The Effect Of Screen Boundary, Familiarity, and Data Type On User's Decision to Scroll or Window.

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When confronted with the task of moving information on a CRT display, what factors affect the decision to use a window or scroll method? This experiment examined 79 users' decisions to scroll or window based on the type of data, pattern, and movement on a CRT display. Subjects with experience in the control of data on a display preferred to scroll. A significantly greater proportion of users chose to scroll when they were familiar with the pattern displayed and when the movement was constrained within the boundary of the screen. The type of movement also significantly affected the time required to indicate whether the movement was due to scrolling or windowing.

INTRODUCTION

People manipulate objects. To closely examine something, people turn it repeatedly to get a "good look" at it. However, people will also control their own position when attempting to survey a large area or when direct control may seem impossible. For example, one gets the same "look at" a precious stone by manipulating its case or by walking around the pedestal on which the case rests. How do people prefer to see the gem?

We face a similar question in the control of information presented on a CRT display. Do people prefer to have control of their valuable data as if it had "handles" or should the CRT have "handles" with which to control the view of the data? Moving data in the first manner, i.e. as if it had "handles", is called scrolling. Viewing information on a CRT by apparently moving the CRT over the data is called windowing. Another description (Bury, Boyle, Evey, and Neal, 1982) of the difference between the scroll and window methods relates to how the objects of interest are found when using a microscope or a telescope. The slide containing the data moves (scrolls) under the microscope. The telescope is moved (windows) across the sky.

By knowing the conditions that lead people to choose the window or scroll method, the software designer can contribute to the ease of use of the system. This study investigates attributes of the information on a display that might affect the user's choice to window or scroll. The type of data on the display (alphanumeric or graphic), the user's familiarity with the context of the information, and the limit to the movement of data could be critical determinants to a user's decision.

Familiarity with the context can be defined in terms of the predictability of the elements in a pattern. The alphabet is in a familiar, predictable pattern. A convenient limit to movement is the boundary created by the edge of the display. The data may be limited to this boundary or it may extend beyond.

Bury, Boyle, Evey, and Neal (1982) used a familiar alphanumeric stimulus that extended beyond the screen boundary. They report that a significantly greater number of subjects chose to window when allowed to freely decide which method to use. In a paper and pencil test using familar graphic stimuli, pilot work suggested that subjects chose windowing with stimuli which extended beyond the screen boundaries. However, subjects chose to scroll with stimuli constrained within the screen boundaries.

The purpose of this experiment was to extend the research to 1) stimuli for which the subjects could have little or no familiarity with the stimulus patterns and 2) graphic systems. The basic question is whether the proportion of subjects choosing the window or scroll method for data movement significantly depends on the type of data (an alphanumeric or graphic context), familiarity with the pattern of the data, or the limit of movement (boundary).

METHOD

Subjects

A total of 79 IBM employees participated in this experiment. The subjects included secretarial, clerical, and DP and non-DP professionals. None of the subjects were totally unfamiliar with moving data on a CRT display.

Apparatus and Stimuli

An IBM Series/1, connected to an IBM Personal Computer with an IBM Color Display, was used to control the selection and presentation of the stimuli. This system also recorded the subjects' responses and an inter-response time.

The subjects responded on the cursor control keys of the Personal Computer keyboard. These control keys are in a starburst pattern. Only responses on the up, down, right, and left keys were permitted.

Eight different types of stimuli were generated based on the factorial combination of data type (alphanumeric or graphic), context (familiar or unfamiliar patterns), and boundary (data limited to on the screen or extending beyond the edge of the screen boundary). The alphanumeric stimuli consisted of a cross with the letters of the alphabet in a column and digits in a row. In the familiar stimuli, the letters and digits were in the expected order while in the unfamiliar stimuli the order of the letters and digits was randomized.

The familiar graphic stimuli were a "happy face" and a U.S. coastal map. The map extended beyond the screen such that about 25% of the coast was presented on any screen. When the map was moved, less than 50% of new coastline appeared. The first coastline that appeared in each set of stimuli was the southeast U.S which included the coast of Florida. The unfamiliar graphic stimuli were part of a map of a factory layout with all text removed. It also had the appearance of a programmer's flowchart.

Stimuli limited to on screen movement remained unchanged during a trial, but stimuli which extended beyond the screen always appeared to extend beyond the screen although the elements of the stimuli would change. That is, a portion of the display was never left blank simply because of a control movement. Approximately 40% of a display would move beyond the edge of the screen when movement off the screen occurred.

Procedure

Subjects were randomly assigned to one of eight groups as defined by the stimulus sets. Table 1 shows the number of subjects assigned to each group.

Table 1

Data Type: Alphanumeric

	Context: Familiar	Unfamiliar
Movement: On	8	8
Off	8	8

Data Type: Graphic

	Context: Familiar	Unfamiliar
Movement: On	8	8
Off	8	8

Each subject received eight trials. The trials were presented in two blocks of four trials with each block containing a trial for each of the control keys. The second block of trials consisted of stimuli with the same data type and movement but with the familiarity of the pattern changed. The stimuli were randomized within a block and the order of presentation was counterbalanced.

A trial consisted of a pair of stimuli. Subjects were allowed to view the first of the stimuli until they felt they could detect the movement of some or all of the picture on the screen. They indicated this by pressing the space bar on the Personal Computer keyboard. The second stimulus was immediately presented and the subject pressed the control key which would have produced the change from the first to the second stimulus.

Subjects were instructed to make the response that indicated how they would design a system to control the movement of information on a screen. The system automatically recorded the response and the latency between the press of the space bar and the selection of a control key. Subjects could repeat a trial as often as they wished by asking the experimenter.

Each subject was read a set of instructions and given two examples of the procedure to follow during the experiment.

RESULTS

Subjects were classified as scrollers or windowers on the basis of their responses during the first block of trials. Subjects were classified as scrollers if, on at least 3 trials in the block, they decided that the movement from the first stimulus to the second would have occurred by moving the data.

Similarly, windowers were classified as those subjects who indicated that the change would have occurred by moving the screen over the data.

Of the 79 subjects who participated in the study, 60 were classified as scrollers and only 4 chose to window. Of the 15 subjects remaining, 8 (classified as others) chose to scroll or window on half the trials. Those subjects that scrolled for one pair of opposite direction stimuli and windowed for the other did not appear to link scrolling or windowing with vertical or horizontal movement. The remaining seven subjects made at least two uninterpretable responses (e.g., responding "up" for a "left" trial). The data from these subjects were not used in any analysis.

The number of subjects classified as scrollers, windowers, and others was analyzed with the chi-square test of hypothesized population proportions. The result showed a significant difference, $X^2(2)=81.3$, $p<0.001$, (Bradley, 1976).

The remaining analyses were done only on the 64 subjects who could be classified as scrollers or windowers as defined above. The number of subjects who chose to window or scroll in the three conditions is displayed in Table 2.

The Fisher's exact probability test (Bradley, 1976) was conducted to test whether the proportion of scrollers to windowers differed significantly in the groups that saw a) alphanumeric or graphic data, b) familiar or unfamiliar patterns, and c) the data move only within the boundary of the screen or beyond it. The results showed that the exact probability for observing the proportion, or a more extreme one, of scrollers to windowers in the alphanumeric and graphics groups was p=0.396. Since similar proportions were obtained in the movement and pattern familiarity groups, the probability for each set of data is p=0.057.

Table 2

a)

	Data Type: Alphanumeric	Graphic
Scrollers	31	29
Windowers	1	3

p=0.396

b)

	Pattern: Familiar	Unfamiliar
Scrollers	32	28
Windowers	0	4

p=0.057

c)

	Movement: On screen	Beyond edge
Scrollers	32	28
Windowers	0	4

p=0.057

The median response latency for each block of trials was determined for each subject. A 4 factor analysis of variance (data type(2), movement(2), pattern(2), block(2)) was conducted. The block variable relates to the transfer from familiar to unfamiliar stimuli and vice versa. Three sources of variance were significant: movement on or beyond the screen boundary, $F(1,56)=34.5$, $p<0.01$; the interaction of movement with data type, $F(1,56)=3.98$, $p<0.05$; and the interaction of pattern with block of trials, $F(1,56)=8.09$, $p<0.01$. The data for the interactions is presented in Tables 3 and 4.

Table 3

		Movement: On Screen	Beyond
Data Type:	Graphic	4.4	1.7
	Alpha	4.1	2.3

Note: Mean response latency (sec.) for the graphic and alphanumeric stimuli by the type of movement that occurred during a trial.

Table 4

		Block: First	Second
Pattern:	Familiar	3.2	2.7
	Unfamiliar	3.6	2.9

Note: Mean response latency (sec.) for the familiar and unfamiliar patterns by whether they occurred as the first or second block of trials.

DISCUSSION

The purpose of this experiment was to answer the following questions about the control of information on a CRT display: (1) Do subjects prefer to control the movement of graphic information with the same rules that they use for controlling textual material? (2) Is a preference for scrolling or windowing dependent on previous knowledge (familiarity) about the data? (3) Does the movement of the data within the boundary of the screen or beyond its edge affect the decision to window or scroll?

The results of this experiment may be summarized as follows: the proportion of subjects using the scroll method over the window method significantly differs in the movement groups and in the pattern groups. The results of the response latency analysis indicates a significant effect for movement on or beyond the screen boundary which differs depending on the type of data on the display. Subjects responded more quickly to graphic than to alphanumeric stimuli when the stimuli remained on the screen, but they took longer to decide on the graphic stimuli than the alphanumeric when the stimuli moved beyond the edge of the screen.

Also, the response latency decreased with practice. However, there was a greater decrease in latency in the transfer from an unfamiliar to a familiar pattern than in the transfer from familiar to unfamiliar.

The subjects in this experiment favored scrolling. It must be kept in mind that the population to which these results can be generalized is one whose people are well versed in computer systems in which control of data movement is commonplace, e.g., text processing. This probably accounts for the dramatic difference in preference results between the Bury et al (1982) study and this experiment. A study of how the attributes of the display -content,context pattern, and size of the data- affect the naive users' decision to scroll or window is in preparation.

In any case, previous experience appears to be a critical factor such that a description of a product's intended audience should be required reading for programmers. Although a drafting person and a factory floor technician may have similar needs from a graphic system, their previous experience (e.g. with spatial representation problems) is likely to be considerably different. Products intended for each audience might solve the question of window or scroll with opposite methods.

The results of both the response latency analysis and the decision data suggests that movement beyond the edge of the display affects a user's decision to scroll or window. Several factors in this experiment should be considered. First, subjects saw abrupt changes in the stimuli for each trial. A smooth transition - although taking longer to complete - might decrease the time required to indicate which direction an object moved.

Finally, there is considerable interest in how people, untrained in graphic arts, can most easily transfer a graphic representation into a computer representation of the graphic. This experiment represents an initial attempt to address some of the questions involved in designing the user-system dialogue for that group of users of graphic systems.

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