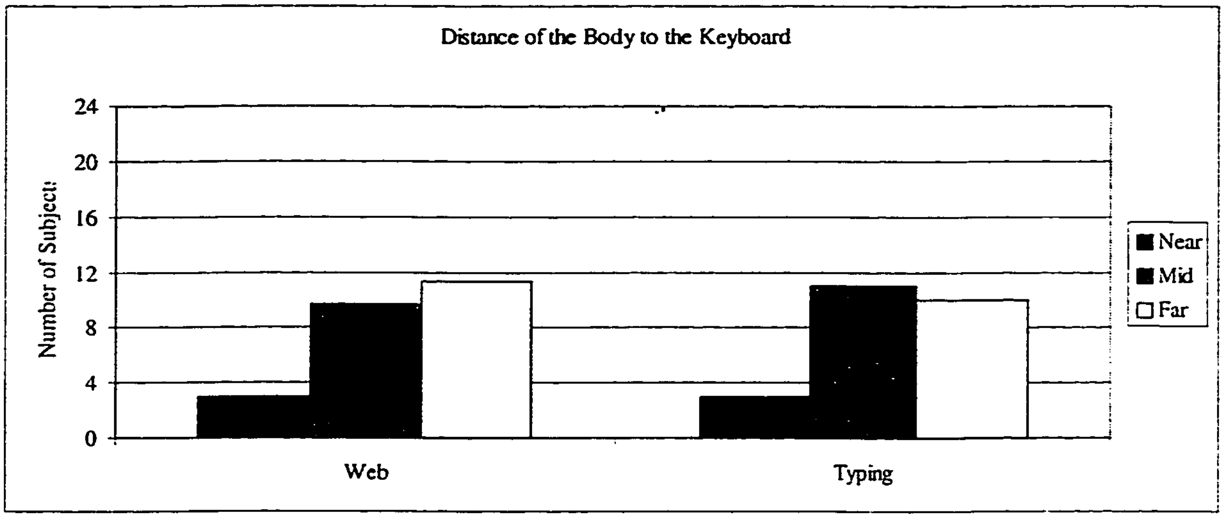


Figure 7. Distance of the body from the keyboard as a function of task category.

Position of the Head and Neck

Similar to the measure previously described of the distance of the body from the keyboard, the position of the head and neck is a subjective, relative measure describing the position of the head and neck relative to the torso. Pictures demonstrating the difference between these two measures are presented again for convenience in Figure 8.

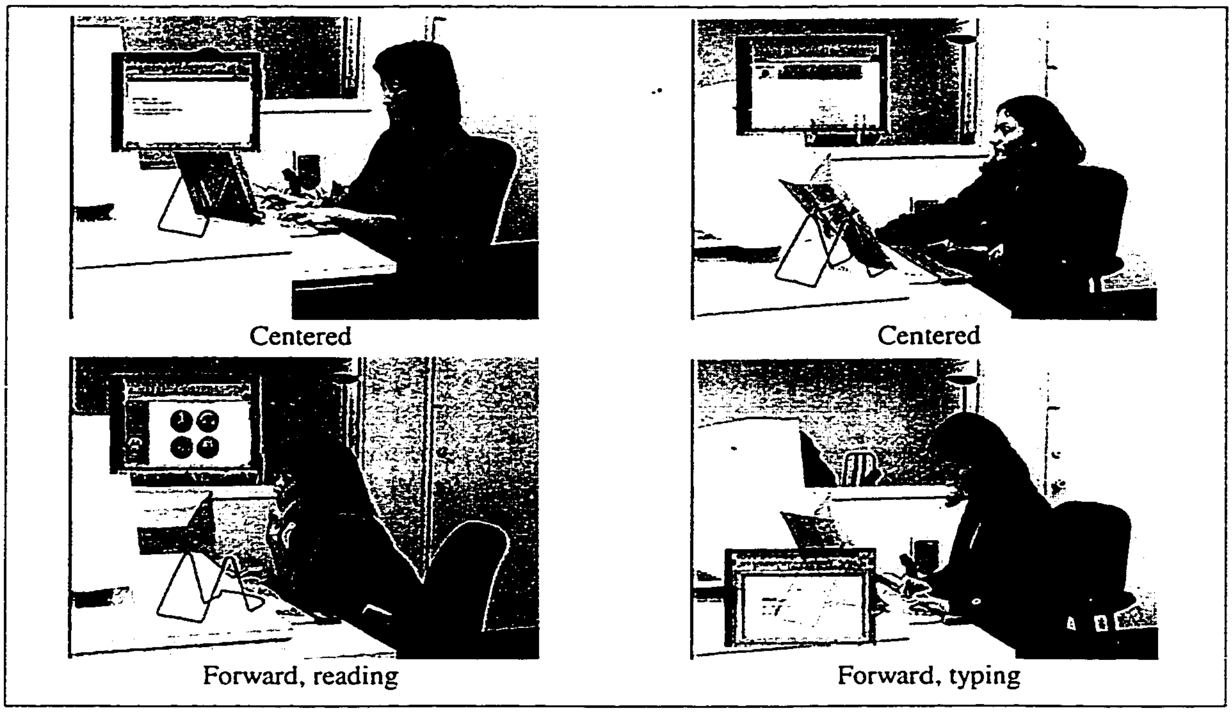


Figure 8. Examples of centered and forward head and neck positions.

All tasks. The relationship between the four tasks and the position of the head and neck did not reach statistical significance ($\chi^2 = 3.83$, $p > 0.05$), although the data suggest that when typing, the head and neck position was more forward and less centered than the Web tasks. Across all tasks, the head and neck were in forward positions for 34% of the participants, and in centered positions for 66% of the participants. The results across all tasks are presented in Figure 9.

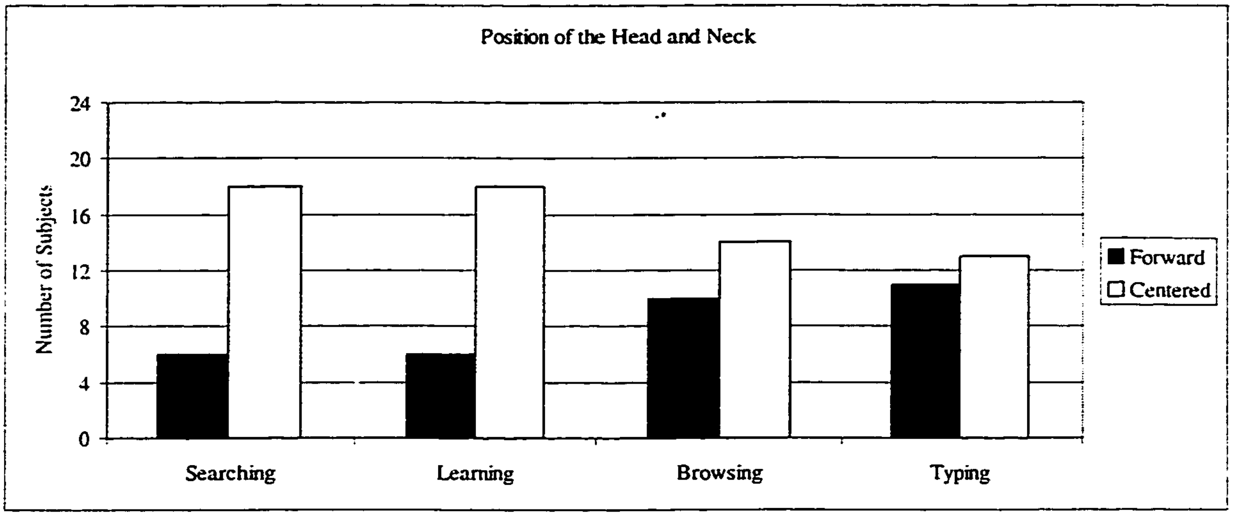


Figure 9. Position of the head and neck as a function of task performed.

Web tasks. The relationship between the three Web tasks and the position of the head and neck did not reach statistical significance ($\chi^2 = 2.09$, $p > 0.05$). Participants maintained head and neck positions that were more forward and less centered in the browsing task than during either the searching or learning tasks. Across both the searching and learning tasks 75% of the participants maintained centered head and neck positions, while 25% maintained forward head and neck positions.

Web vs. typing. The relationship between the categorical tasks and the position of the head and neck did not reach statistical significance ($\chi^2 = 1.19$, $p > 0.05$). Participants were more likely to maintain forward head and neck positions and less likely to maintain centered head and neck positions when typing than when performing Web tasks. Web users maintained centered and forward head and neck positions 69% and 31% of the time, respectively. Within the typing task the results were nearly equal between centered head and neck positions. The results across the categorical tasks are presented in Figure 10.

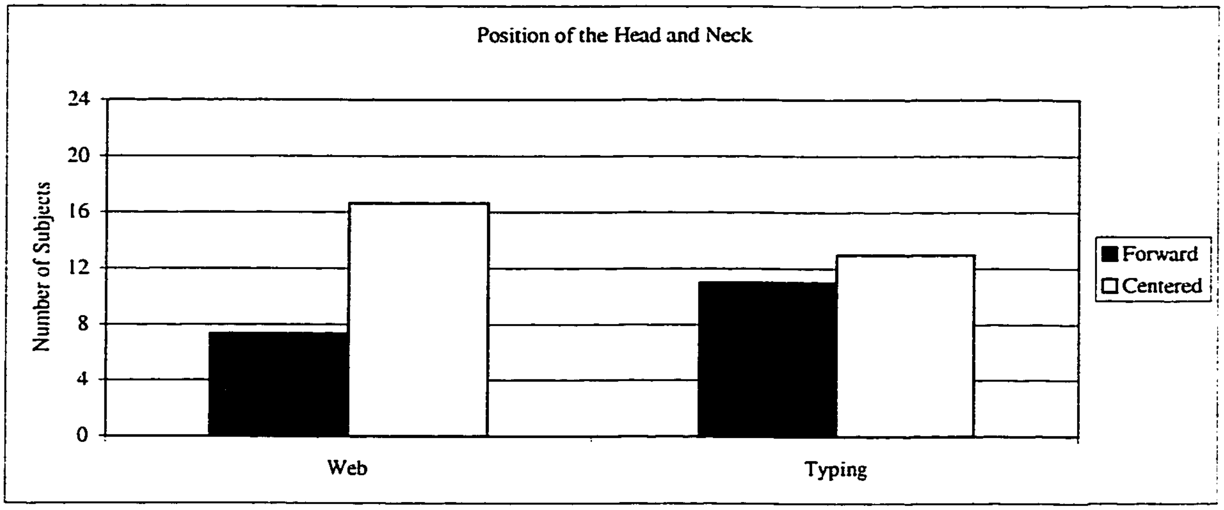


Figure 10. Position of the head and neck as a function of task category.

Typing Accommodation and Whole Body Posture

The whole body posture of the participants was described by evaluating whether or not the participant could type when in his/her representative posture. All participants maintained whole body postures that were conducive to typing during the typing task. If the participant maintained a typing posture in the torso, but would have to move the chair in order to create an appropriate position of the limbs for typing, then that condition was included in the category of not being able to type without repositioning. The rationale for this is that changing the whole body posture is implied in the action of moving the chair to the appropriate location in front of the keyboard. Similarly, this category was applied to the condition where the representative posture of the participant included twisting the torso, the reason being that the movement required to align the body in the chair implies that a change in whole body posture would be required in align the body for typing. Pictures demonstrating the difference between these two measures are presented again for convenience in Figure 11.

Posture during the Typing task	Posture during the Learning task – whole body posture is nearly the same as the typing posture – typing is possible	Posture during the Browsing task – whole body posture must be repositioned in order to type.

Figure 11. Example of differences between typing and non-typing postures based on whole body posture.

All tasks. The relationship between the four tasks and the ability of a person to type based on whole body posture was significant ($\chi^2 = 14.17$, $p < 0.05$). As expected, all participants maintained postures conducive to typing during the typing task, but this was not the case between the Web tasks, where "non-typing" postures were maintained by 38% of the participants. Postures that were not conducive to typing (i.e., semi-relaxed postures) were most frequent in the browsing task, followed by the learning task and lastly the searching task. This finding is not surprising given the fact that the searching task requires more keyboard (and mouse) inputs than the other two Web tasks. The results across all tasks are presented in Figure 12.

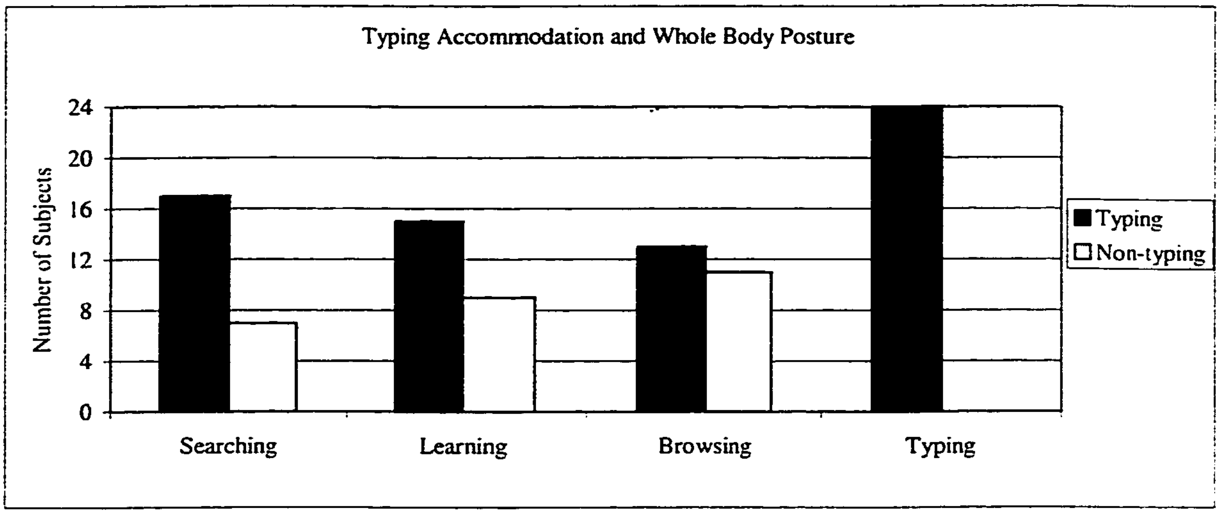


Figure 12. Typing accommodation and whole body posture as a function of task performed.

Web tasks. The relationship between the three Web tasks and whole body posture did not reach statistical significance (χ^2 = 1.42, p > 0.05). The highest frequency of non-typing postures was observed in the browsing task at 46%, as compared to the 38% and 29% frequencies of non-typing postures observed in the learning and searching tasks, respectively. As expected, participants were more likely to be in postures that directly support typing inputs in the searching task than in either the learning or browsing tasks because of the amount of typing required.

Web vs. typing. There is a relationship between the categorical tasks and whole body postures that support typing. This relationship met the chi-squared test of statistical significance (χ^2 = 11.08, p < 0.05). As expected, all participants maintained postures conducive to typing within the typing task, while only 38% of the participants maintained typing postures during the Web tasks. The results across the categorical tasks are presented in Figure 13.

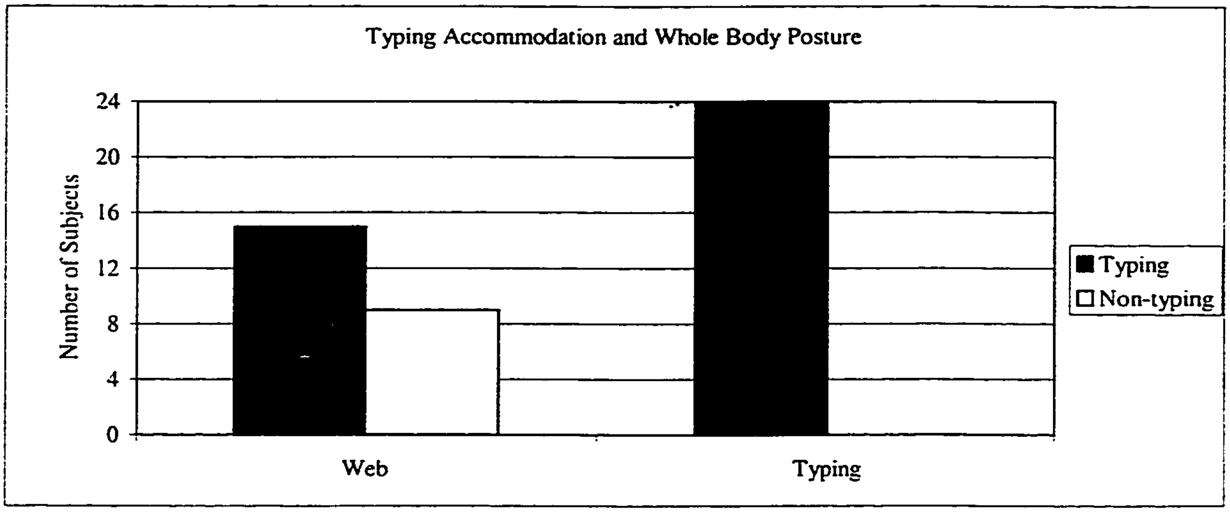
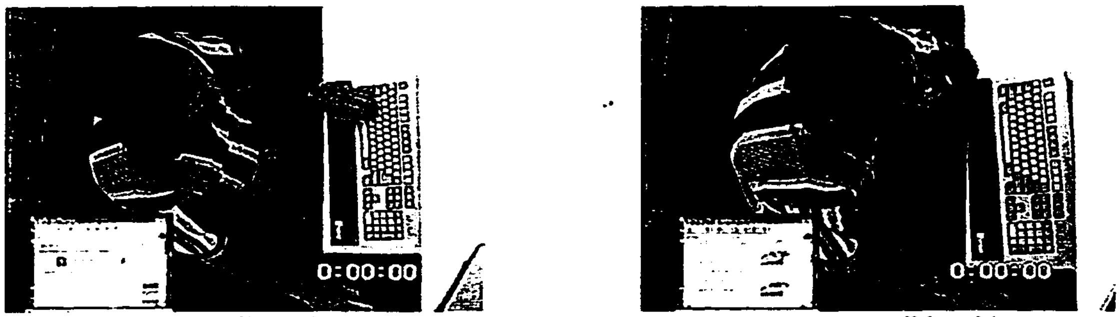


Figure 13. Typing accommodation and whole body posture as a function of task category.

Typing Accommodation and the Position of the Upper Limbs

Upper limb positions were described by evaluating if the participant could type when in his/her representative posture. All participants maintained upper limb postures that were conducive to typing during the typing task. During the Web tasks, the posture was categorized as "typing is not possible without repositioning" if the upper limbs had to be repositioned in order to type. Conversely, the posture was categorized as "typing is possible without repositioning" if an effective typing posture required only a minor adjustment in the position of the upper limbs. A minor adjustment is defined by the hands being lateral or near the keyboard and the elbows at the side of the participant. Examples of these postures are presented again for convenience in Figure 14.



Typing is possible with only a minor adjustment of the upper limbs

Typing not possible without repositioning the upper limbs

Figure 14. Example of differences between typing and non-typing postures based on upper limb posture.

All tasks. The relationship between the four tasks and the ability of a person to type based on the position of the upper limbs (shoulders, arms, hands) was significant ($\chi^2 = 61.46$, $p < 0.05$). All of the participants maintained upper limb postures that were conducive to typing during the typing task, but this was not the case between the Web tasks, where non-typing postures were maintained by 87% of the participants. The results across all tasks are presented in Figure 15.

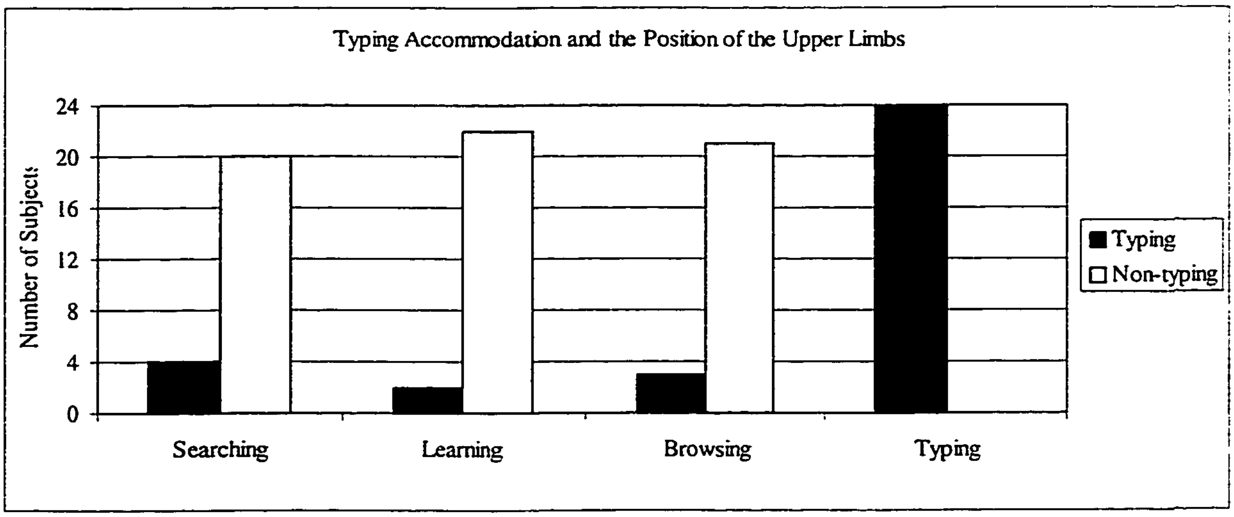


Figure 15. Typing accommodation and the position of the upper limbs as a function of task performed.

Web tasks. The relationship between the three Web tasks and the position of the upper limbs did not reach statistical significance ($\chi^2 = 0.76$, $p > 0.05$). As expected, typing was best supported by the upper limb postures assumed during the searching task, and was least supported in the learning task. Maintaining positions of the upper limbs that would require repositioning to type occurred with 92% of the participants in the learning task, 88% of participants during the browsing task and 83% of participants during the searching task.

Web vs. typing. There is a relationship between the categorical tasks and the ability to type based on the position of the upper limbs. This relationship met the chi-squared test of statistical significance ($\chi^2 = 37.33$, $p < 0.05$). While all of the participants maintained postures that were conducive to typing within the typing task, across the Web tasks the positions of the upper limbs were conducive to typing with only 13% of the participants. These results across the categorical tasks are presented in Figure 16.

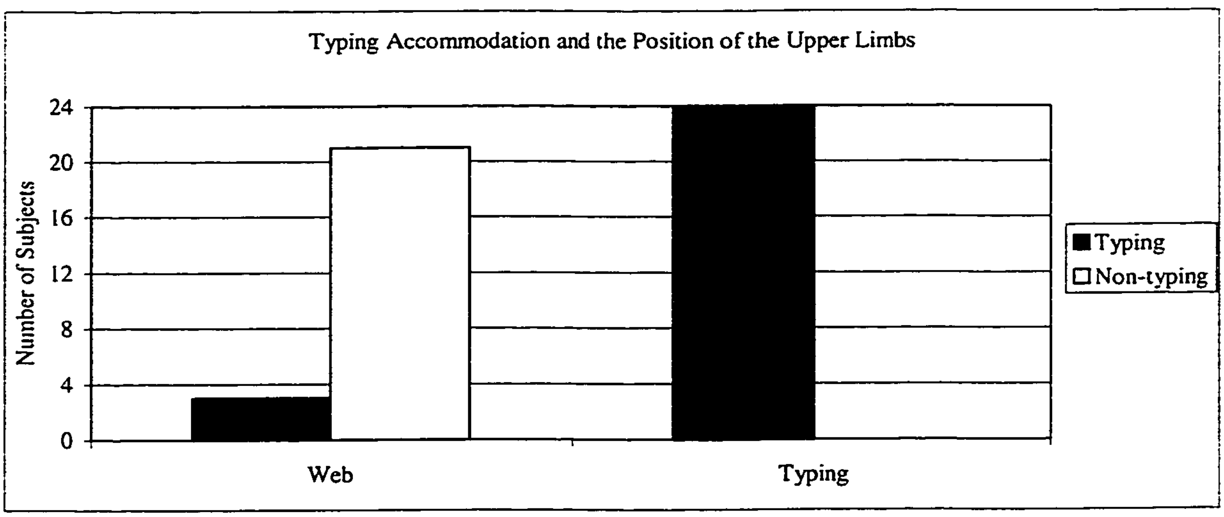


Figure 16. Typing accommodation and the position of the upper limbs as a function of task category.

Location of the Mousing Hand

The location of the mousing hand was recorded from the representative posture of participants across the four tasks. During the typing task, this location was over the keyboard across all of the participants. During the Web tasks, the location of the mousing hand ranged from staying on the mouse regardless of activity to placing it on the lap when not actively using the mouse.

All tasks. The relationship between the four tasks and the location of the mousing (right) hand was significant ($\chi^2 = 97.01$, $p < 0.05$). When typing, all participants maintained the mousing hand over the keyboard as expected. During the browsing and searching tasks, participants primarily retained the mousing hand on the mouse throughout the tasks, and to a minor degree placed the mousing hand on the lap while waiting for pages to load. However, during the learning task participants retained the mousing hand on the mouse less often, and located the hand in the lap more often, relative to the other Web tasks. The learning task was the only Web task where the mousing hand was observed being maintained primarily over the keyboard in order to access the arrow keys. The results across all tasks are presented in Figure 17.

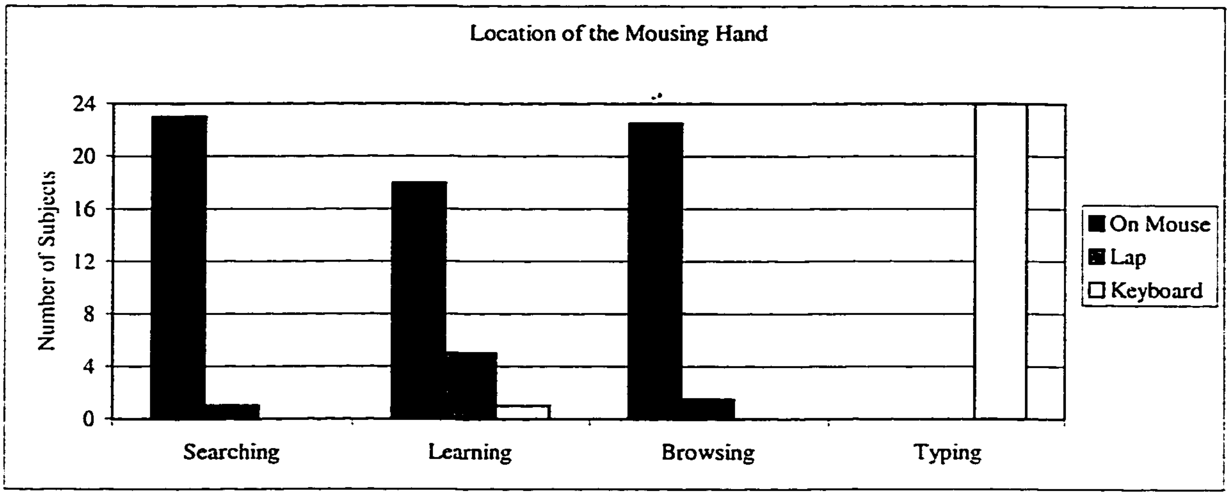


Figure 17. The location of the mousing hand as a function of task performed.

Web tasks. The relationship between the three Web tasks and the location of the mousing hand did not reach statistical significance ($\chi^2 = 6.52$, $p > 0.05$). During Web tasks approximately 95% of the participants kept the mousing hand on the mouse throughout both the searching and browsing tasks. Participants kept the mousing hand on the mouse less often, and in the lap more often during the learning task than in the searching and browsing tasks. The learning task was the only task where the mousing hand was placed over the keyboard for navigation with the arrow keys for a majority of the task.

Web vs. typing. There is a relationship between the categorical tasks and the location of the mousing hand. This relationship met the chi-squared test of statistical significance ($\chi^2 = 46.81$, $p < 0.05$). All participants maintained the mousing hand over the keyboard during the typing task, while Web users rarely (1%) maintained the mousing hand at the keyboard. Across Web tasks, 88% of participants maintained their hand on the mouse, 10% released the mouse and placed the hand on the lap and 1% used the arrow keys on the keyboard for navigation. The results across the task categories are presented in Figure 18.

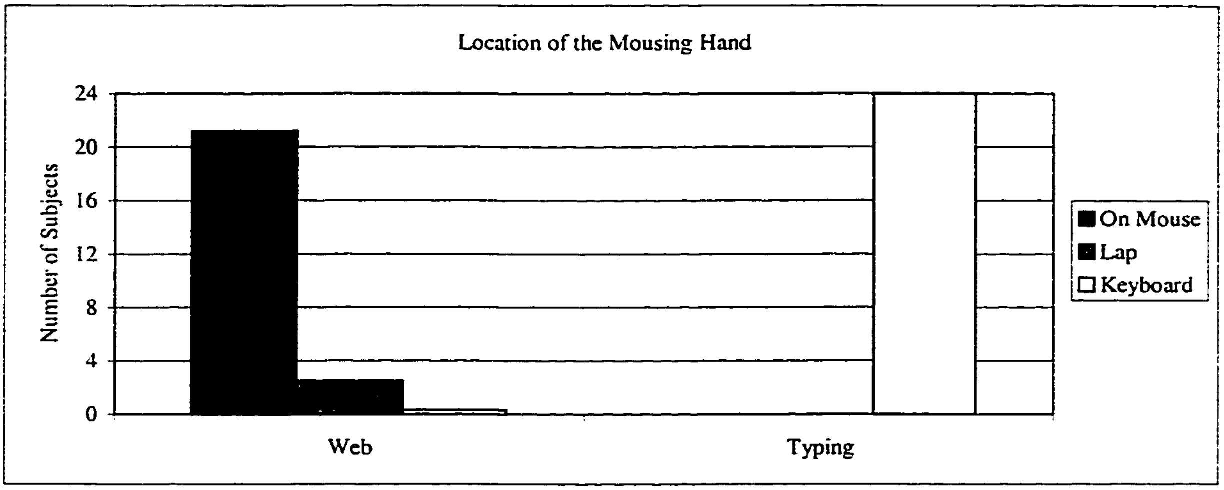


Figure 18. The location of the mousing hand as a function of task category.

Contact of the Non-mousing Elbow with a Surface

Contact of the non-mousing elbow with a surface. The elbow location of the non-mousing arm was recorded from the representative posture of each participant. If the elbow was in contact with a surface such as the tabletop, the results are shown as either "contact" or "no contact." All of the participants were right-handed; thus the following results are reported as the location of the left elbow.

All tasks. The relationship between the four tasks and contact between the participants' left elbow and a surface did not reach statistical significance ($\chi^2 = 3.89$, $p > 0.05$). The location of the left elbow was observed in contact with the armrest of the chair and at the side of the body during the typing task. During the Web tasks the elbow was on the armrest, at the side of the body, and was also maintained on the lap and on the desktop. As expected, the elbow was located on the desktop more often during the browsing and learning tasks than during the searching task. Across all tasks, the left elbow was in contact with a surface for 77% of the participants and was hanging next to the body (no contact) with 23% of the participants. The results across all tasks are presented in Figure 19.

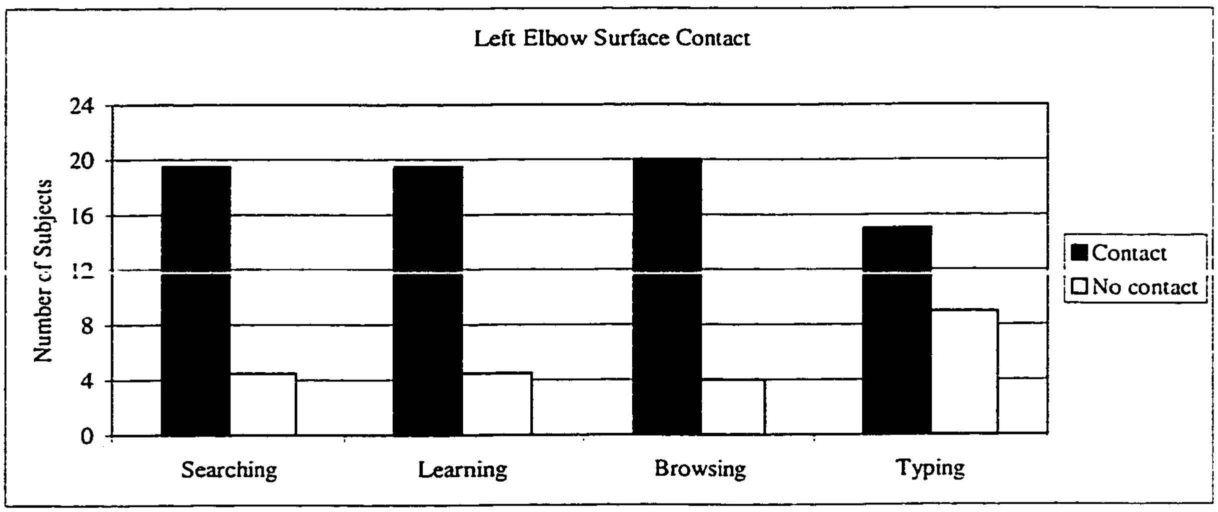


Figure 19. Surface contact with the left elbow as a function of task performed.

Web tasks. The relationship between the three Web tasks and the location of the left elbow did not reach statistical significance ($\chi^2 = 0.05$, $p > 0.05$). The left elbow was located at the side of the body for 17-19% of participants across all three Web tasks. The elbow was observed on the lap only during the learning task. An example of elbow placement on the desktop is presented in Figure 20.

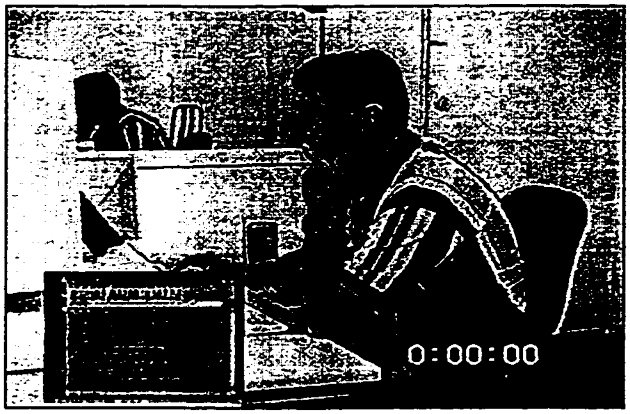


Figure 20. Example of a left elbow placement during the Learning task.

Web vs. typing. The relationship between the categorical tasks and the location of the left elbow did not reach statistical significance ($\chi^2 = 2.30$, $p > 0.05$). The left elbow was in contact with a surface more often and next to the body less often in the Web tasks than compared to the typing task. Though the elbow was located on the table and on the lap during Web tasks, neither of these locations were observed during the typing task. The results across the categorical tasks are presented in Figure 21.

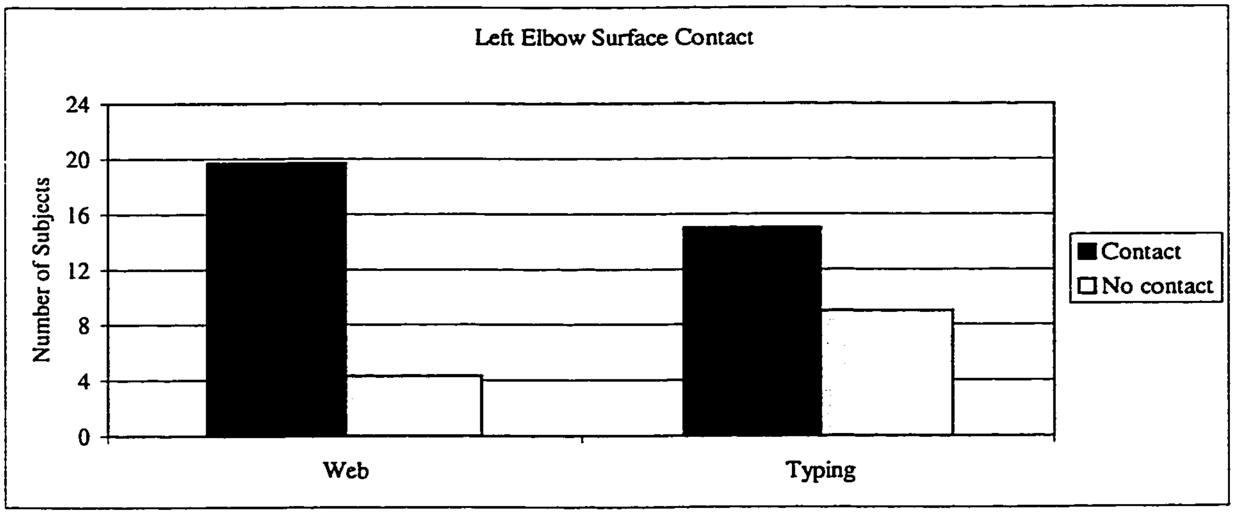


Figure 21. Surface contact with the left elbow as a function of task category.

Location of the Non-mousing Hand

The location of the non-mousing hand was recorded from the representative posture of each participant across the four typing tasks. The non-mousing hand of all participants was the left hand. The location of the non-mousing hand was naturally above the keyboard across all the participants during the typing task.

All tasks. The relationship between the four tasks and the location of the non-mousing (left) hand was significant ($\chi^2 = 91.85$, $p < 0.05$). During the typing task, all participants naturally maintained the non-mousing hand over the keyboard. In contrast, the non-mousing hand was observed over the keyboard for only 10% of the participants during the searching task, 2% of the participants during the browsing task, and by none of the participants during the learning task. While a variety of locations were observed for the non-mousing hand during the Web tasks, it was primarily located either on the lap or on the face. During the searching and learning tasks the hand was on the lap a majority of the time, while the hand was on the face and head a majority of the time during the browsing task. The results across all of the tasks are presented in Figure 22.

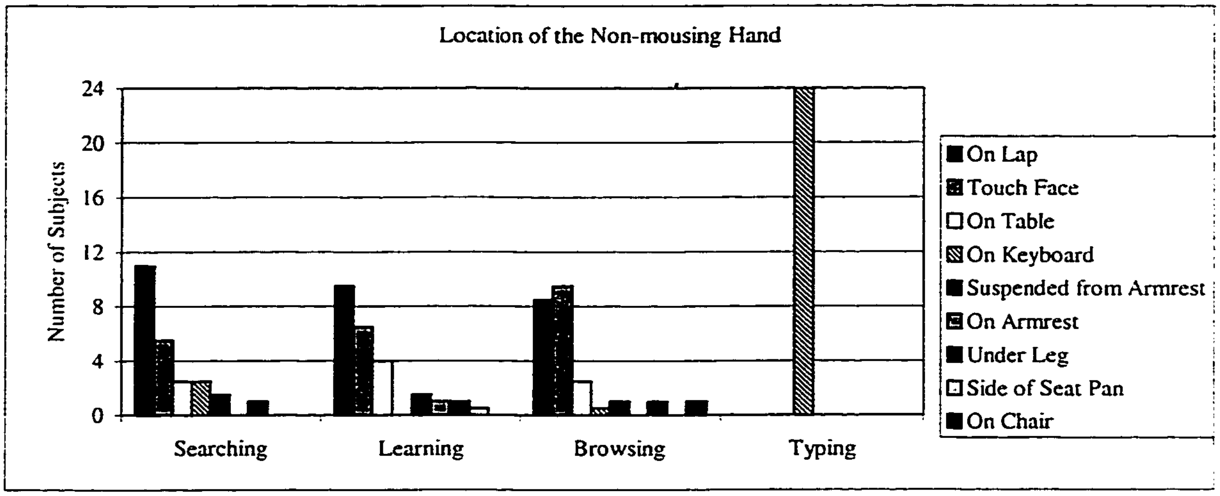


Figure 22. The location of the non-mousing hand as a function of task performed.

Web tasks. The relationship between the three Web tasks and the location of the non-mousing hand did not reach statistical significance ($\chi^2 = 10.66$, $p > 0.05$). The non-mousing hand was located a majority of the time on the lap or touching the face and head across all three Web tasks. These two locations combined to represent 75% of browsing task locations, 69% of searching task locations and 67% of learning task locations. The non-mousing hand was on the table 17% of the time during the learning tasks and 10% of the time during both the searching and browsing tasks.

Web vs. typing. There is a relationship between the categorical tasks and the location of the non-mousing hand. This relationship met the chi-squared test of statistical significance ($\chi^2 = 44.16$, $p < 0.05$). While all participants located the non-mousing hand at the keyboard during the typing task, only 4% of the Web users maintained the mousing hand in this location. During the Web tasks, the non-mousing hand was placed on the lap by 40% of the participants, touched the face and head of 30% of the participants and was placed on the table by 13% of the participants. The results are presented in Figure 23.

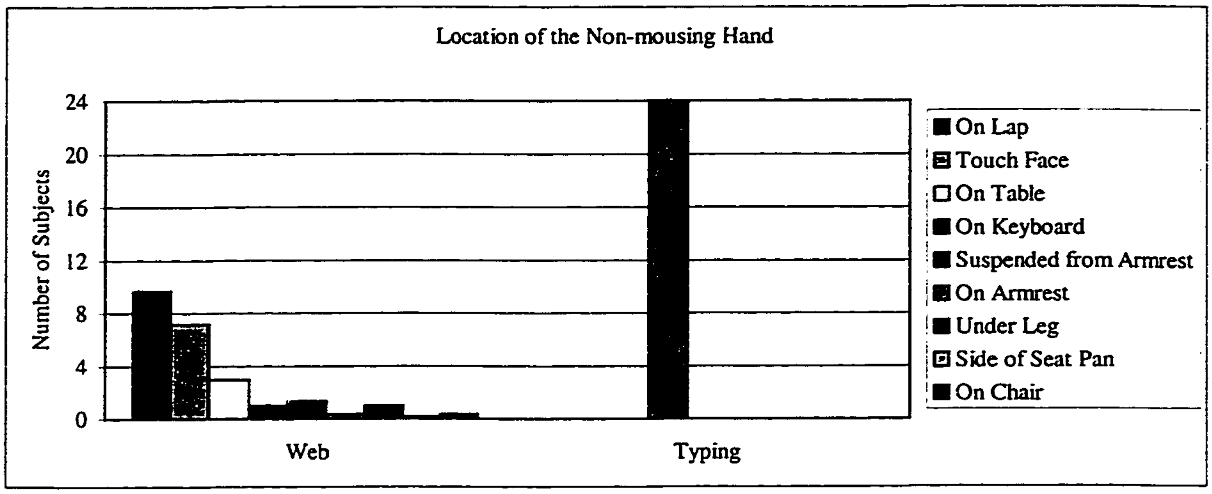


Figure 23. The location of the non-mousing hand as a function of task category.

Observed Waiting Postures

Participants used the waiting periods to briefly touch the face and head, and to a lesser extent, to relax their arms. Overall, participants rarely took the opportunity to change their body posture, stand up or stretch while waiting for pages to load.

Summary of Results

The chi-squared results reached statistical significance when considering all tasks and categorical Web vs. typing tasks for the measures of typing accommodation and whole body posture, typing accommodation and the position of the upper limbs, and the location of the mousing and non-mousing hands. The chi-squared results did not reach statistical significance for the measures of distance of the body to the keyboard, position of the head and neck, and the left elbow location in any of the three data groupings.

None of the chi-squared results reached statistical significance when considering only the three Web tasks. The outcomes are summarized in Table 2.

Table 2

Summary of chi-squared results by measure and data group.

	Chi-squared data group		
Measure	All tasks	Web tasks	Task categories
Body to keyboard distance	Not Significant	Not Significant	Not Significant
Head and neck position	Not Significant	Not Significant	Not Significant
Typing and whole body position	Significant	Not Significant	Significant
Typing and upper limb position	Significant	Not Significant	Significant
Mousing hand location	Significant	Not Significant	Significant
Left elbow surface contact	Not Significant	Not Significant	Not Significant
Non-mousing hand location	Significant	Not Significant	Significant

DISCUSSION

As shown by the data analysis, the null hypothesis that there is no difference between Web postures and typing postures can be rejected with reasonable certainty. These results support Andre's (1998) observation that there are postures associated with Web tasks that are indeed different than typing postures. These postures include the position of both the mousing and non-mousing hands and the ability of a Web user to type based on the position of the torso and upper limbs. As discussed earlier, these alternative postures are made possible by the fact that during Web interaction a) the user is de-coupled from the keyboard, b) the user is de-coupled from the desktop, and c) the user must often wait for sites to load. Next, the main findings of the study are reviewed as a function of various postural dimensions and then the ergonomic implications of the observed postures are discussed.

Distance of the Body to the Keyboard

Web users were generally farther away from the keyboard, and less engaged with the keyboard and desktop than during the typing task. Thus, one could conclude that they adopted more "relaxed" postures on occasion. However, because the Web user must remain engaged with the mouse, extension of the mousing arm and contact of the wrist on the desktop is prevalent. The extension of the mousing arm can lead to increased contact pressure being placed on the wrist and elbow, transferring pressure to the underlying nerves. Static loading of the arm and shoulders also occurs. Thus, a tradeoff exists whereby Web use leads to more relaxed whole body postures, but increases the extension of the mousing arm and the propensity to plant at the wrist. An example of observed arm extension is presented in Figure 24.

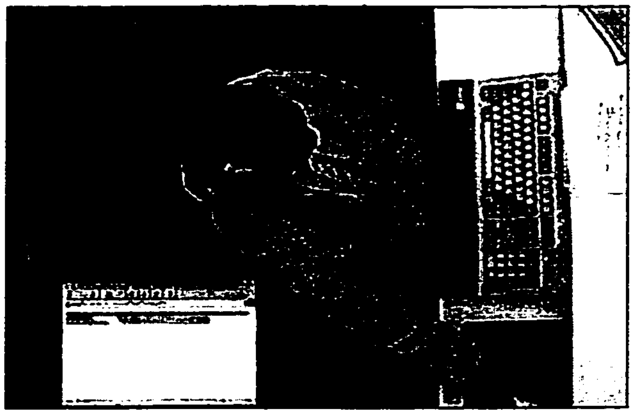


Figure 24. Example of arm extension during the Browsing task due to the distance of the body from the keyboard.

Position of the Head and Neck

In general, Web usage led to less frequent forward position of the head and neck relative to the typing task. This finding is not surprising since the requirement to read text (during the typing task) requires greater visual/perceptual resolution than does the requirement to view graphics (during the Web tasks). In addition, rotation of the head and neck occurred during the typing task as source documents on the desktop that are to the side or below the monitor were viewed. Neck forward flexion occurred when the head is flexed to view the keyboard, display and desktop documents. Both cases require muscle activity in the neck to maintain equilibrium (Andersson, 1987). In summary, the reduced need to view the keyboard or desktop source documents afforded by the Web tasks resulted in a greater frequency of relaxed (centered) head and neck postures.

Typing Accommodation and Whole Body Posture

Naturally, all participants maintained whole body postures that supported typing during the typing task, and to a lesser extent, during the searching task. Participants were more likely to adopt non-typing whole body postures, either leaned forward or relaxed back, during the learning and browsing tasks where typing is limited. When some amount of typing was required during these tasks, participants either changed to a typing posture or attempted to type from the non-typing posture (for example, typing a few keystrokes with only the mousing hand). An example of a non-typing whole body posture is presented in Figure 25.

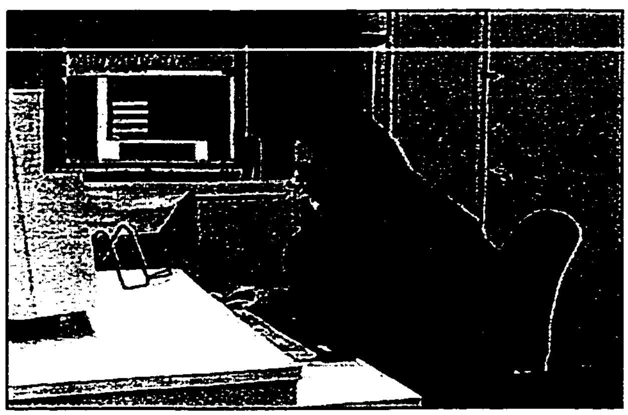


Figure 25. Example of a non-typing whole body posture during the Browsing task.

Typing Accommodation and the Position of the Upper Limbs

Similar to the findings for whole body posture, some (38%) participants took the opportunity to adopt non-typing postures of the upper extremities during Web tasks. These non-typing postures varied in their apparent ergonomic risk (from leaning forward with the elbow on the desktop and the wrist supporting the head to placing the hands in the lap). Also, some participants were observed typing with the mousing hand in order to avoid repositioning the non-mousing arm. As expected, these non-typing postures were observed most frequently during the learning task, which mostly involved viewing the text and visual material on the screen. An example of a non-typing posture during the Learning task is presented in Figure 26.

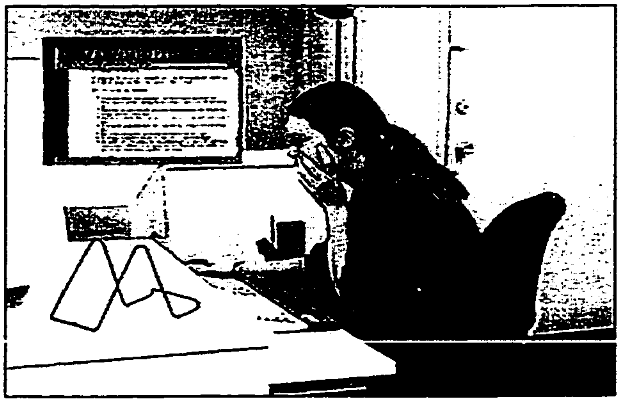


Figure 26. Example of a non-typing upper limb posture during the Learning task.

Location of the Mousing Hand

All participants maintained the right hand over the keyboard during the typing task, while this location was maintained by only 1% of Web users. Primarily, Web users maintained static wrist postures by holding the mouse throughout the task, regardless of whether active mouse control was required or not. As one exception, during the learning task 21% of the participants released the hand from the mouse and placed it in the lap. Further, the learning task was the only task where the right hand was placed over the keyboard for navigation with the arrow keys (4% occurrence). An example of a participant's mousing hand on the lap is presented in Figure 27.

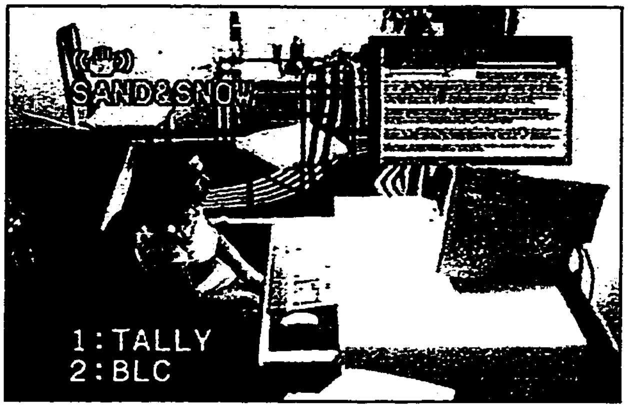


Figure 27. Example of the mousing hand placed on the lap.

One might expect an even larger percentage of participants relaxing the right hand away from the mouse during the learning (reading/viewing) task. However, participants often chose to maintain the right hand on the mouse in order to use the cursor as a placeholder while reading, similar to using a fingertip or ruler on paper. The mouse was also used during the learning task to scroll the page content.

Contact of the Non-Mousing Elbow with a Surface

During the Typing task the left elbow was observed either in contact with the chair armrest or suspended in the air. During the Web tasks the left elbow was observed either in contact with the chair armrest or in one of three other postures: 1) suspended/hanging in the air, 2) resting on the lap or 3) leaning on the desktop. The latter condition, which was most commonly observed during the browsing task, can result in excessive contact pressure at the elbow and underlying nerves (Armstrong, Martin, Franzblau, Rempel, & Johnson, 1995). Web users often placed the left elbow on the armrest as a result of a leaning posture that was not observed during the typing task. An example of elbow placement on the armrest is presented in Figure 28.

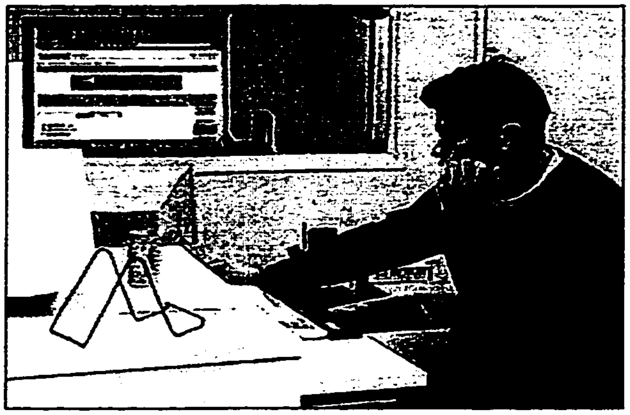


Figure 28. Example of the elbow placed on the chair armrest during the Searching task.

Location of the Non-Mousing Hand

The placement of the non-mousing (left) hand best demonstrated the postural variability afforded by the Web tasks relative to the typing task. For the most part, the left hand was situated on the lap or touching the face during the Web tasks, although there were a total of nine distinct locations observed. An example of a participant's hand touching the face is presented in Figure 29.

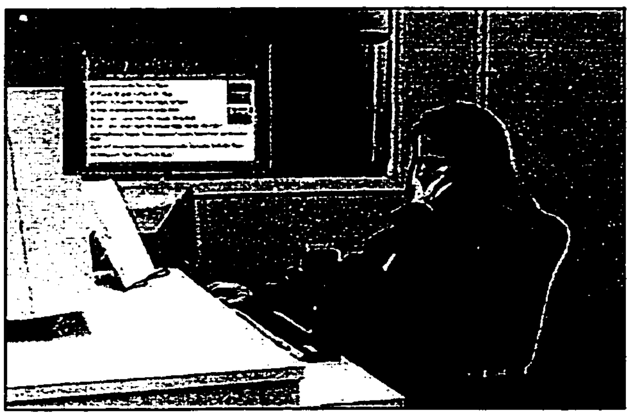


Figure 29. Example of the non-mousing hand touching the face.

Observed Waiting Postures

Due to inherent delays in the Web, a variety of activities were observed during waiting periods that included putting both hands in the lap, stretching and rubbing the face and eyes. Yet, overall, participants did not change or relax their posture during the majority of the waiting opportunities.

For familiar or predictable content, where the user expects desired content (for example, a series of cartoons), the tendency to hold the mouse would not be expected when waiting because navigation from the page would not necessarily be immediate. If, however, the page that is loading is novel or unknown, then the mousing hand could be expected to stay on the mouse because navigation or scrolling is likely. This theory was borne out in the searching and browsing tasks, but not in the learning task. During extended reading, 75% of participants retained the right hand on the mouse in order to scroll or to use cursor as a placeholder.

Summary

Across all measures, there were many instances where Web task postures differed in kind or frequency from typing task postures. Further, there were postural variances attributed to the different requirements of the three Web tasks. Postures observed during the course of the Web tasks can be classified as both beneficial and detrimental.

Potentially beneficial postures include:

1. Adopting a more reclined whole body posture.
2. Relaxing the hand/arms in the lap.

Potentially detrimental postures include:

1. Leaning forward.
2. Placing the elbow on the desktop.
3. Over-extending the arm to reach the mouse.

Future Research

Many participants leaned on the left elbow when it was on the armrest. If a chair without armrests was used during the Web tasks, it is unknown whether the participants would lean forward more often and place the elbow on the table, or if the hand would rest more often on the lap. Understanding the postural implications of using a chair with and without armrests during Web tasks would be an important area for further investigation (see Appenrodt & Andre, 1999).

Another issue to address concerns the finding that when reading Web content, some people use the mouse to scroll line-by-line or section-by-section, while others manipulated the mouse and used the cursor as a placeholder while reading. How can Web reading tasks be supported in a way that does not require maintaining static postures on the mouse or the arrow keys?

Finally, since waiting is an inherent aspect of all Web tasks, this appears to be the most promising avenue for promoting postural change or relaxation.

Implications

From the results of this study, it is clear that Web users are assuming a variety of postures that may have both positive and negative effects on health. When asked, many of the study participants noticed no change in their posture over the course of the session, even when the changes were quite apparent to an observer. Web users should be made aware of the postural issues that can arise when using the Web, and be provided with information and training in how to incorporate beneficial postures and dynamic behaviors into their Web use regimen.

Guidelines to consider for healthy postures when using the Web include:

1. While waiting for pages to connect or load, change your body posture, relax your arms at the side of your body, or better yet, stand up and stretch. Don't hold the mouse, or hover over the keyboard when you don't have to.
2. Be careful not to plant the elbow of the non-mousing arm on the armrest or desktop when leaning forward; instead, allow that arm to hang at the side of your body or relax in your lap.
3. If you adopt a reclined posture while Web browsing, consider moving your mouse closer to your body.
4. Take advantage of the flexibility afforded by Web browsing to vary your postures—try not to remain in any one posture for too long.
5. Do not twist your body to one side.
6. Time flies when you're having fun, so be careful not to spend too much time surfing the Web as a form of entertainment. We spend enough time on our computers performing work-related tasks. Remember that the "R" in RSI stands for repetitive.

Limitations

While the representative postures were obtained from videotape analysis and documentation, the methods used to determine the postures were subjective. The study did not analyze dynamic postures within each task, but rather focused on the dominant posture that was maintained during each task. Because the study was conducted in a usability laboratory, the full range of postural variations that people actually assume when using the Web may be much greater than those observed. The chair used in the study had armrests that the participants leaned against. Different chair types, with and without armrests, may have an effect on postures when using the Web. The time allowed for each task was constrained, allowing only limited postural variation to take place. Postures may vary a greater amount when participants use the Web for a longer period of time.

CONCLUSION

Karwowski, Eberts, Salvendy, & Noland (1994) provide several examples of previous research that link postural rigidity (and other posture dimensions) typically accompanied by traditional computer (text entry) activities to discomfort, risk of shoulder and neck disorders, and repetitive stress injuries (RSI). Web users are provided with an opportunity to vary their postures outside of those that have been historically observed and recommended for keyboard-intensive data entry tasks. This study clearly demonstrates that Web postures can be, and are, different than typing postures. The question is "Do these postures allow users to minimize their exposure to computer-related injuries?" The answer is both "yes" and "no."

As most democratic societies well know, increased freedom and flexibility often results in both uses and abuses. So too is the case with Web tasks, which in the present study were found to facilitate both beneficial and detrimental postures. The present study serves as the first step towards a larger research effort aimed at identifying and promoting the range of beneficial postures afforded by Web tasks, and mitigating the attendant detrimental postures.

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Appendix A

San Jose State University Institutional Review Board Approval

San José State
UNIVERSITY

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TO: Jeffrey Dale English
1885 Birchwood Lane.
Tracy, CA 95376

FROM: Serena W. Stanford *Serena W. Stanford*
AVP, Graduate Studies & Research

DATE: September 17, 1998

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

"Posture and Internet Navigation: An Observational Study"

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 any and all data that may be collected from the subjects. The Board's 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 Serena Stanford, Ph.D., immediately. Injury includes but is not limited to bodily harm, psychological trauma and release of potentially damaging personal information.

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 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.

Appendix B

Demographic Survey

Date: ____________

Subject #: _________

Name: ______________________________

Age: _______

Gender: Male / Female

Dominant hand: Left / Right

Mouse hand: Left / Right

Years of computer experience: _________

Months (or years) of Internet experience: ________

Minutes per day using the Internet: ________

Minutes per week using the Internet: ________

Where are you using the Internet? Home / Work / Other: _______

Current computer input device used for navigation (mouse, trackball, other?): ___

Appendix C

Consent Form

I, ________________________, volunteer to participate in the research study entitled Internet Navigation, to be conducted at the office of Interface Analysis, under the direction of Jeffrey English and Anthony Andre, Ph.D.

The procedures have been explained to me and I understand them fully. They are as follows: 1) The purpose of the study is to evaluate the usability of the Internet. 2) The study will last approximately 1 hour. 3) No risks to me are expected from my participation in this study.

I understand that this consent and data may be withdrawn at any time without penalty. Questions about the research may be addressed to Jeffrey English at 209-833-0950. Complaints about the research may be presented to Louis Freund, Ph.D., Professor of Industrial and Systems Engineering, Director, Human Factors / Ergonomics Program, SJSU, at 408-924-3890. Questions about research, subjects' rights, or research-related injury may be addressed to Serena Stanford, Ph.D., Associate Academic Vice President for Graduate Studies and Research, at 408-924-2480. I have been given the right to ask questions, and my questions, if any, have been answered to my satisfaction. I understand that all or part of the session may be videotaped. I agree to allow the experimenters to use still pictures or video clips of me in publications and presentations about this study. I understand that the data will be reported in group form and individual data will be kept confidential. I have received a signed and dated copy of this consent form.

________________________________ ________________________

Participant's Signature Date

________________________________ ________________________

Investigator's Signature Date

Appendix D

Task Instructions

Before Beginning

- ❑ delete bookmarks, empty cache file, delete history
- ❑ lighting, music, all computers and monitors on, tape ready
- ❑ SJSU student – sign in on the blue sheet
- ❑ demographic survey
- ❑ 2 consent forms – 1 to retain, 1 for the subject to take

- ➢ "This study involves the usability of the Internet.
- ➢ There are 4 activities for you to participate in.
- ➢ Each activity is important to the success of the project, so if you have any questions during an activity, please feel free to ask.
- ➢ The total time for the session will be approximately 1 hour, with a 5 minute break.
- ➢ These tasks are fairly straightforward, so while you are on the computer, I will be doing some work in another office. There are offices in the back (toward the observation room), so you may hear people talking or walking around…don't pay any attention to that, ok?
- ➢ Do you have any questions?"

- ❑ introduce the subject to the equipment, and the possible adjustments. Aid the subject in any adjustments, as necessary
- ❑ go to the first task

Appendix D

Task Instructions

Internet Searching

- ☐ provide the subject with the list of web page content to locate and bookmark.

- "The point of this exercise is to understand how easy it is for people to find specific information on the Internet.
- Do you understand how to search and how to bookmark a page?
- Here is a list of 9 subjects.
- Please search the Internet at your own pace, locate any page that contains each subject, and bookmark that page.
- Some subjects are very specific, and may describe only one web page. Other subjects may be more broad, meaning that there may be many pages with the correct content.
- Do not bookmark any page until it is finished loading on the screen. If you get stuck or frustrated, move on to the next one.
- Do you have any questions?
- This session will last 15 minutes."

- ☐ if applicable, document the initial "typing" posture of the subject
- ☐ **start recording**
- ☐ ask subject to begin the task
- ☐ end task after 15 minutes
- ☐ stop recording
- ☐ bring subject away from the computer, to the interview table
- ☐ review the task with the subject

Appendix D

Task Instructions

Internet Learning

- "Please search the Internet to find information about the weather phenomenon El Niño for approximately 10 minutes.
- Learn as much as you can about the subject during this time.
- You can go to as many sites as you would like to, but at the conclusion of this task there will be a brief true/false quiz asking general questions about El Niño.
- The quiz will be easy; this is not an evaluation of how much you learn, but rather how well the Internet supports learning.
- Do you have any questions?"

- [ ] **start recording**
- [ ] if applicable, document the initial "typing" posture of the subject
- [ ] ask subject to begin the task
- [ ] end task after 10 minutes
- [ ] stop recording
- [ ] bring subject away from the computer, to the interview table
- [ ] give the quiz

Appendix D

Task Instructions

Internet Browsing

- "You have 15 minutes to browse the Internet for any subjects that you have an interest in.
- There is no need to bookmark or learn about any particular subject, just browse as you normally would.
- Take this opportunity to find and look at sites that you do not normally have the opportunity to see regardless of the content.
- If you come up with anything wild let me know!
- The purpose of this is to understand how well the Internet supports your ability to find the subjects that interest you.
- Do you have any questions?"

- [ ] **start recording**
- [ ] if applicable, document the initial "typing" posture of the subject
- [ ] ask subject to begin the task
- [ ] end task after 15 minutes
- [ ] stop recording
- [ ] bring subject away from the computer, to the interview table
- [ ] give the Internet Usability Survey

Appendix D

Task Instructions

Text Entry

- ❑ 5 minute break (restroom key)
- ❑ open Microsoft Word
- ❑ provide the subject with the prepared text document and a document holder

- ➢ "Please type as much of this document into the computer as you can in 5 minutes.
- ➢ Edit any mistakes that you make, and format the text to look like the text on the page.
- ➢ Do you have any questions?"

- ❑ **start recording**
- ❑ ask subject to begin the task
- ❑ end task after 5 minutes
- ❑ stop recording
- ❑ bring subject away from the computer, to the interview table

- ❑ debrief instructions
- ❑ post-experiment survey
- ❑ SJSU student – sign their green sheet – if they don't have it, then give them one

- ❑ delete bookmarks, empty cache file, delete history

Appendix E

Web Sites to Bookmark

Use the Yahoo! search engine. Find and "bookmark" one site for each of the following types of content below. Do not bookmark the page until it is fully loaded on the display, and that you can say for certain that it contains the information requested.

1. A 1997 Corvette for sale.
2. A 1995 Academy Awards winners list.
3. The current weather in Phoenix, Arizona.
4. A review of the movie Titanic.
5. The San Jose Sharks homepage.
6. The CIA World Factbook listing for Algeria.
7. A map of the Bay Area Rapid Transit system.
8. A pasta recipe.
9. A picture of the Eiffel Tower.

Appendix F

Data Collection Log Example

Subject #1

Measure	Searching Task
Body to keyboard distance	
Near	
Mid	✔
Far	
Head and neck position	
Centered	✔
Forward	
Typing and whole body position	
Typing	✔
Non-typing	
Typing and upper limb position	
Typing	
Non-typing	✔
Mousing hand location	
On Mouse	✔
Lap	
Keyboard	
Left elbow surface contact	
Contact	✔
No contact	
Non-mousing hand location	
On Lap	
Touch Face	✔
On Keyboard	
On Table	
Suspended from Armrest	
On Armrest	
Under Leg	
Side of Seat Pan	
On Chair	

Appendix G

El Niño Quiz

Circle the best response.

1. El Niño is a weather phenomenon that results in thunderstorms. True / False

2. El Niño occurs only 1 or 2 times in 1,000 years. True / False

3. El Niño is caused by changes in atmospheric pressure. True / False

4. Damage from El Niño comes not just from rainfall, but also from massive landslides, floods and erosion. True / False

5. Peruvians named this phenomenon El Niño, meaning "the angry turkey," because it first appeared around Thanksgiving. True / False

- Was the El Niño information available on the Internet easy to use? Yes / No Useful? Yes / No

Appendix H

Internet Usability Survey

1. How easy is it to find information that you are looking for?

   difficult somewhat difficult somewhat easy easy very easy

2. Are search engines helpful?

   not helpful somewhat helpful helpful very helpful

3. From the search engine results, which information was the most helpful to you:

   - the site name
   - the site description
   - the page title

4. Is it easier to read light color letters on a dark background or dark letters on a light background?

5. When you find information on the Internet that you find useful, do you print it, bookmark it, or both?

Appendix I

Typing Text to Input

Paul Revere's Ride
Henry Wadsworth Longfellow

Listen, my children, and you shall hear
Of the midnight ride of Paul Revere,
On the eighteenth of April, in Seventy-five;
Hardly a man is now alive
Who remembers that famous day and year.

He said to his friend, "If the British march
By land or sea from the town tonight,
Hang a lantern aloft in the belfry arch
Of the North Church tower as a signal light--
One if by land, and two if by sea;
And I on the opposite shore will be,
Ready to ride and spread the alarm
Through every Middlesex village and farm,
For the country folk to be up and to arm."

Then he said "Good-night!" and with muffled oar
Silently rowed to the Charlestown shore,
Just as the moon rose over the bay,
Where swinging wide at her moorings lay
The Somerset, British man-of-war;
A phantom ship, with each mast and spar
Across the moon like a prison bar,
And a huge black hulk, that was magnified
By its own reflection in the tide.

Meanwhile, his friend through alley and street
Wanders and watches, with eager ears,
Till in the silence around him he hears
The muster of men at the barrack door,
The sound of arms, and the tramp of feet,

And the measured tread of the grenadiers,
Marching down to their boats on the shore.

Appendix J

Debrief Instructions

Thank you for your participation in this study!

As previously described to you, this study is being conducted to evaluate the usability of the Internet. We define usability in a rather broad way—from the user's ability to easily obtain desired information, to the required postures and resultant comfort of the user. Thus, in addition to our interests in how the Internet supports the various tasks we asked you to perform, we are also interested in the postures and comfort level achieved when performing these tasks. We did not tell you specifically about the postural aspect of the research because we did not want you to feel self-conscious about it, or to influence the postures that are comfortable for you. By characterizing the usability of the Internet both in terms of finding and learning information, and the resultant postures required of Internet interaction, we hope to develop a more comprehensive set of usability guidelines that speak to the efficiency and comfort of using the Internet.

We very much appreciate your participation in this study, thank you again. Do you have any questions?

Appendix K

Post-Study Survey

1. What posture is the most comfortable for you when using the Internet?

2. Did you notice any changes in your posture during the session today? yes / no

   If yes, why did you change your posture?

3. Have you had any prior training in ergonomics for working at a computer? yes / no

   If yes, please explain.