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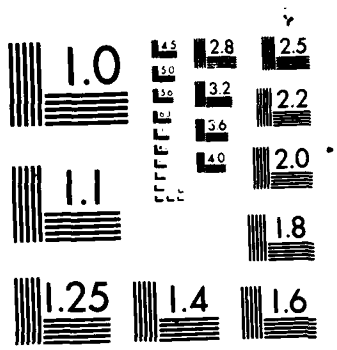

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Technical Memorandum 1-87

TEXT-EDITING PERFORMANCE ON A VISUAL DISPLAY SCREEN AS A FUNCTION OF WINDOW HEIGHT AND MESSAGE LENGTH

Maureen M. Larkin

January 1987

U. S. ARMY HUMAN ENGINEERING LABORATORY
Aberdeen Proving Ground, Maryland

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Text-editing performance on a visual display screen was studied as a function of five different window heights (1, 4, 8, 16, and 23 lines) and three different message lengths (short = 1 line, medium = 10-15 lines, and long = 23 lines). Performance and attitude data were collected on 30 subjects. A multivariate analysis of variance (MANOVA) conducted on the performance data revealed a significant main effect for message length but not for window height nor for the interaction between these two variables. Subjects took longer to locate text in medium and long messages than in short

messages. A second MANOVA revealed that regardless of window-height condition, subjects' general attitudes toward computers became more positive following their interactions with the computer. Taken together, the results indicate that people's text-editing performance and attitudes are not adversely affected as the amount of text that is displayed on a computer screen is reduced. Therefore, depending on the task, larger computer screens may not offer significant advantages to users.

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Executive Summary

The Problem

As technology improves, equipment requiring a human-computer interface is becoming both smaller and more sophisticated. Correspondingly, visual displays are being made smaller than the usual 23-line window height. If this miniaturized equipment is to be properly designed for the user, then human factors specialists need empirical evidence on how window height and message length influence the text-editing performance of the people who use the equipment.

This study investigated the effects of window height and message length on people's text-editing performance on a visual display screen. Additionally, the effects of window height on people's attitudes toward computers were investigated. Researchers have frequently found that the equipment design that results in the best performance is not always the design that is most preferred by the user.

Methodology

Window height and message length were manipulated in a one between- and one within-subjects design. Window height was the between-subjects variable; message length, the within-subjects variable. Text-editing performance was studied as a function of five different window heights (1, 4, 16, and 23 lines) and three different message lengths (short = 1 line, medium = 10-15 lines, and long = 23 lines). Thirty subjects were randomly assigned to the five window-height conditions. Prior to interacting with the test equipment, each subject was asked to complete an attitude questionnaire. Each of 72 stimulus messages that contained errors to be edited was presented to the subject both on an Apple® IIe computer monitor and on an individual sheet of paper. The subject used techniques from Portable WordStar® to edit each of the stimulus messages on the Apple® monitor. Speed and accuracy measures were collected on each of the stimulus messages. When all 72 messages were completed, the subject was asked to complete the postexperimental attitude questionnaire.

Results

A multivariate analysis of variance (MANOVA) on the performance data revealed a significant main effect for message length, $F(8, 96) = 7.12$, $p < .001$, but not for window height or for the interaction between the two factors. The univariate analyses of variance (ANOVA) indicated significant message length effects for mean locating time, $F(2, 50) = 48.50$, $p < .001$, and for mean total time, $F(2, 50) = 31.78$, $p < .001$. Post-hoc analyses on the mean locating times revealed significant differences between the means for short and medium messages, short and long messages, and medium and long messages. Post-hoc analyses on the mean total times revealed significant differences between the means for short and medium messages and for short and long messages but not between the means for medium and long messages.

A MANOVA on the attitudes data revealed a significant main effect for time for the pre- and the postexperimental questionnaires, $F(15, 11) = 3.97$, $p < .01$. The univariate ANOVAs indicated subjects' attitudes became significantly more favorable toward computers for 9 of the 15 questionnaire items following their interaction with the computer.

Conclusions

The results indicate that, regardless of window height, text-editing performance was not significantly influenced by the amount of text that was displayed on the screen at one time. Time to locate information in a stimulus message was affected by the length of the message in which the error occurred. Subjects took longer to locate text in the medium- and long-length messages than they did in the short messages; however, time to edit the error, once found, was not significantly influenced by the length of the message. Subjects' responses to the pre- and postexperimental attitude questionnaires agree with the performance data analyses and indicate a positive reaction to computers regardless of prior exposure to any specific window-height condition.

Chapter I

Introduction

The increased availability and use of computers has generated much interest on the design of human-engineered computer interfaces. Consequently, guidelines have been developed for the design of the software interface (see, for example, Al-Awar, Chapanis, & Ford, 1981; Smith & Aucella, 1983) and the hardware interface (see, for example, Hendricks, Kilduff, Brooks, Marshak, & Doyle, 1983; Shneiderman, 1980). Guidelines on the design of the software interface include recommendations for usable menus and selection of user-oriented vocabulary terms. Guidelines for computer hardware include recommendations on keyboard design and on visual display units or computer screens.

The first set of published guidelines was written by Engel and Granda (1975). These guidelines were intended to help software developers design the visual display interface between the computer program and the human user. Engel and Granda's report includes guidelines on the physical layout of the screen, the content of the data on the screen, the choices of command language to use, the entry techniques of users, and general behavioral principles that relate to human capabilities and limitations. The authors knew that their guidelines were incomplete but had intended them as a basis for experimental research in the area of screen design. Few experimental studies on human-computer issues were published, however, and 5 years later at a presentation before the Human Factors Society, Granda (1980) repeated the need for empirically-based guidelines that would provide specific answers on how to design visual display screens to suit the user.

Other guidelines for the human-computer interface have generally concentrated on the design of data entry techniques (Brown, et al., 1983; Sidorsky & Parrish, 1980; Smith & Aucella, 1983), display formats (Brown, et al., 1983; Keister, 1983; Department of Defense, 1983; Smith & Aucella, 1983), and procedures for correcting errors (Brown, et al., 1983; Sidorsky & Parrish, 1980). Guidelines on hardware design also have provided information on optimal viewing angles, lighting, seat height, and workspace layout (Hendricks, et al., 1983; Parrish, et al., 1983). Unfortunately, much of the information in these and other such articles is based on the personal experiences and observations of the authors. Only a few of the guidelines are supported by experimental evidence. Nonetheless, these suggestions provide some structure for research on the design of the human-computer interface.

For example, it is now generally recognized that numerous parameters must be considered when designing a visual display screen. In particular, specialists now consider how information on a visual display screen will be viewed by the person using the computer screen. The design considerations involved in presenting information can be divided into two categories: the movement of information and the quantity of information on the screen.

The first category, movement of information, includes selecting between allowing the user to scroll or to page through information on the screen. These two movement options are best understood if one views the screen as a window through which the text of a document is seen. Scrolling allows the user to move that window up or down line by line, thus exposing various portions of the document. This movement option is analogous to moving a magnifying glass up and down over an otherwise unreadable page of text. Paging, on the other hand, requires the user to move a full screen-length block of text behind the screen at one time. Paging mirrors the act of flipping a page in a printed manuscript. Research indicates that for inexperienced users, paging is superior to scrolling for both performance and attitude measures (Schwarz, Beldie, & Pastoor, 1983).

The second category, the quantity of information on the screen, is indexed by measures of character density, line length, and window height. Character density determines the size of the characters on the screen and is usually defined as 40 or 80 characters per line (2.1 or 4.2 per cm). Line length defines the amount of information presented as it compares to the width of the screen visible to the person. For example, text could be displayed on one-third, two-thirds, or the entire width of the screen, leaving two-thirds, one-third, or none of the screen width available for graphic information. Window height is the number of vertical lines of text visible to the person on the screen. For example, a computer screen could be designed to present 1, 4, 8, 16, or 23 lines of information or text at one time.

The quantity of information that needs to be displayed on a computer screen is a crucial area of investigation. As technology continues to improve and the price of electronics continues to decrease, equipment requiring a human-computer interface is becoming both smaller and more sophisticated. Correspondingly, visual displays are being made smaller than the usual 23-line window height. For example, designers have built handheld input and output devices with 1- and 2-line window heights, military telecommunications systems with 1-line window heights, and portable personal computers with 16-line window heights. Only recently has such miniaturized equipment been built with the benefit of empirical evidence on how window height influences the performance of the people who use the equipment.

Window height affects the time it takes people to locate information in text. Neal and Darnell (1984) conducted two studies to examine this effect. In the first experiment, subjects edited text on partial-line (1 line by 32 characters) and partial-page displays (20 line by 80 characters). Subjects were required to make revisions on four types of printed documents: narrative text, business letters, outlines with two levels of indentation, and tables composed of three columns of text. Each printed document had a single revision marked on it. No significant differences were found between the partial-line and the partial-page displays for locating time, revising time, overall editing time, or the number of errors made.

In the second experiment, subjects edited text on the same size partial-page display and on a full-page display (60 lines by 80 characters). The full-page display showed the entire printed page document. The documents containing narrative text that were used in the first experiment were replaced in the second experiment by a document that contained a combination of business letter, columnar, and outline elements. In this experiment, Neal and Darnell found that subjects could locate information in text faster with a 60-line window height than with a 20-line window height screen. No differences were found, however, between the 60-line and 20-line window heights for revising time, overall editing time, or the number of errors made.

Neal and Darnell attributed the locating time differences to their subjects' differential strategies when interacting with a 20- versus a 60-line display. Subjects who used a 20-line display, tended to use the find command to locate the editing error and to spend time inspecting the error to verify that the computer had correctly located it. Conversely, when their subjects used a 60-line display, they visually located the error and then used the cursor control keys to position the cursor at that location.

The authors concluded that although people may depend upon the computer more heavily and hence locate text less easily when using a computer screen with a 20-line window height, they are not hampered in performing editing tasks when given such displays. People are not hampered with the smaller window heights when performing editing tasks because they need to see only the small area of the screen that contains the error to be corrected.

Similar results have been reported by Elkerton and Williges (1984). These authors investigated the effects of window height on file search performance, or, in other words, people's ability to locate and retrieve information from text. The window heights examined were 1, 7, 13, and 19 lines. As in the Neal and Darnell study, the Elkerton and Williges study indicates that file search performance is slowest with the smallest, or one-line, window height. No significant differences were found in file search performance among the 7-, 13-, and 19-line window heights. The authors suggested that subjects using the one-line window height screen became lost in the text and could not remember what text was above or below the single line displayed.

Elkerton and Williges point out, however, that larger screens are not always more effective than smaller screens. Their data indicated that as window height increased, the number of lines the subject must move the cursor (file movement) also increased. Although people may use more search strategies and may be slower with 1-line window height screens, they may be more accurate in file movement with the smaller 1-line window heights than with the larger window height screens (Elkerton & Williges, 1984; Neal & Darnell, 1984).

A second effect of window height is its influence on the person's ability to read text as it is scrolled on the screen. To investigate this effect, Duchnicky and Kolers (1983) manipulated the screen characteristics of line length (1/3, 2/3, and 3/3 screen width), character density (40 or 80 characters per line), and window height (1, 2, 3, 4, or 20 lines per screen). Their subjects were asked to read text on the screen and then to review 10 questions intended to test their reading comprehension. Subject performance was assessed by measuring reading time rates. The results indicated that the line widths of two-thirds and three-thirds are read 25% faster than are one-third line widths and that 80-character displays are read 30% faster than are 40-character displays. Window height also affected the readability of text scrolled on the screen. Text presented in 4-line window heights was read at the same rate as was text in 20-line window heights. Text in 1- and 2-line window heights was read only 9% slower than was text in 20-line window heights. Therefore, although window heights of 1 or 2 lines are slightly less efficient for reading scrolled text, increasing the window height from 4 to 20 lines does not markedly improve efficiency.

Purpose

The purpose of the present study was to investigate the effects of window height and message length on people's text-editing performance. Each subject edited text on an Apple® IIe computer screen that presented 1, 4, 8, 16, or 23 lines of text at one time. The 1- and 23-line window heights were selected because they delimit the smallest and largest numbers of lines that can be presented on an Apple® computer screen at one time. The three intermediate window heights of 4, 8, and 16 lines were selected because such screen sizes are now used with portable civilian and military computers (for example, the Epson® PX-8, the Radio Shack® TRS-100, the Radio Shack® TRS-200, and the military's Single Subscriber Terminal).

The present study examined the effects of these various window heights as subjects edited text of three different lengths. Message lengths were presented in short- (1-line), medium- (10-15 line), and long- (23-line) length sizes. Subject performance was assessed with both time and accuracy measures.

The purpose of examining the combined effects of window height and message length was to determine if smaller screen sizes would limit user performance. Although it seemed likely that smaller window height screens would restrict users as they edited lengthy messages, as Neal and Darnell (1984) found in their second experiment, it seemed unlikely that such screens would restrict performance as users edited shorter messages. In contrast to a 23-line message, a 1-line message can be seen in its entirety regardless of whether the window height or the screen is 1, 4, 8, 16, or 23 lines in size.

In addition to performance measures, the effects of window height were assessed with attitude measures. Attitude information was collected because researchers have frequently found that the equipment design that results in the best performance is not always the design that is most preferred by the user (Shackel, 1981).

Research Hypotheses

1. There will be a significant difference in text-editing performance among the five window height conditions.

2. There will be a significant difference in text-editing performance among the three message lengths.

3. There will be a significant difference in attitudes toward computers among the five window height conditions.

Chapter 2

Method

Subjects

Thirty military and civilian subjects voluntarily participated in this experiment. Eighteen of the subjects were men and twelve of the subjects were women. The subjects were recruited from sources available on Aberdeen Proving Ground, Maryland. The subjects had to be familiar with the location of keys on a Qwerty typewriter keyboard but did not have to be knowledgeable of computers or word processing systems. Similarly, subjects did not have to possess typing skill because such skills have not been found to add significant error variability when people perform simple tasks such as text-editing (Weeks, Kelly, & Chapanis, 1974). Each subject was tested individually in a session that lasted about 2 hours.

Apparatus and Materials

Test equipment. A series of stimulus messages was presented to the subjects on an Apple® IIe computer system. The system consisted of an Apple® IIe computer, two disk drives, an Apple® monochrome monitor, a 10-megabyte ProFile® hard disk, an Amdek® 300A monochrome monitor, and an Epson® FX-100+ printer. The computer was equipped with an 80-column card that had an upper- and lowercase character generator.

Subjects interacted with the Apple® IIe computer through an Apple® keyboard. The Apple® keyboard was modified slightly for this experiment (see Figure 1). Because the Esc, Delete, Tab, Caps Lock, open Apple, closed Apple, and Reset keys were not needed in this experiment, these keys were covered with blank stick-on covers that closely matched the color of the original keys. In addition, a new set of cursor keys was created on the equal, left bracket, right bracket, and apostrophe keys with the equal key being the up arrow key; the apostrophe key, the down arrow key; the left bracket key, the left arrow key; and the right bracket key, the right arrow key. The key that is directly to the right of the Caps Lock key was specially programmed and labeled "Done."

A Thunderclock Proclock® timer card was installed in the Apple® computer. The Thunderclock Proclock® automatically recorded each subject's keystrokes on the keyboard while simultaneously recording the elapsed times in seconds.

While a subject interacted with the Apple® IIe computer system, an experimenter monitored the subject's performance from another room. The experimenter viewed an Amdek® 300A monitor that was unobtrusively connected to the subject's Apple® IIe system. The Amdek® monitor echoed all of the information presented on and entered into the subject's Apple® IIe monitor.

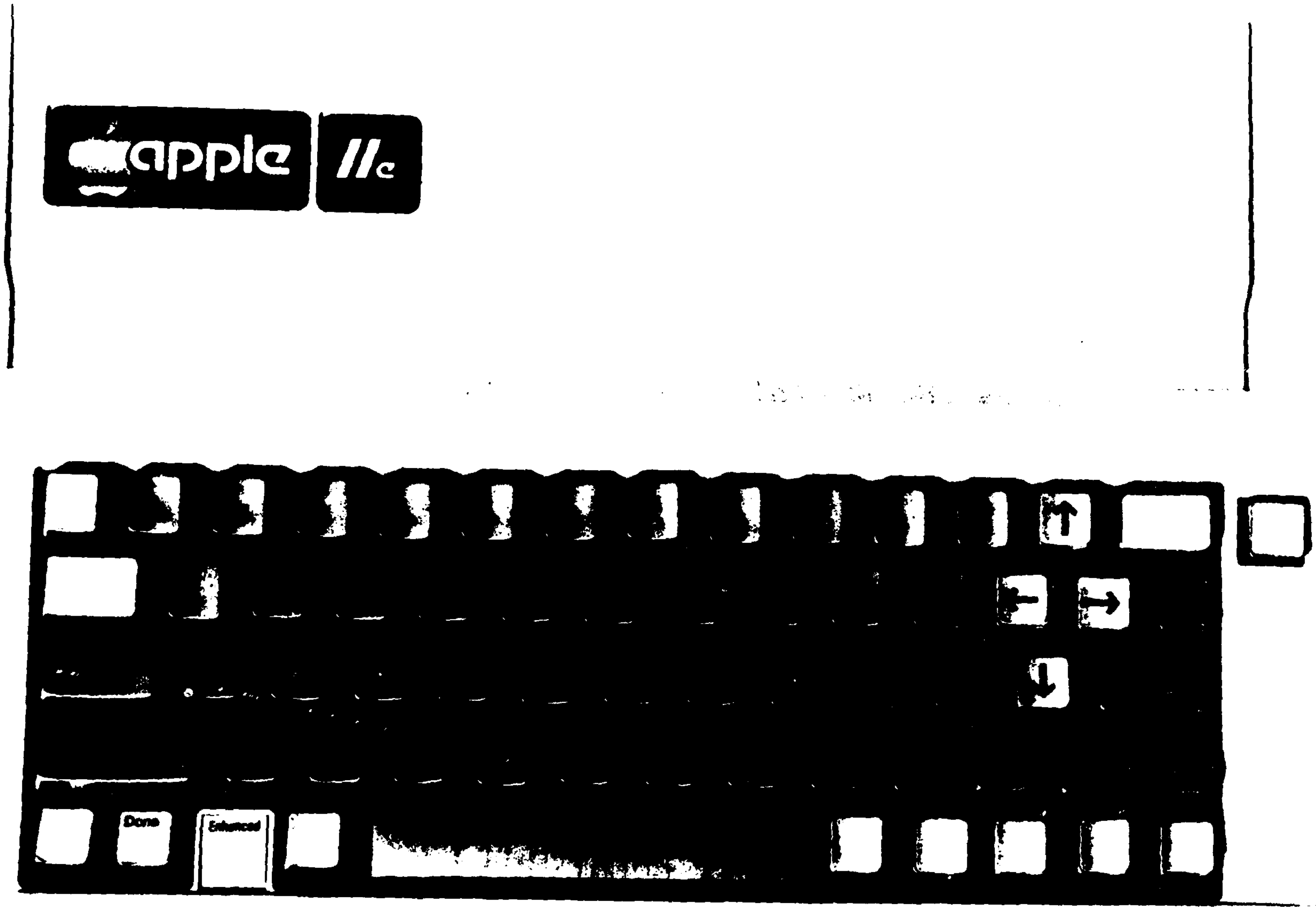


Figure 1. Modified Apple® IIe keyboard.

Displays. The 1-, 4-, 8-, 16-, and 23-line by 80-character window heights were generated on the Apple® monitor by a program that was written in Applesoft® BASIC specifically for this study. The program ran on ProDos® (Professional disk operating system). The stimulus messages were oriented on the display so that the first line of each message was presented at the upper left-hand corner of the screen. This is the position where people expect to see the first line of text (Neal & Darnell, 1984; Waern & Rollenhagen, 1983). The resulting combination of window heights and upper-line positioning of stimulus messages on the 23-line Apple® monitor meant that there were 22, 19, 15, 7, and 0 blank, or unused, lines of screen below the stimulus message on each trial for the 1-, 4-, 8-, 16-, and 23-line window height conditions. Figures 2 and 3 show the screen designs for the 4- and 23-line window height conditions.

Editor. The subjects used four editing techniques from the Portable WordStar® word processing system (Portable WordStar® Reference Manual, 1984). These techniques were insert character, insert word, delete character, and delete word. The techniques were written into the test software program and functioned exactly like the techniques in Portable WordStar®.

To insert a character or word, the subject pressed the Control and V keys at the same time. The subject then typed in the desired characters and the characters were inserted at the cursor position while the rest of the line was pushed to the right. To delete a character, the subject pressed the Control and G keys at the same time. This action deleted the character at the cursor position and caused the rest of the line to move to the left to fill in the resulting space. To delete a word, the subject pressed the Control and T keys at the same time. This action deleted the word at the cursor position and caused the rest of the line to move to the left to fill in the resulting space. A subject could scroll line by line through a stimulus message by pressing either the up or down cursor key continuously.

Tasks. Three sets of tasks were used in this experiment. The tasks were combinations of four types of revisions by three message lengths by three locations of revision type. These 36 combinations were repeated twice and then presented on 72 different stimulus messages so that a task set contained a fixed sequence of 72 different editing tasks. The three task sets differed only in the random order in which the 72 editing tasks were presented. Subjects were randomly assigned to a given task set so that two subjects within each window height condition worked with each set of tasks.

As mentioned earlier, the four types of revision were insert character insert word, delete character, and delete word. The three lengths of stimulus messages were short (1 line), medium (10-15 lines), and long (23 lines). The text for the messages was taken from articles in a selection of volumes of Reader's Digest. These message lengths and types were considered to be representative of the lengths and types that people typically enter on various sizes of visual display screens and were similar to lengths and types used by other researchers in similar studies (Sullivan & Chapanis, 1983). The three locations of revision type were beginning,

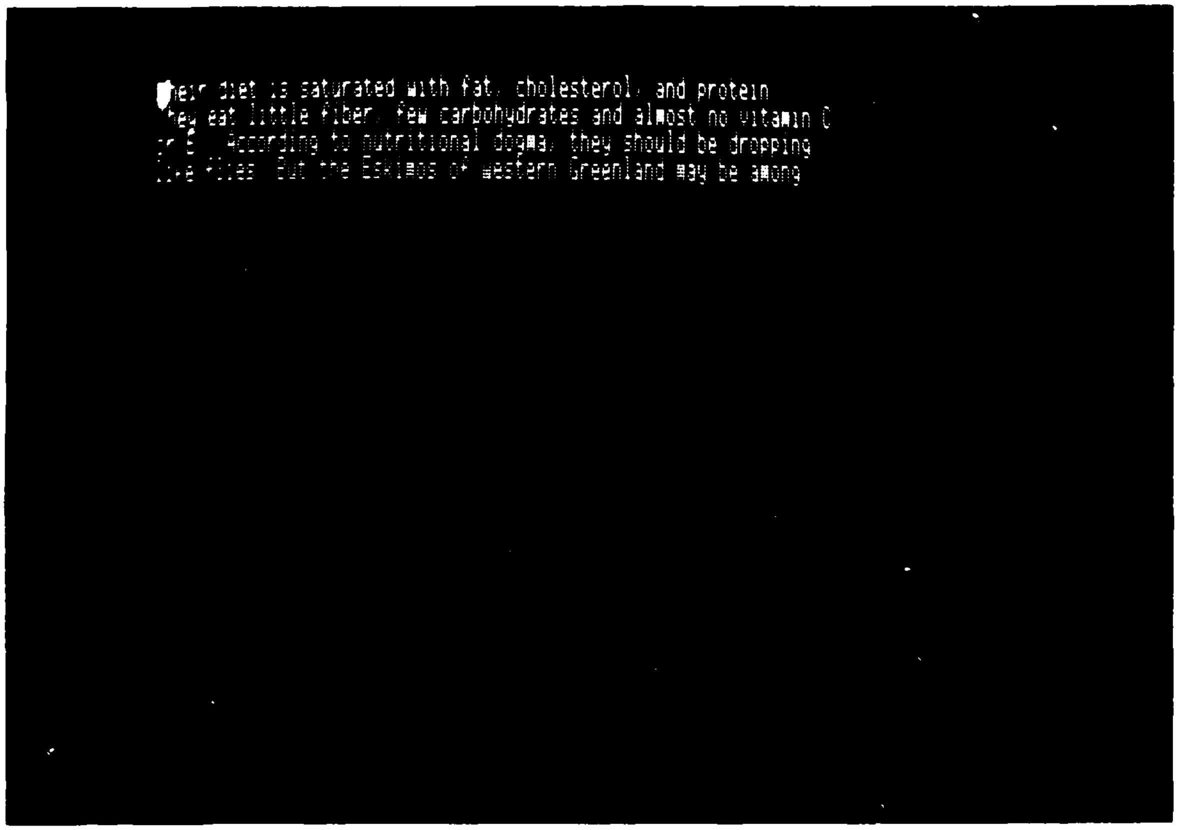


Figure 2. Screen design for 4-line window height.

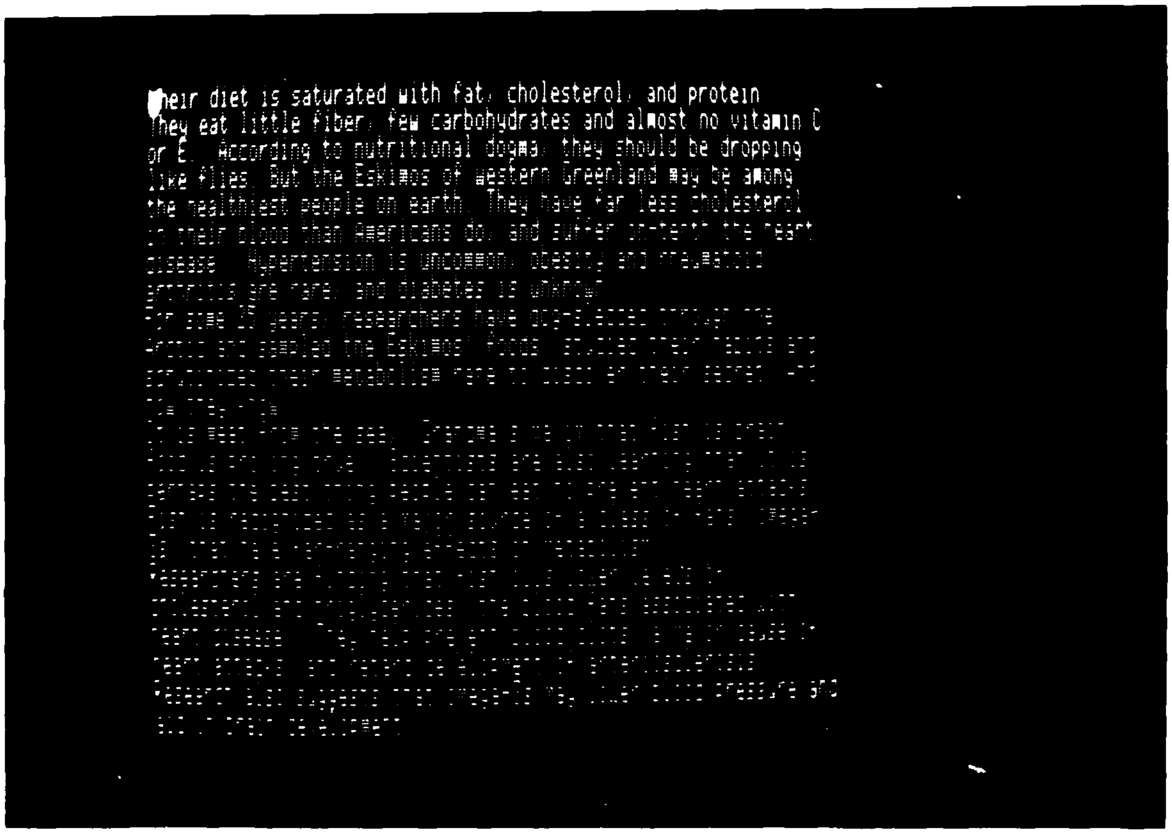


Figure 3. Screen design for 23-line window height.

middle, and end of a stimulus message. These levels of revision location were defined as the initial one-third, second one-third, and latter one-third of the total number of words within the message.

Each of the 72 stimulus messages was presented to the subjects both on an 8-1/2 by 11-inch sheet of paper and on the Apple® monitor. The paper versions were printed in boldface using an Epson® FX-100+ printer. Because there were one inch left and right margins on each printed sheet, each stimulus message contained a maximum of 65 characters per line. The lines of text were single spaced and paragraph indentations were not shown. Each printed sheet was marked with a single handwritten editing comment where the revision was to be made by the subject. An example of a medium-length stimulus message with its needed revision is shown in Figure 4. All 72 sheets were placed in a three-ring binder.

When each stimulus message was displayed on the Apple® monitor, the cursor was always positioned at the upper left-hand corner of the message. In all other ways, the stimulus message on the monitor was identical to the format and content of the printed stimulus message.

Questionnaires. Two questionnaires were used to assess subjects' attitudes toward computers in general and toward the use of computers as used in the present experiment. The preexperimental questionnaire consisted of 15 pairs of bipolar adjectives assembled in a semantic differential format designed to assess the subjects' general attitudes toward computers. The particular adjectives used were selected from a previous study of attitude assessment (Zoltan & Chapanis, 1982).

The postexperimental questionnaire was comprised of two parts. The first part consisted of the same 15 bipolar pairs of adjectives as the preexperimental questionnaire. This part of the postexperimental questionnaire differed from the preexperimental questionnaire only in that a new random order of presentation was used both within and among the adjective pairs. The second part of the postexperimental questionnaire consisted of 19 Likert-type statements and 1 choice selection item. These 20 questions were designed to assess the subjects' attitudes toward the editing task and toward the physical characteristics of the window height condition to which they had been assigned. Both the pre- and the postexperimental questionnaire are presented in Appendix A.

Procedure

Window height and message length were manipulated in a one between- and one within-subjects design (see Table 1). Window height was the between subjects variable; message length, the within subjects variable. Subjects were randomly assigned to the five window-height conditions. To insure that all subjects received the same instructions, the experimenter referred to detailed written instructions throughout the test session (see Appendix B). Before the subject interacted with the Apple® IIe computer, he or she

In Ireland there are two main types of stcne wall. Double walls are sturdier and easier to build, with the two parallel stacks of stone tending to support each other and a loose filling of spall in between. But the single wall is more spectacular -- a delicate fretwork running acoss the fields, with gaps through which the passer-by can see greens and golds and the dancing of the sunlight on the sea. The walls are, of course, a necessity; no one builds them for sport. They are a place to put stones cleared from the fields. They also serve as a windbreak against North Atlantic storms, holding down the arable soil that island families have created over generations by hauling baskets of sand and seaweed up from the water and spreading them out on bare rock.

INSERT THE CHARACTER "r"

Figure 4. Medium-length stimulus message with handwritten editing comment.

TABLE I

Experimental Design

		Message Length (lines of text)		
		Short	Medium	Long
	1	S_1, S_2, S_3, S_4, S_5, S_6	S_1, S_2, S_3, S_4, S_5, S_6	S_1, S_2, S_3, S_4, S_5, S_6
	4	S_7, S_8, S_9, S_{10}, S_{11}, S_{12}	S_7, S_8, S_9, S_{10}, S_{11}, S_{12}	S_7, S_8, S_9, S_{10}, S_{11}, S_{12}
Window Height (lines of screen)	8	S_{13}, S_{14}, S_{15}, S_{16}, S_{17}, S_{18},	S_{13}, S_{14}, S_{15}, S_{16}, S_{17}, S_{18},	S_{13}, S_{14}, S_{15}, S_{16}, S_{17}, S_{18},
	16	S_{19}, S_{20}, S_{21}, S_{22}, S_{23}, S_{24}	S_{19}, S_{20}, S_{21}, S_{22}, S_{23}, S_{24}	S_{19}, S_{20}, S_{21}, S_{22}, S_{23}, S_{24}
	23	S_{25}, S_{26}, S_{27}, S_{28}, S_{29}, S_{30}	S_{25}, S_{26}, S_{27}, S_{28}, S_{29}, S_{30}	S_{25}, S_{26}, S_{27}, S_{28}, S_{29}, S_{30}

was given a brief description of the study and then asked to complete a consent form (see Appendix C). The experimenter then asked the subject some questions about his or her background that were designed to gain information about the subject's experience with typewriter keyboards and computers (see Appendix D). After the background information was collected, the subject was asked to complete the preexperimental questionnaire.

After the subject completed the preexperimental questionnaire, he or she was escorted to a soundproof test room. The subject was asked to sit in front of the Apple® IIe computer screen and the experimenter sat to the right of the subject. The binder containing the printed stimulus messages for the demonstration session was placed on an easel at the subject's right. The experimenter explained how to use the keyboard and how to use the loose-leaf binder that contained the stimulus messages. The subject received a demonstration of the editing techniques and was shown how to use the cue card that described the editing techniques. At any time throughout the experiment, the subject could refer to the cue card if help was needed in remembering how to use an editing technique.

After the demonstration was over, the experimenter removed the binder containing the demonstration messages from the easel and replaced it with the binder containing practice messages. The subject was then asked to complete the eight practice problems. During the practice session, the experimenter remained in the test room with the subject and answered any questions that the subject had about the test equipment, procedures, and materials. When the subject completed the practice set, the experimenter replaced the practice binder with the binder containing the 72 test stimulus messages and then left the subject to work alone in the test room.

The subject turned to the first page in the binder to see a printed copy of the first stimulus message and pressed the Return key to see the same message displayed on the Apple® monitor. The subject moved the cursor to the revision point in the stimulus message and then made the same revision that was shown on the page in the binder to the text presented on the screen. A single revision was made on each stimulus message. When the first message was completed the subject pressed the Done key and then turned to the next page in the binder. A prompt on the screen instructed the subject to press the Return key so that the next message to be edited would be displayed on the screen. The subject made the required revision, and then pressed the Done and Return keys. The rest of the messages in the binder were completed the same way. The procedure is similar to one used by other researchers (Neal & Darnell, 1984).

The dependent variables of speed and accuracy were recorded automatically by the Thunderclock Proclock® and were used to assess subject performance. Overall editing time, locating time, revising time, and an accuracy measure for the editing task were recorded for each of the 72 trials. Overall editing time was the time between the moment a stimulus message first appeared on the screen to the time the subject pressed the Done key. Locating time was the time between the presentation of the message on the screen and the first keystroke of a noncursor, or editing key. This time then reflected the time it took to position the cursor at the revision point. Revising time was the time between the first keystroke of the editing action and the pressing of the Done key.

Errors were insertion or deletion tasks that the subject failed to complete correctly on the screen. Any errors that the subject made and then corrected during the trial were not identified but had an influence on the overall editing time. The types and definitions of dependent variables were similar to those used by other researchers (Neal & Darnell, 1984).

Following the completion of all 72 editing tasks, the subject returned to the questionnaire room and completed the postexperimental questionnaire.

Chapter 3

Results and Discussion

Four different sets of data were statistically analyzed. The first set of data consisted of the performance measures of locating time, editing time, total time, and accuracy. These measures were collected as the subjects interacted with the computer. The second set of data was the subjects' responses to the 15 semantic differential items that were collected both before and after they interacted with the computer. The third set of data was the subjects' responses to the 19 Likert scale statements that were collected in Part II of the postexperimental attitude questionnaire. The fourth set of data was the subjects' responses to the window height selection items that was the last question in Part II of the postexperimental attitude questionnaire.

Effects on Performance

Before the performance data were statistically analyzed, they were combined to form four derived dependent variables. As previously described, the editing revisions were presented to the subjects in three different message lengths. Each subject edited 24 short messages, 24 medium messages, and 24 long messages. For each subject, a single mean value was calculated for locating, editing, and total time and for accuracy within each of the message length conditions. Therefore, a total of 12, rather than 288, observations were examined for each subject.

A one between- and one within-subjects multivariate analysis of variance (MANOVA) was conducted on the performance data. The between-subjects factor was the window height variable; the within-subjects factor was the message length variable. A MANOVA was used because 86% of the intercorrelations among the 12 observations were statistically significant.

The analysis did not yield a significant main effect for window height or a significant interaction effect between window height and message length; however, a significant main effect for message length was obtained, $F(8, 96) = 7.12$, $p < .001$. To determine which of the dependent variables contributed to the significant message length MANOVA effect, individual one between- and one within-subjects univariate analyses of variance (ANOVA) were conducted. Examination of the univariate ANOVAs indicated that there are no significant effects for the mean editing time and accuracy measures. The overall mean for editing time was 8.03 seconds and the overall mean for accuracy was 97% correct. The univariate ANOVAs did reveal significant effects for mean locating time, $F(2, 50) = 48.50$, $p < .001$, and for mean total time, $F(2, 50) = 31.78$, $p < .001$.

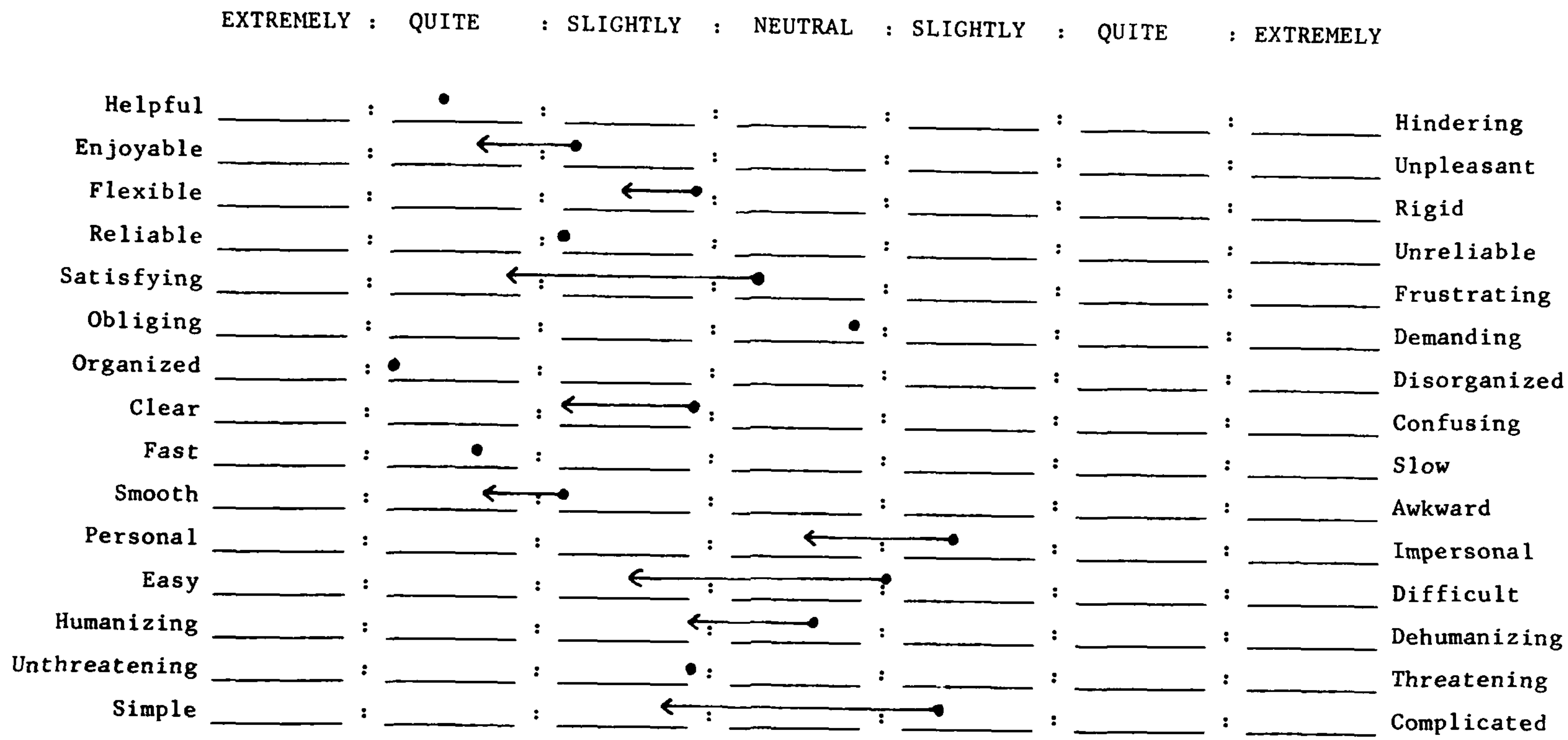
Tukey post-hoc analyses on the mean locating times for message length revealed significant differences between the means for short and medium messages, $q(3, 50) = 6.17$, $p < .01$, between the means for short and long messages, $q(3, 50) = 8.84$, $p < .01$, and between the means for medium and long messages, $q(3, 50) = 2.66$, $p < .05$ (Ms = 14.84, 21.01, and 23.67 seconds for the short, medium, and long messages). A Tukey test performed on the mean total times revealed significant differences between the means for the short and medium messages, $q(3, 50) = 7.43$, $p < .01$, and between the means for the short and long messages, $q(3, 50) = 8.70$, $p < .01$, but not between the means for the medium and long messages (Ms = 22.49, 29.93, and 31.20 seconds for the short, medium, and long messages).

Taken together, these analyses do not indicate that speed or accuracy is affected by varying the size of the window height of a computer screen when users perform simple text-editing tasks. Likewise, editing time and accuracy are not influenced by the length of the message in which an editing correction needs to be made. The length of a message, however, does affect the time it takes a person to locate an editing error, and, as a consequence, the time it takes to complete an editing task. Locating an error in a 1-line message takes a person approximately two-thirds the time it takes a person to locate an error in either a 10 to 15-line or a 23-line message. This finding indicates that locating time is largely a function of visual scanning, rather than of cursor movement. Furthermore, the lack of significant window height or interaction effects on either the time or the accuracy measures indicates that such scanning is not restricted when a user must search through a message that can only be seen one line at a time.

Effects on Attitudes

Semantic differential items. A one between- and within-subjects MANOVA was performed on the subjects' responses to the 15 semantic differential items. Window height was the between-subjects factor; time of presentation (pre-, postexperimental), the within-subjects factor. The analysis revealed no significant effect for window height or for the interaction between window height and time. The lack of a significant window height effect indicates that there is no evidence that subjects exposed to one or only a few lines of text at a time felt any less positive about computers than did subjects exposed to full screens of text. Furthermore, the lack of a significant interaction effect indicates that attitudes toward computers were equally distributed among the window height conditions both before and after their interactions with the computer.

The MANOVA did reveal a significant effect for time of presentation, $F(15, 11) = 3.97$, $p < .01$. Individual univariate ANOVAs indicated significant pre-, postexperimental differences for 9 of the 15 adjective pairs. The overall pre- and postexperimental means for all 15 adjective pairs are presented in Figure 5. In general, as shown in Figure 5, the subjects' attitudes toward computers were more favorable following their interactions with the computer. Not one postexperimental mean was on the negative side of any adjective pair.



Note. Enclosed circles (•) represent the preexperimental attitude means on each scale. A line with an arrowhead indicates that attitudes changed significantly from the pre- to the postexperimental measurement on that particular scale. Arrowheads represent the postexperimental means for these attitude scales. Attitude scales appear in the order used for the preexperimental measurement. The order of adjectives within the bipolar pairs has been rearranged *so* that the more positive adjective always appears in the left-hand column and the more negative adjective appears in the right-hand column.

Figure 5. Mean responses to pre- and postexperimental attitude questionnaires.

Likert scale items. A one-way MANOVA with window height as the between-subjects factor was performed on the subjects' postexperimental responses to the 19 Likert scale items. The analysis revealed no significant effect for window height. The overall means for all 30 subjects for each of the 19 questionnaire items are presented in Table 2. As shown in Table 2, the subjects' attitudes toward the computer were generally favorable. Not one of the mean values was on the negative side of the scale.

Window height selection item. The last question in the postexperimental questionnaire was a discrete selection item that asked the subjects which window height they would prefer to use if they had the choice. The possible choices were the five window heights examined in the present study: 1, 4, 8, 16, or 23 lines. A chi-square performed on the data did not reveal a significant effect. Subjects' preferences for window heights on computer screens were scattered among the five choices such that, regardless of prior condition, no one window height was favored any more or less by the subjects.

TABLE 2

Mean Responses to Likert Scale Questionnaire Items

Questionnaire Item	Mean
1. When I changed information in a one-line message, finding information on the screen was extremely easy - extremely difficult.	1.30
2. When I changed information in a medium-length message, finding information on the screen was extremely easy - extremely difficult.	1.87
3. When I changed information in a full-length message, finding information on the screen was extremely easy - extremely difficult.	2.13
4. When I changed information in a one-line message, the amount of information I could see on the screen was extremely comfortable - extremely cumbersome.	1.33
5. When I changed information in a medium-length message, the amount of information I could see on the screen was extremely comfortable - extremely cumbersome.	1.87
6. When I changed information in a full-length message, the amount of information I could see on the screen was extremely comfortable - extremely cumbersome.	2.37
7. When I changed information in a one-line message the amount of information I could see on the screen was extremely adequate - extremely inadequate.	1.30
8. When I changed information in a medium-length message, the amount of information I could see on the screen was extremely adequate - extremely inadequate.	1.83
9. When I changed information in a full-length message, the amount of information I could see on the screen was extremely adequate - extremely inadequate.	2.03

(Continued)

TABLE 2 (Continued)

Mean Responses to Likert Scale Questionnaire Items

Questionnaire Item	Mean
10. Inserting characters on the screen was extremely easy - extremely difficult.	1.40
11. Inserting words on the screen was extremely easy - extremely difficult.	1.53
12. Deleting characters on the screen was extremely easy - extremely difficult.	1.27
13. Deleting words on the screen was extremely easy - extremely difficult.	1.23
14. When I changed information in a one-line message, I could remember my place in the information on the screen.	1.50
15. When I changed information in a medium-length message, I could remember my place in the information on the screen.	1.80
16. When I changed information in a full-length message, I could remember my place in the information on the screen.	2.03
17. When I changed information in a one-line message, I felt confident that I had made the correct change on the screen.	1.30
18. When I changed information in a medium-length message, I felt confident that I had made the correct change on the screen.	1.40
19. When I changed information in a full-length message, I felt confident that I had made the correct change on the screen.	1.47

Note. Means could range from 1 to 7, with 4 indicating neutrality. For items 1 through 13, values less than 4 indicate various shades of agreement with the positive modifier beneath each question; values greater than 4 indicate various shades of agreement with the negative modifier beneath each question. For items 14 through 19, values less than 4 indicate various shades of agreement with the statement; values greater than 4 indicate various shades of disagreement with the statement.

Chapter 4

Conclusions

The purpose of this study was to examine the combined effects of window height and message length on text-editing tasks to determine if smaller screen sizes limit user performance. The results of the experiment indicate that user speed and accuracy are not differentially affected when the amount of information the user can see on the screen at one time is varied. If a user's speed in completing a text-editing task is affected at all, it is affected not by the limitations of the screen size, but rather by the length of the message in which an error needs to be corrected. People take longer to reposition the cursor, and hence to locate an error, when a message is medium to long in length (either 10-15 or 23 lines long) as opposed to short in length (1-line long). The difference in locating times between long and short messages seems reasonable considering that it should take longer to reposition a cursor farther from the cursor's original position than to reposition a cursor closer to its original position. These results suggest that a large component of locating time is comprised of visual scanning and planning rather than of physical movement of the cursor.

Because the effects of window height on text-editing performance have been examined previously, comparisons can be made between the results of those studies and those of the present study. In Neal and Darnell's (1984) first experiment and in the present experiment, no performance differences were found among the various window height conditions. In Elkerton and Williges' study (1984) and in Neal and Darnell's second experiment, however, performance differences were found among window-height conditions. Elkerton and Williges suggest that when users interact with a screen limited to a 1-line window height, they take longer to locate information in text than when they interact with a screen allowing a 7-, 13-, or 19-line window height. Similarly, Neal and Darnell found that subjects spent more time locating information when the window height was limited to 20 lines of text as opposed to 60 lines of text.

Elkerton and Williges attributed their subjects' performance decrement to their tendencies to become lost within text when they can only see one line of text at a time on the computer screen. Neal and Darnell, however, attributed the locating time difference more to strategies used to reposition the cursor rather than to users becoming disoriented. Neal and Darnell suggested that Elkerton and Williges' subjects tended to become disoriented with the one-line window height screen more as a consequence of the experimental procedure than of reality. In the Elkerton and Williges study, subjects were repeatedly and randomly rotated from one window-height condition to the next within the course of the experiment. In contrast, subjects in both of Neal and Darnell's experiments, although also repeatedly tested, worked with the various window-height screens in a series of counterbalanced blocks.

The differences in results between the present study and those of the aforementioned studies can best be explained by examining the two ways in which the procedures of those studies differed from those of the present study. First, each subject in the present study was tested within one and only one window-height condition rather than repeatedly. The decision to use a between-subjects rather than a within-subjects comparison was based on the observation that in a true working environment one would complete a document, and hence a series of revisions within that document by using the same computer. Given that a single computer has the capacity to consistently display the same number of lines of text each time one uses it, a between-subjects comparison more realistically mirrors what occurs in a typical working environment. Furthermore, when a user makes text-editing revisions on a screen by referring to a paper document, he or she usually starts at the beginning of the paper and works through to the end. Therefore, a user's tendencies to become lost in the document when they use a single-line display, as with Elkerton and Williges' procedure, would be unlikely in a true working environment.

Second, unlike Neal and Darnell's subjects, subjects in the present study were instructed on how to locate an editing error in only one way--using the cursor keys. Thus, differences in locating time between 1-line and greater-line window-height conditions would not occur in the present study if such differences, as Neal and Darnell suggest, are primarily a function of differences in locating strategies.

Taking these two arguments together, it is not surprising that users' performance in the present study was not adversely affected by the smaller window heights. It would appear that when users have the opportunity to repetitively use a particular computer screen's window height they adapt to that window height regardless of its size limitations.

The results of the attitude data analyses were unexpected. Subjects felt favorably toward the editing task and computers regardless of the window height with which they worked. Subjects' reactions toward computers in general became more positive following their interactions with the various window-height computer screens. Subjects neither all preferred the largest window height nor the window height screen they had used. Regardless of prior exposure within the experiment, the subjects favored each of the tested window heights about equally.

Taken together, the results of the present experiment lead to several conclusions. First, in tasks involving simple text-editing revisions where users work from paper onto a computer screen, screens of different window heights do not differentially influence the users' speed or accuracy. Second, regardless of the window height of the computer screen that they use, there is no evidence that attitudes toward the computer are differentially affected. And third, given a well-defined, simple to execute task, users of computers, regardless of the screen's window height, will feel more positively toward computers after, as opposed to before, their interactions with that computer.

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APPENDIX A

PRE- AND POSTEXPERIMENTAL ATTITUDE QUESTIONNAIRES

PREEXPERIMENTAL QUESTIONNAIRE

The following page has pairs of adjectives separated by dashes and colons. These dashes correspond to various degrees of intensity of opinion as shown by the words Extremely, Quite, Slightly, and Neutral at the top of the page. Please use these adjectives to give your frank opinion of electronic computers. Between each pair of words, put one (and <u>only</u> one) check mark where it most accurately reflects your opinion.

For example, if you were to see the adjectives "good" and "bad," and you feel that electronic computers are quite good, mark the sheet this way:

	Extremely:	Quite :	Slightly:	Neutral :	Slightly:	Quite :	Extremely	
Good	________ :	___✓___ :	________ :	________ :	________ :	________ :	________	Bad

However, if you think that computers are extremely bad, mark the sheet this way:

Good	________ :	________ :	________ :	________ :	________ :	________ :	___✓___	Bad

If you feel that computers are neither good nor bad, put a check mark on the middle dash of that line.

IMPORTANT:

1. Please respond to every set of adjectives even if some of them do not seem to describe computers exactly. Do not skip any.

2. Put each check mark on a dashed line between colons. NOT on a colon.

3. Remember to use only one check mark for each pair of adjectives.

IN MY OPINION, COMPUTERS ARE....

	EXTREMELY	QUITE	SLIGHTLY	NEUTRAL	SLIGHTLY	QUITE	EXTREMELY	
Hindering	____	____	____	____	____	____	____	Helpful
Unpleasant	____	____	____	____	____	____	____	Enjoyable
Flexible	____	____	____	____	____	____	____	Rigid
Reliable	____	____	____	____	____	____	____	Unreliable
Satisfying	____	____	____	____	____	____	____	Frustrating
Demanding	____	____	____	____	____	____	____	Obliging
Organized	____	____	____	____	____	____	____	Disorganized
Clear	____	____	____	____	____	____	____	Confusing
Fast	____	____	____	____	____	____	____	Slow
Smooth	____	____	____	____	____	____	____	Awkward
Impersonal	____	____	____	____	____	____	____	Personal
Difficult	____	____	____	____	____	____	____	Easy
Dehumanizing	____	____	____	____	____	____	____	Humanizing
Threatening	____	____	____	____	____	____	____	Unthreatening
Simple	____	____	____	____	____	____	____	Complicated

POSTEXPERIMENTAL QUESTIONNAIRE: PART I

The following page has pairs of adjectives separated by dashes and colons. The dashes correspond to various degrees of intensity of opinion as shown by the words Extremely, Quite, Slightly, and Neutral at the top of the page. Please use these adjectives to give your frank opinion of electronic computers. Between each pair of words, put one (and only one) check mark where it most accurately reflects your opinion.

For example, if you were to see the adjectives "good" and "bad," and you feel that electronic computers are quite good, mark the sheet this way:

	Extremely	Quite	Slightly	Neutral	Slightly	Quite	Extremely	
Good	________	✓	________	________	________	________	________	Bad

However, if you think that computers are extremely bad, mark the sheet this way:

Good	________	________	________	________	________	________	✓	Bad

If you feel that computers are neither good nor bad, put a check mark on the middle dash of that line.

IMPORTANT:

1. Please respond to every set of adjectives even if some of them do not seem to describe computers exactly. Do not skip any.
2. Put each check mark on a dashed line between colons. NOT on a colon.
3. Remember to use only one check mark for each pair of adjectives.

IN MY OPINION, COMPUTERS ARE ....

	EXTREMELY	QUITE	SLIGHTLY	NEUTRAL	SLIGHTLY	QUITE	EXTREMELY	
Awkward								Smooth
Personal								Impersonal
Disorganized								Organized
Humanizing								Dehumanizing
Unreliable								Reliable
Fast								Slow
Hindering								Helpful
Difficult								Easy
Flexible								Rigid
Unpleasant								Enjoyable
Satisfying								Frustrating
Simple								Complicated
Obliging								Demanding
Threatening								Unthreatening
Clear								Confusing

POSTEXPERIMENTAL QUESTIONNAIRE: PART II

The following statements ask about your opinions on this study. Each statement has seven response choices below it. Please check the response that best describes your opinion about each statement.

Please respond to every statement. If you have no opinion about a statement, please do not leave it blank. Rather, place a check on the line for NEUTRAL.

1. When I changed information in a one-line message, finding information on the screen was

Extremely Easy	Easy	Slightly Easy	Neutral	Slightly Difficult	Difficult	Extremely Difficult

2. When I changed information in a medium-length message, finding information on the screen was

Extremely Easy	Easy	Slightly Easy	Neutral	Slightly Difficult	Difficult	Extremely Difficult

3. When I changed information in a full-length message, finding information on the screen was

Extremely Easy	Easy	Slightly Easy	Neutral	Slightly Difficult	Difficult	Extremely Difficult

4. When I changed information in a one-line message, the amount of information I could see on the screen was

Extremely Comfortable	Comfort-able	Slightly Comfortable	Neutral	Slightly Cumbersome	Cumbersome	Extremely Cumbersome

5. When I changed information in a medium-length message, the amount of information I could see on the screen was

Extremely Comfortable	Comfort-able	Slightly Comfortable	Neutral	Slightly Cumbersome	Cumbersome	Extremely Cumbersome

6. When I changed information in a full-length message, the amount of information I could see on the screen was

Extremely Comfortable	Comfort-able	Slightly Comfortable	Neutral	Slightly Cumbersome	Cumbersome	Extremely Cumbersome

7. When I changed information in a one-line message, the amount of information I could see on the screen was

Extremely Adequate	Adequate	Slightly Adequate	Neutral	Slightly Inadequate	Inadequate	Extremely Inadequate

8. When I changed information in a medium-length message, the amount of information I could see on the screen was

Extremely Adequate	Adequate	Slightly Adequate	Neutral	Slightly Inadequate	Inadequate	Extremely Inadequate

9. When I changed information in a full-length message, the amount of information I could see on the screen was

Extremely Adequate	Adequate	Slightly Adequate	Neutral	Slightly Inadequate	Inadequate	Extremely Inadequate

10. Inserting characters on the screen was

Extremely Easy	Easy	Slightly Easy	Neutral	Slightly Difficult	Difficult	Extremely Difficult

11. Inserting words on the screen was

Extremely Easy	Easy	Slightly Easy	Neutral	Slightly Difficult	Difficult	Extremely Difficult

12. Deleting characters on the screen was

Extremely Easy	Easy	Slightly Easy	Neutral	Slightly Difficult	Difficult	Extremely Difficult

13. Deleting words on the screen was

Extremely Easy	Easy	Slightly Easy	Neutral	Slightly Difficult	Difficult	Extremely Difficult

14. When I changed information in a one-line message, I could remember my place in the information on the screen.

Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

15. When I changed information in a medium-length message, I could remember my place in the information on the screen.

Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

16. When I changed information in a full-length message, I could remember my place in the information on the screen.

Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

17. When I changed information in a one-line message, I felt confident that I had made the correct change on the screen.

Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

18. When I changed information in a medium-length message I felt confident that I had made the correct change on the screen.

Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

19. When I changed information in a full-length message I felt confident that I had made the correct change on the screen.

Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree

20. If I had my choice, I'd want a computer screen to display the following number of lines of information:

1 Line	4 Lines	8 Lines	16 Lines	23 Lines

APPENDIX B

INSTRUCTIONS FOR THE SUBJECTS

WELCOME AND THANK YOU FOR COMING TODAY! This study will investigate people's abilities to use computer screens and keyboards. We are interested in understanding how people interact with computer screens. After answering an initial questionnaire about computers, I will show you how to change information on the screen and then you will make changes to information on the screen. The information you see on the screen will also be printed on sheets of paper. These sheets will show you what changes you are tc make by using the keyboard. When you have finished making changes to the information on the screen you will be asked to complete a second questionnaire about computers. Your answers on the questionnaires and your responses on the computer screen will be kept confidential. The entire test session will last about 2 hours. Do you have any questions? If you would like to participate in this study, please read and then sign this consent form. (Hand the consent form to the person)

(BACKGROUND INFORMATION)

Now I would like to ask you a few questions about your experience with computers. (Ask the person the questions on the Background Information sheet and fill in their answers)

(FIRST QUESTIONNAIRE)

Now I would like you to fill out this questionnaire. Please read the instructions at the beginning of the questionnaire.

Do you have any questions about how to fill out the questionnaire? If not, please take a few minutes now to complete the questionnaire. When you are finished please meet me outside. (Leave the person alone in the room)

(TRAINING SESSION)
(Introduction)

Now I will show you how to use the test equipment and how to use the test materials. After you feel that you understand how to use the equipment and the materials you may practice what you have learned by completing some problems that are similar to the problems you will do in the actual test session. (Turn on the test equipment so it can warm up)

(Training)

I will now explain how to use the keyboard to make changes on the screen. (Enter Subject ID#, select correct condition, and select Demo session)

These are the keys you will use to move this small square, or cursor as it is called. to the place on the screen where you want to make a change. The right arrow key moves the cursor to the right on the screen (Demonstrate); the left arrow key moves the cursor to the left on the screen (Demonstrate); the down arrow moves the cursor down the screen (Demonstrate); and the up arrow moves the cursor up the screen. Notice (Demonstrate) that when you use the right arrow cursor key to move the cursor all the way to the right side of the screen, if you want to then move the cursor down to the next line on the screen you must use the cursor down key. There may be times when the information on the sheets of paper is longer than the amount of information that you can see on the screen. When this happens, you should use the down arrow key to allow the computer to show you the rest of the information. Do you have any questions so far?

This notebook contains the sheets of paper with the changes you will make to the information on the screen by using the keyboard. The information on these sheets of paper will be different lengths. When I tell you to begin, you will open the notebook, turn to the first page to see what change you should make, and then make the change to the information on the screen. After you have made the change on the screen, you should press this key (point to the DONE key), which is the DONE key. This key tells the computer that you have finished making the change and are ready to see the next sheet of information on the screen.

Now I will explain how to use the keyboard to make changes to information on the screen. This is the CONTROL key (point to key). Each time you want to make a change on the screen, you will need to hold down this key AT THE SAME TIME that you press another key. I will explain how to do this in a moment.

There are 4 kinds of changes that you will be asked to make. These changes are INSERT CHARACTER, INSERT WORD, DELETE CHARACTER, and DELETE WORD. You can use this cue card (put out the cue card) to help you remember which keys to use to make these changes.

If you want to INSERT a letter, or CHARACTER as it is often called, you first use the cursor keys to get to the place on the screen where you want to make the change. You should put the cursor on the character to the right of the place where you want to insert the new character. Then you hold down the CONTROL key while you press the "V" key at the same time until you see the word "INSERT" at the bottom on the screen. After the word "INSERT" appears on the screen, you can let go of these two keys. Then you type in the character that is written on the sheet in the notebook. The character is inserted to the left of where the cursor is positioned. Then you press the DONE key.

I will now show you how to INSERT a CHARACTER. (Open the notebook, explain the handwritten editing comment on the sheet, and demonstrate how to make the change)

If you want to INSERT a WORD you first use the cursor keys, just like before, to get to the place on the screen where you want to make the change. You should put the cursor on the first character of the word that is directly to the right of where you want to insert the new word. Then you hold down the CONTROL key and press the "V" key at the same time until you see the word "INSERT" at the bottom of the screen. Then you type in the word that is written on the sheet in the notebook. You should type each character deliberately. If you type too quickly the keyboard will not accept your entries. The new word will be inserted to the left of where the cursor is positioned. Then you press the DONE key.

Now I will show you how to INSERT a WORD. (Turn to the next page, explain the handwritten editing comment, and show how to make the change) As you can see, the only difference between how to insert a character and how to insert a word is that when you insert a word you must type in more characters or letters.

If you want to DELETE a CHARACTER, you must first move the cursor to the place on the screen where you want to make the change. You should put the cursor directly on the character that you want to delete. Then you must hold down the CONTROL key and press the "G" key at the same time. Then you must press the DONE key.

I will now show you how to DELETE a CHARACTER. (Turn to the next page, explain the handwritten editing comment, and show how to make the change on the screen)

If you want to DELETE a WORD, you must first move the cursor to the place on the screen where you want to make the change. You should put the cursor directly on the first charcter of the word you want to delete. Then you must hold down the CONTROL key and press the "T" key at the same time. Then you must press the DONE key.

I will now show you how to DELETE a WORD. (Turn to the next page, explain the handwritten editing comment, and show how to make the change)

As I mentioned earlier, you can look at this cue card whenever you need help in remembering how to use the keyboard.

Do you have any questions on how to use the keyboard? Do you have any questions on how to use the notebook and the keyboard together to make changes to information you will see on the screen? If not, you are now ready to practice what you have just learned. I'll be here to answer questions during the PRACTICE session but when you do the actual test session you will be left in the room alone. So please feel free to ask as many questions as you like during the practice session. You may now open the PRACTICE notebook and work through the practice problems. (Now I will stay in the room and let the subject work through the practice session)

(TEST SESSION)

VERY GOOD! Now you are ready to begin the actual test session. Please work at your own speed but be as accurate and quick as you can. When you have finished working through the TEST notebook please meet me back in the room where you filled out the questionnaire. You may now open the TEST notebook and begin. (I will leave the room and go around the corner to watch the slave monitor. Before the person has completed all 72 trials, I will go back to the questionnaire room to be ready to meet him or her there)

(SECOND QUESTIONNAIRE)

GREAT! You are almost finished.

Now I would like for you to fill out this questionnaire. Please read the instructions on the first page of the questionnaire.

Do you have any questions on how to fill out Part I of the questionnaire? If not, please read the instructions for Part II of the questionnaire. Do you have any questions on how to fill out the questionnaire?

If not, please take your time and complete the questionnaire now. When you are finished filling out the questionnaire, please meet me outside. (Leave the person alone in the questionnaire room)

Thank you very much for your participation. I have enjoyed having you.

APPENDIX C

CONSENT FORM

DEPARTMENT OF THE ARMY
U.S. ARMY LABORATORY COMMAND
HUMAN ENGINEERING LABORATORY
ABERDEEN PROVING GROUND, MARYLAND 21005-5001

REPLY TO
ATTENTION OF

VOLUNTEER AGREEMENT

PROJECT: Computer Screen Research

PLACE: US Army Human Engineering Laboratory, Aberdeen Proving Ground, MD

PRINCIPAL INVESTIGATOR: Maureen M. Larkin

PURPOSE: This study will investigate people's abilities to use computer screens and keyboards. After answering an initial questionnaire about computers, you will be shown how to change information on the screen and then you will make changes to information on the screen. The information you see on the screen will also be printed on sheets of paper. These sheets will show you what changes you are to make, using the keyboard. When you have finished making changes to the information on the screen you will be asked to complete a second questionnaire about computers. Your answers on the questionnaires and your responses on the computer screen will be kept confidential. The entire test session will last about 2 hours.

CONSENT: My signature below certifies that this study has been explained to me by Ms. Larkin and that all my questions have been answered satisfactorily. I understand that there are no known physical or mental risks to me as a result of participating in this study. I voluntarily agree to participate and I understand that I may decline to participate or withdraw from the study at any time without penalty.

SIGNATURE: ______________________________ DATE: ________________________

NAME: ______________________________
PLEASE PRINT

APPENDIX D

BACKGROUND INFORMATION SHEET

BACKGROUND INFORMATION SHEET

SUBJECT ID #:_____ CONDITION:_____ ORDER #:____

NAME:_______________________________________

1. What is your profession? ________________________________

2. Have you ever used a typewriter? ____ YES ____ NO

   If yes, do you use a typewriter where you work?

   ____ YES ____ NO

   If you use a typewriter where you work, how much do you use it?

   ____ VERY OFTEN ____ FREQUENTLY ____ SELDOM

3. Is there a computer where you work? ____ YES ____ NO

   If yes, have you ever used it? ____ YES ____ NO

   If yes, how much have you used it?

   ____ VERY OFTEN ____ FREQUENTLY ____ SELDOM

4. Have you ever --

   Written your own program(s)? ____ YES ____ NO

   If yes, have you used a program that you wrote?

   ____ YES ____ NO

   Used a program written by someone else?

   ____ YES ____ NO

   Used a word processor to write a letter or a report?

   ____ YES ____ NO

   If yes, which word processing program? ____________

   Had someone else (or a computer facility) use a computer for you? ____ YES ____ NO

NOTES:____

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