Representing Dynamic Mouse Commands in Static Displays: Developing Graphical Symbols

Rachelle N. Ornan and Michael S. Wogalter

Department of Psychology
North Carolina State University
Raleigh, NC 27695-7801 USA

ABSTRACT

Participants used either a Likert scale or a ratio scale to rate their preferences for graphical symbols illustrating the mouse motions of click, double-click, drag, click and drag, and left click. Through an iterative design process, symbols were selected and modified as they were rated. After several iterations, 54 participants evaluated the accumulated symbol set. In general, participants preferred symbols that were less abstract and more literal representations of the intended mouse actions; this is contrary to how these commands have been illustrated in printed computer documentation. Intermediate abstract symbols were rated almost as high as the literal symbols, and had the advantage of illustrating some mouse commands that could not be easily created with a literal symbol. Several design recommendations for symbols in computer instructions and symbols for other purposes are offered.

INTRODUCTION

The mouse has become a common part of human-computer interfaces since the popular adoption of the Apple Macintosh and later Microsoft Windows operating systems. These graphical user interface systems rely on pointing, selecting and dragging objects to control processing. The mouse is still the dominant pointing device, with the track pad, trackball, and isopoint also available. In research, the mouse appears to be the easiest to learn to use, and produces better performance than other pointing devices (e.g., Long, Whitefield & Dennett, 1984). Most purchased computer software is accompanied by printed documentation intended to enable effective use. Because of the mouse's now common presence, it is surprising that there is no empirical research literature on how to best represent mouse commands in the static two-dimensional print medium.

Apple Macintosh documentation has not maintained a consistent presentation of mouse commands over the years. Even within one manual--the 1991 Apple Macintosh User's Guide, at least three graphical approaches to describing mouse actions are employed. The first shows a single click symbol that resembles an arrow (similar to Figure 1's Single Click A). Graphical instructions for drag show dotted outlined images of where a desktop item had been and a solid image of where the item should be. The third representation consists of a simple screen shot of a pull-down menu, which superimposes the mouse arrow over the highlighted menu item. It is not clear from this graphic that a click and drag is needed. In other chapters of the same guide, mouse actions are described using only text. Sometimes it is supplemented with arrows or lines that point to the area of the screen mentioned in the text. There is no consistent representation of mouse movements in this and other kinds of computer documentation material.

The use of pictographs of the computer screen has been shown to be more helpful to novice computer users than other methods of presenting information (Wogalter & Post, 1989). In addition, the instructional use of icons in printed materials and displays has been shown to decrease the time necessary to increase user efficiency and confidence (Howard, O'Boyle, Andre, & Motoyama, 1991). Icons have been shown to convey complex information more succinctly in a single representation than in cluttered combination of text and graphics for multi-step functions on a copy machine(Howard et al., 1991).

For good performance results on tests of attention and comprehension, pictographs should be simple, intuitive, and easily understood by both novice and expert. Performance has also been linked to the concreteness of the symbol. The more concrete a symbol (i.e., less abstract) the better the performance on matching tasks (Jones, 1978, 1983; Rogers & Osborne, 1987).

Howard et al. (1991) and other researchers have shown the benefits of consulting users for their suggestions and input in the design of icons. Icons systematically developed with the input of users tend to be more understandable than those that may have been designed by a single individual with limited experience.

This study employs an iterative design and test strategy that seeks to identify the characteristics of highly rated symbols for five categories of mouse command actions: single click, double click, drag, click and drag and left click. A preliminary study was initially conducted that involved a total of 60 participants who evaluated symbols in the five categories in three rounds of design and test protocols. The preliminary study gathered user feedback to establish a larger set of symbols for use in the main study

METHOD

Participants

Fifty-four North Carolina State University (NCSU) undergraduate students (33 males and 21 females) participated in the study to fulfill a research credit requirement for their introductory psychology course. The average age was 19.1 (SD = 1.62) years of age. Average computer use per day was 3.2 hours (SD = 1.89). All participants were familiar with the use of a mouse and the operations of a graphical user interface computer operating system.

Procedure

The study was composed of three parts. In Part 1, participants were asked to assign a mouse command of click, double-click, drag, or left-click to a set of symbols projected individually on a screen in a randomized order. Participants were presented with the following definitions.

Single Click: The motion of depressing the left, right, or middle mouse key and releasing it one time.

Double Click: The motion of depressing and releasing the left, right, or middle mouse key twice in rapid succession.

Drag: The motion of moving the mouse in the intended direction without depressing any button.

Click and Drag: The motion of depressing the left, right, or middle mouse button and moving the mouse while keeping the key depressed, and releasing the button when mouse is repositioned.

Left Click: The motion of depressing the left mouse button and releasing it one time.

Symbols shown to participants can be described as having three levels of abstraction: *abstract*, *intermediate abstract*, and *literal*. Abstract symbols consist of arrows and/or circles (e.g., Single Click F). Intermediate abstraction describes symbols that include views of the mouse as seen from above by itself or accompanied by arrows (e.g., Single Click C) or numbers (e.g., Single Click E). Literal describes symbols with a side view of a hand on a mouse (i.e., Single click A) with and without arrows. The total number of symbols presented in each category varied from 14 to 20. A subset of the symbol depictions used in this research are shown in Figure 1. Each colun presents symbols from one of the five mouse command categories.

In Part 2, half of the participants used a Likert scale and half used a ratio scale to make judgments about the symbols based on how effectively they conveyed the intended mouse command. Using the Likert scale, participants made ratings on how well the symbols represented a mouse command category on a 9-point scale that ranged from 0 (does not represent at all) to 8 (excellent representation). The ratio scale instructed participants to estimate how likely the population would understand the symbol as representing the intended mouse motion. This scale was nominally 101 points ranging from 0% of the population would understand to 100% of the population would understand.

In Part 3, participants were asked to give their preferences, new ideas, and improvements for the existing symbols. Ideas generated from participants' feedback and the researcher's observations were then incorporated into a subsequent round of testing.

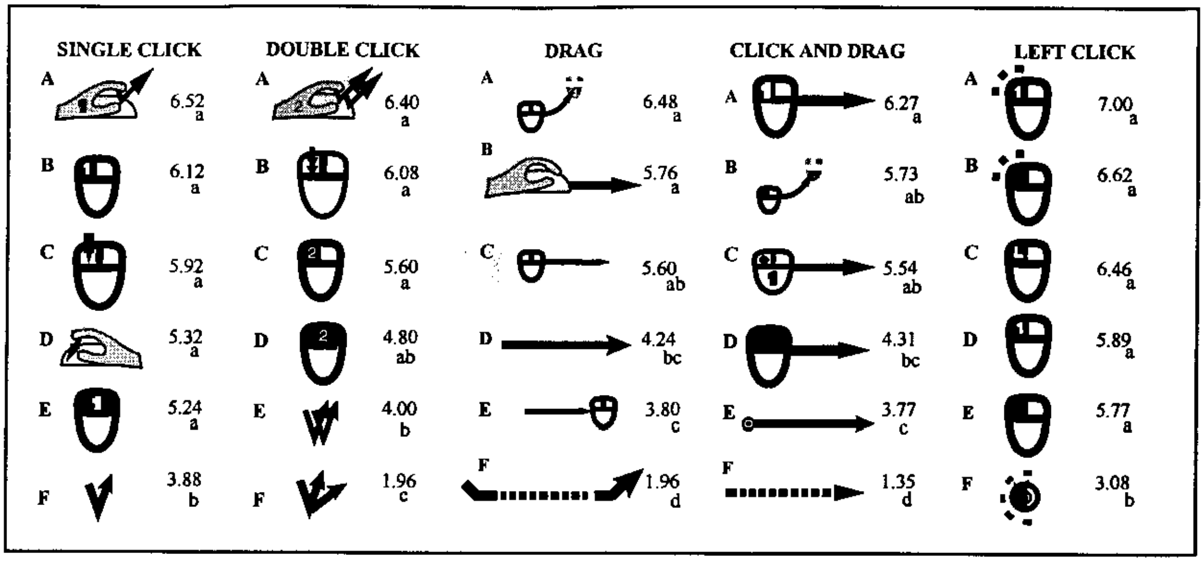
RESULTS

The correlations between the Likert and ratio preference scales for each category ranged from 0.92 to 0.98. To simplify presentation of the results, only the Likert mean ratings are presented.

The mean Likert correspondence ratings are shown in Figure 1.

A one-way repeated measures analysis of variance (ANOVA) was used for each mouse command. Tukey's Honestly Significant Difference (HSD) was used as the post-hoc test for pairwise comparisons. Significant differences at $p < .01$ are reported in subscripts. Symbols with identical subscript letters are not significantly different.

FIGURE 1. Symbols and mean Likert preference ratings



Means in the same column that do not share subscripts differ at $p < .01$ level in the Tukey's HSD Comparison.

Single Click

The ANOVA was significant, $F(13,312)=23.30$, $p < .0001$). Symbol A, a literal hand-on-mouse symbol received the highest mean rating. However, the first five symbols (A to E) were not significantly different from each other, hall all of them were rated significantly better than the sixth and most abstract symbol (F).

Double click

The ANOVA was significant, $F(13,312)=19.30$, $p < .0001$)). Symbol A, a literal hand-on-mouse symbol, received the highest mean correspondence rating. However, its rating was not significantly higher than symbols B to D, the intermediate abstract symbols. The two abstract double-arrow symbols were rated lowest. Symbol F was significantly lower than symbol E. Symbol E was not significantly different from symbol D.

Drag

The ANOVA was significant, $F(12,300)=19.65$, $p < .0001$). The literal symbol of hand-on-mouse in profile (B) was rated the second highest drag symbol. Symbol A, an intermediate abstract symbol, was rated the highest. It illustrated an overhead view of a mouse being dragged from a starting to an ending location. However, the Symbols A, B, and C (the latter another intermediate abstract symbol) were not significantly different from each other. Symbol C also did not significantly differ from symbol D, an abstract bold arrow. Symbol D was not significantly different from symbol E, an intermediate abstract symbol. Symbol C which had an arrow pointing away from the mouse was given higher ratings than a mouse with an arrow pointing towards it (symbol E). Symbol F, an abstract arrow, was rated significantly lowest of this set.

Click and Drag

The ANOVA was significant, $F(19,475=19.95)$, $p < .0001$). Symbol A, an intermediate abstract symbol with the number "1" superimposed at the mouse button, was rated highest. However, this symbol did not significantly differ from symbols B and C which were also intermediate abstract symbols. Symbol D, another intermediate abstract symbol, did not differ from symbols B and C. Symbols D and E, the latter an abstract symbol, did not differ. Symbol F, an abstract symbol, was rated significantly lower than the other symbols.

Left click

The ANOVA was significant, $F(9,225=35.42$, $p < .0001$). All of the left click symbols were intermediate abstract symbols except for symbol F. Symbol A was given the highest mean ratings, but the first five symbols in this set did not significantly differ. The last and most abstract symbol (F) of this set was rated significantly lower than the other five symbols.

intermediate abstract symbol, did not differ from symbols B and C. Symbols D and E, the latter an abstract symbol, did not differ. Symbol F, an abstract symbol, was rated significantly lower than the other symbols.

Left click

The ANOVA was significant, $F(9,225=35.42$, $p < .0001$). All of the left click symbols were intermediate abstract symbols except for symbol F. Symbol A was given the highest mean ratings, but the first five symbols in this set did not significantly differ. The last and most abstract symbol (F) of this set was rated significantly lower than the other five symbols.

DISCUSSION

For some symbols, participants appeared to prefer a more literal representation of the mouse and/or hand to symbolize the mouse commands. The literal symbols surpassed all or most others in three of the five categories (single click, double click and drag). However, for some of the categories there were no literal symbols in the set. And some of the intermediate abstract symbols were as highly preferred as the literal ones. The more abstract symbols received the lowest correspondence ratings.

Although extra arrows, numbers or letters did not raise preferences significantly, they raise resolution and screen real estate requirements. If a lower resolution symbol is rated as positively as one that requires higher resolution to be legible, then the simpler, less detailed symbol would be preferred among the two.

Due to the nature of iterative design processes, the specific symbols that we tested in this study could have been somewhat different. A different set of participants in the preliminary iterative design and test sessions might have produced somewhat different patterns of ratings and made somewhat different suggestions on improving the symbols than the ones who participated.

There were no literal representations in the set tested for the more complicated click and drag, and left click commands. Literal representations of these mouse commands symbols were difficult to create. While literal symbols were preferred for three of the five mouse commands, there was not a literal symbol for the other two mouse commands. Thus, if it was desirable to have a consistent system (the same look) across all five categories of commands, then symbols from the intermediate abstract category would probably need to be used.

The present findings are directly applicable for the display of a static representation of dynamic mouse motions. The findings are not only applicable to static printed computer documentation, but they may also be useful in displaying dynamic instructional presentations in video and macro clips that provide online tutorials and help demonstrations. Future research might investigate the extent to which these results would be applicable to dynamic and interactive displays. Verification of the correspondence ratings using open-ended comprehension measures would be useful in indicating the results applicability and generalizability.

The methods employed in this research are applicable to the design and testing of symbols for concepts other than mouse commands. For example, safety-related symbols for warnings can be developed and evaluated in a similar manner.

The results of this study suggest that people prefer more literal mouse command illustrations than more abstract representations. Abstract symbols require less display space but they may compromise performance because they are less specific and may be misunderstood. The intermediate abstract symbols seem to be an appropriate compromise because a) they can represent more categories of mouse commands, b) some are not significantly different from the best literal symbols, c) they are simpler to draw, and d) they tend to contain less detail that might compromise legibility. As more buttons and functions are assigned to the mouse (e.g., Z-direction information), additional symbol design work may be necessary.

REFERENCES

Howard, C., O'Boyle, M.W., Andre, T., Motoyama, T. (1991). The relative effectiveness of symbols and words to convey photocopier functions. *Applied Ergonomics, 22*, 218-224.

Jones, S. (1978). Symbolic representation of abstract concepts. *Ergonomics*, *21*, 573-577.

Jones, S. (1983). Stereotypy in pictograms of abstract concepts. *Ergonomics*, *26*, 605-611.

Long, J.B., Whitefield, A.D., & Dennett, J. (1984). Effect of display format on the direct entry of numerical information by pointing. *Human Factors*, *26*, 3-17.

Rogers, Y., & Osborne, D.J. (1987). Pictorial communication of abstract verbs in relation to human-computer interaction. *British Journal of Psychology, 78*, 99-112.

Wogalter, M. & Post, M. (1989). Printed tutorial instructions: Effects of text format and screen pictographs on human-computer task performance (pp. 133-138). *Proceedings of INTERFACE '89*. Santa Monica, CA: Human Factors and Ergonomics Society.