USER INTERFACE DESIGN FOR THE SMALL SCREEN DISPLAY

Chen Zhao[1], *Tao Zhang*[2], *Kan Zhang*[1],
[1]Institute of Psychology, Chinese Academy of Sciences, Beijing 100101, China
[2]Institute of Biophysics, Chinese Academy of Sciences, Beijing, China

ABSTRACT

This research investigates how the type of information display (black and white, color) and the amount of information display affect the users' performance on a memory task. The results suggest type of information display significantly affect user performance. When the display was in color, participants performed better. The amount of information displayed did not affect performance, however post-test ratings showed participants preferred less information and they rated displays with intermediate amounts of information most comfortable. These results may be used to guide more effective design of small screen displays.

INTRODUCTION

In today's western society, we are practically surrounded by small interface devices. The variety of small interface devices is impressive such as: mobile phones, PDA, CD player, television, set microwave oven, etc. The limitations set by small dimensions and limited ways of interacting make small interfaces more problematic to design than desktop computers. Creativity is needed for users to feel comfortable with the small interfaces without fear of breaking them or causing confusion. But much of the academic HCI-community, has not looked at this.

There are many rules for PC interface design. They all agree that the users' attention should be focused centrally on the screen and that the attention shifting should be from left to right and from top to bottom. It is still unknown whether these rules apply to small interfaces. Can users selectively attend to a chosen position without visual interference from another position? Are there certain display characteristics or task properties which facilitate or hamper performance of small displays? In this study, we designed two experiments to probe these questions. The first experiment investigated how certain display characteristics affect users' performance on small screens. In the second experiment, the spotlight model of attention was compared for small screens and PCs. Here we only reported the first experiment.

A memory task was used to evaluate how the type of information displayed and the amount of information displayed affected user performance with small screen displays. We predicted that user performance with less information would be better than displays with more information. Also, user performance would be better for the colored displays. In the post-experimental rating of preference, we predicted that the participant would give colored displays with less information a more positive ranking.

EXPERIMENT

Methods

Participants. The participants consisted of 20 undergraduates who had normal and normal-corrected vision and normal color perception. Participants were paid RMB 15 Yuan /h for their participation.

Apparatus and materials. A Legend 486 PC was used, which includes a color video monitor (14 inch, 1028×768 pixels resolution), a touch screen, a standard 101 keyboard, and a two-button mouse. The Experiment software was

programmed by Visual Basic and running on Windows 98 operating system, time precision is 1/1000 second based on system clock instead of Visual Basic timer. A small screen display (40 ×40 pixels) was simulated on a pure dark background.

Experiment Design. A 2 × 3 within subject design was used. Two variables, Display Type (black and white display, and color) and the Amount of Information were varied within subjects. We used three levels of amount of information: Low (6 icons in the screen, presented in a 3 × 2 matrix); Intermediate (9 icons, presented in a 3 × 3 matrix); and High (presented in a 4 × 3 matrix). The different display types were assigned in two blocks. Each block is consisted of 108 trials. The amount of information was randomly assigned in both of blocks. The order of two types of information display presentation was counterbalanced between participants.

Procedure. Participants were tested individually during a two-week period. Participants received both written and oral instructions describing the simulation and the tasks. In the experimental session, the participants completed two blocks of trials (one for each type of information display). We used a recognition task to measure performance and the accuracy of memory as the dependant measure. First, the participants were asked to remember the information displayed on the screen. When participants thought they memorized the information, they pressed the space key to continue next section. Then, participants were asked to play a mirror-puzzle game for one minute. This was done to allow any short-term memory information to transfer to long-term storage. Finally, they were given a recognition task. On the small screen computer display, a symbol was presented at a random position. The participant's task was to select the icon that was displayed at this position. Four options (including the target) appeared at the bottom of screen. Participant touched the target to finish the recognition task. Because many of equipment with small screen uses touching screen as the main input method, we use touch screen instead of traditional keyboard input. After the experiment the participants were asked to rank their preference and comfort on different interface displays.

Result

The data were analyzed using the Statistics Package for Social Sciences (Version 10.0), using Multivariate Analysis of Variance (MANOVA).

Figure 1 shows mean performance score as a function of both the type of information display and the amount of information display. A significant main effect was found for the type of information F (1, 20)=12.995, p=0.002. The color display resulted better performance on memory. The main effect of the amount of information display on performance was not significant, F (2,40)=2.216, p=0.122. There was no interaction of type of information display and the amount of information display, F (2, 40)=1.708, p=0.194.

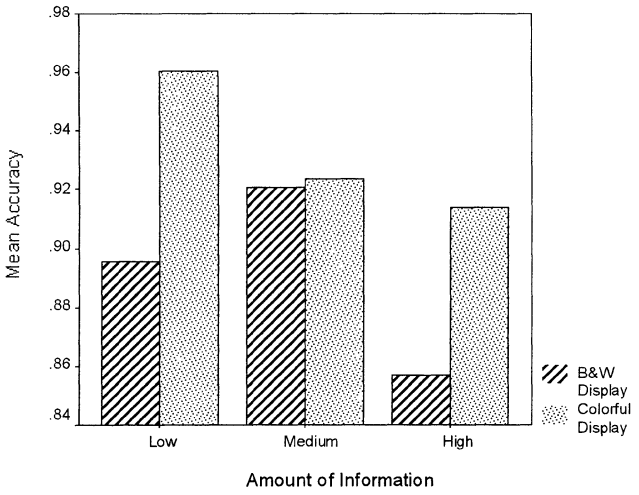

Figure 1. The type of information display and the amount of information display on memory performance

DISCUSSION

The goal of this study was to gain a better understanding for what aspects of display design can prove beneficial to users. Since the study was

an initial effort within this domain, we only controlled the type and the amount of information display using a simulated small screen display. As hypothesized, we found that memory task was performed better using color display than black and white display. Gernandes (1995) pointed out that when designing interface with particular icons for international users, it relies on colors to make it work.

According to our hypothesis, user performance should be better when there is less information. However, our results showed that the amount information did not each statistical significance. Although a trend toward significance can be seen in a t-test between the intermediate and high information conditions (t_{19}=2.11, p=0.048). It may be that the experimental task was too easy. We found participant memory performance was very good even in high information condition. Although the interaction between type of information display and amount of information display was not significant, we do see a possible performance difference between the color and the black and white conditions in the low amount information and high amount information from Figure 1. So we did the test to compared black and white display with color display in low amount information condition, the performance difference was found significant, t_{19}=3.23, p=0.004. The performance difference was not significant in medium amount of information display (t_{19}=0.554, p=0.586) or high amount of information condition (t_{19}=2.018, p=0.058).

After the experiment, participants were asked to rank their preference and comfort with different interface designs. A 5-point Likert scale was used. Higher scores represented better preference and comfort ratings. From the questionnaire, participants gave the color interface the highest ranking ($Mean_{color}$=4.16, $Mean_{b\&w}$=2.86). Participants also liked the lower amounts of information most ($Mean_{low}$=3.93), followed by the medium amount ($Mean_{medium}$=3.63). The higher amounts of information was given the lowest score, ($Mean_{high}$=2.70). It's interesting that participants rated the medium amount information display as more comfortable ($Mean_{medium}$=4.09) compared to low amount of information ($Mean_{low}$=3.86) and high amount information ($Mean_{high}$=3.05). This is different with our previous hypothesis. These results may be used to guide more effective design of small screen. For example, combining the time data and Likert scale questionnaire, we recommend medium information amount for the small screen interface.

REFERENCES

Altmann, E. M., Larkin, J. H., and John, B. E., (1995). Display navigation by an Expert Programmer: A Preliminary Model of Memory. Proceedings of CHI'95. 3-10.

Lee, S. Y., and Soh. B. K., (2000). Conceptual Graphical User Interface Design for an Electronic Technical Manual With a Small Screen Display. Proceedings of APCHI /ASEAN Ergonomics 2000. 198-204.

Franzke, M., Turning Research into Practice: Characteristics of Display-Based Interaction. Proceedings of CHI'95. 421-428.

Fernandes, T., (1995). Global Interface Design---A Guide to Designing International User Interfaces. AP Professional. MA

Zhao, C., Zhang, K., & Yang, H. H., (2000). Study on Endogenous and Exogenous Visual Selective Attention. The Proceedings of The IEA 2000/HFES 2000. I144-I147