

Involving Chinese Users in Analyzing the Effects of Languages and Modalities on Computer Icons

Sri H. Kurniawan¹, Ravindra S. Goonetilleke² and Heloisa M. Shih²

¹Institute of Gerontology and Dept. of Industrial and Manufacturing Engineering, Wayne State University, 226 Knapp Bldg, 87 E. Ferry St., Detroit, MI 48202 USA. Email: af7804@wayne.edu.

²Dept. of Industrial Engineering and Engineering Management, Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong. Email: ravindra@ust.hk.

Abstract

The present study investigated the effect of modality and language on icons' appropriateness and meaningfulness for Chinese users. Based on the findings of the previous studies of computer icons, three hypothesis were developed: H1: Bimodal icons rate the highest; H2: Icons with Chinese characters rate higher than icons with English words; and H3: Pictorial icons rate higher than verbal icons. Fifty Hong Kong Chinese daily computer users participated in the experiments. The results suggested that H1 and H2 are partially supported and H3 is not supported. A significant interaction between the language and modality was observed. The best icon group for Chinese users is the bimodal Chinese group.

1 Introduction

The use of icons to represent interactive objects in computer systems has become a common phenomenon in human-computer interface design. Various studies testing icon preference, appropriateness and meaningfulness have resulted from this trend (e.g. Lodding, 1983; Stephanidis & Akoumianakis, 1997; Choong & Salvendy, 1997; Tudor, 1994). Parallel to this line of studies, various studies on the effects of icon modality have also been conducted (e.g. Strijland, 1993; Young & Wogalter, 1988; Selcon, Taylor & Shadrake, 1992; Guastello, Traut & Korienek, 1989). Different studies adopted different concept of what modality represents. While some research studied modality as an avenue of sensation, such as auditory, visual, etc (Brewster et al, 1996; Brown et al, 1989), others defined modality as the form of representation, such as pictorial and verbal (Guastello et al, 1989; Bernsen, 1994), which is also the definition adopted in the present study.

Findings on different aspects of icons were reported in various studies. Guastello, et al (1989) found that (1) Mixed modality icons were rated as distinctively more meaningful than their alternatives. (2) Ratings were occasionally bolstered by population stereotypes acquired through experience. (3) Long abbreviations are preferable to short ones. (4) It is possible to construct pictograms that are more meaningful than the industry's standards, and (5) Verbal icons are sometimes preferred over pictorial icons when mixed modes are not available. The author also stated that "ratings [of meaningfulness] were occasionally bolstered by population stereotypes..." (p. 99).

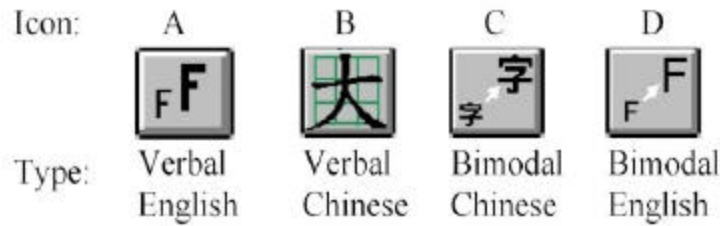
In an experiment investigating the use of warning/caution icons and verbal warning messages, the combination of icons and verbal warning was proved to improve response latencies (Selcon et al, 1992). Young and Wogalter (1988) performed an experiment to determine whether the salience of warning messages would improve the memory of warnings in proceduralized instructions by giving subjects verbal warning messages, either accompanied by meaningfully-related icons or without the icons, and found that content recall and semantic learning was significantly better for subjects who received the combination of verbal warning and icons.

Studies have suggested that the results of a particular study on icons can not be generalized across different user populations (e.g. Guastello, 1989) In other words, there might be a need to investigate icons in a specific population of prospective users. Recently some researches investigated the effect of using native language verbal representation on icon-related tasks or icon characteristics (e.g. Choong & Salvendy, 1997, 1998; Sacher, 1998) to investigate whether the results obtained for English-speaking population yield the same findings for non-English-speaking population. In line with Guastello et al's suggestion, non-English-speaking user population showed different preference and task performance when using icons with local characters.

Choong and Salvendy (1997) conducted a study on the effect of icon modality and language on the task performance of Chinese and American user groups. They found that while bimodal icons were superior for both groups, Chinese users performed better on pictorial icons when bimodal icons were not available. The term bimodal in

their study refers to pictorial icon complemented by labels. Pictorial icons complemented by Chinese labels were tested on Chinese users (similarly, English labels were tested on American users). The present study is based on Choong and Salvendy's study, focusing on Chinese users and extending the number of tested functions.

In the current study, different combinations of modalities (verbal, pictorial, and bimodal) and languages (English and Chinese) were used to create some of the tested icons that would be compared to icons currently displayed in commercial software. Most commercial icons are pictorial icons (e. g. icons on the "Toolbar" in Microsoft Office™ products). Bimodal icons in the current study were defined as icons where some parts of the function were represented by a (Chinese or English) word and the other parts by non-word objects. The example of tested function and icons is shown in Figure 1.



Note: The Chinese character in Icon B means "big" and in Icon C means "font"
 Figure 1: Example of icons for the function "Increase Font Size" used in the experiments

Based on the findings of the previous studies, three hypothesis were developed:

- H1: Bimodal icons rate highest in appropriateness and meaning
- H2: Icons with Chinese characters rate higher than icons with English words in appropriateness and meaning.
- H3: Pictorial icons rate higher than verbal icons in appropriateness and meaning.

2 Methods

Fifty (26 male and 24 female) Hong Kong Chinese, all daily computer users, participated in the experiments. Twenty-six of the participants were familiar with Chinese software, while the other 24 were not. The participants included office workers and students from various educational backgrounds and occupations. The ages ranged from 18-40 years (mean = 25.3, std. dev. = 5.5 years).

A paper-based questionnaire was used to test the hypotheses. All of the instructions, questions and ratings were displayed in both English and Chinese languages. Typical time to fill in the whole set was half an hour. The subjects were compensated with HKD 30 (USD 3.86) at the end of the experiment. The sample of the questionnaire is depicted in Figure 2.

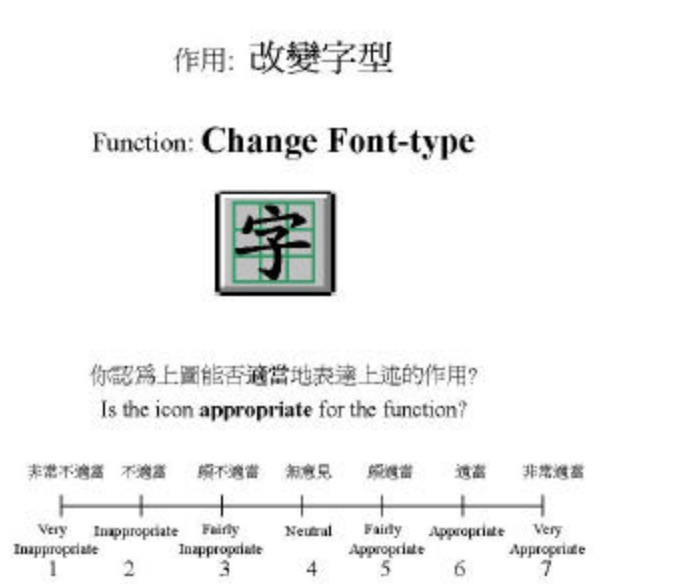


Figure 2: Example of the paper-based questionnaire used in the experiments

The following variables were analyzed in the present study:

Appropriateness. Subjects' opinions of icons' appropriateness were assessed with 7 discrete scale bipolar semantic ratings from "Very Inappropriate" (rated as 1) to "Very Appropriate" (rated as 7).

Meaning. The questionnaire was presented with the same format as appropriateness. The differences were the replacements of the question "Is the icon appropriate for the function?" with "How well does the icon represent the meaning of the function?" The ratings ranged from "Very badly" (rated as 1) to "Very Well" (rated as 7).

Language. Language variable is coded in SPSS into three values, '0' for icons with no word component, '1' for icons with English word, and '2' for icons with Chinese word in them.

Picture. Picture variable is also coded in SPSS into two values, '0' for icons with no picture (only contains word) and '1' for icons with picture in them. Therefore, for example, a bimodal English icon will have a value of '1' for the variable Language and a value of '2' for the variable Picture.

3 Results and Discussions

The purpose of this study was to investigate the effects of modality and language on icon's appropriateness and meaning for Chinese users. Analysis focused on: (1) examining the effect of bimodality on icons' appropriateness and meaning, (2) comparing the effect of the use of Chinese characters and English words on icons' appropriateness and meaning, and (3) comparing the appropriateness and meaning of pictorial and verbal icons.

Across all of the tested icons, the bivariate correlation between appropriateness and meaning is 0.78, suggesting that appropriateness and meaning are strongly related, in conformance with the suggestion of ISO DIS 9186 (1989) that meaning is one of the strongest measures of appropriateness.

The descriptive statistics of the measured variables are shown in Table 1-2.

Table 1: Descriptive statistics of icons' appropriateness and meaning: Language effects

Language	Cases	Mean(St. Dev)	
		Appropriateness	Meaning
0 (No word)	1075	4.44(1.75)	4.47(1.71)
1 (English)	250	5.15(1.72)	5.18(1.71)
2 (Chinese)	375	5.52(1.60)	5.51(1.55)
All	1700	4.78(1.77)	4.80(1.74)

Table 1 showed that icons with Chinese words rate higher than icons with English words or pictorial icons in both appropriateness and meaning. The Bonferroni post-hoc analysis showed that while the difference between Pictorial icons and English icons or Chinese icons is significant with $p \leq 0.05$, the difference between English and Chinese icons is not significant ($p=0.023$). In other words, icons with words (English or Chinese) are considered more meaningful and appropriate than icons with no words (just picture). The result is further verified by Table 2. Hence, Hypothesis 2 is only partially supported.

Table 2: Descriptive statistics of icons' appropriateness and meaning: Picture effects

Picture	Cases	Mean(StDev)	
		Appropriateness	Meaning
0 (W/o picture)	400	5.46(1.56)	5.46(1.54)
1 (With picture)	1300	4.57(1.78)	4.60(1.74)
All	1700	4.78(1.77)	4.80(1.74)

The fact that icons with English words and Chinese words are not significantly different is intriguing, considering that in icons with Chinese words, because of the logogram¹ nature of Chinese words, the words in the icon represent the meaning of the function precisely (see Figure 1 for example). On the other hand, in icons with English words, in order to fit the word in the icon, the word was abbreviated (e.g. 'CLR' for 'CLEAR'), which might lead to misinterpretation and/or require previous exposure to the abbreviation in order to understand it. Therefore, icons with Chinese words in theory should be considered to be more appropriate and meaningful. One of the possible

¹ Logogram means "the actual representation of the object it described" (Gittins, 1986, p. 520)

reasons is that the bilinguality of our Hong Kong Chinese subjects, which treated English and Chinese words to have the same quality of information.

Contrary to the finding of Choong and Salvendy's study (1997), Table 2 showed that verbal icons are better than pictorial icons in appropriateness and meaning. Hence, Hypothesis 3 is not supported. Studies showed that symbols have lower degree of representation than words (Guastello, et al, 1989). Therefore, icons representing their functions with words are considered to have higher meaningfulness and appropriateness than pictorial icons.

The general factorial ANOVA analysis showed significant effect of Language and Picture on Appropriateness and Meaning ($p < 0.001$). In both measures of Appropriateness and Meaning, the interaction between Language and Picture is significant with $p < 0.001$ as shown in Figure 3.

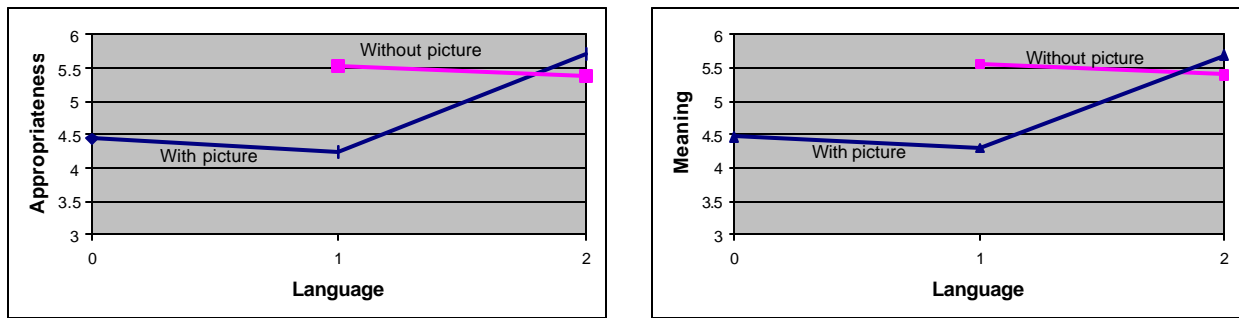


Figure 3: Interaction Plot of Appropriateness and Meaning

The interaction plots in Figure 3 showed that, while in icons with Chinese words complementing the word with picture produced higher ratings, the case is reversed in icons with English words. Visual observation revealed that the highest rating in both appropriateness and meaning is for icons with Chinese words complimented with pictures (in short, bimodal Chinese icons). However, visual observation also showed that the rating of bimodal Chinese icons is very close to icons with just English word. Therefore, Hypothesis 1 is only partially supported.

Tudor (1994) mentioned that “icons and symbols in general need to be empirically evaluated among all groups of prospective users” (p. 62). Based on the result of the analysis, the implication for the icon design is that for Chinese users, the best icon in terms of appropriateness and meaning is bimodal Chinese icon (although the ratings of verbal Chinese icons or verbal English icons are not significantly different). This is an interesting finding considering that although many software have been translated into Chinese, the icons used were not translated or adapted to Chinese users.

4 Conclusions and Further Research

The results of the study showed that using Chinese characters in icons improves subjective ratings of appropriateness and meaningfulness for Chinese users. Designers of computer interfaces who plan to create programs in Chinese should consider using icons incorporating Chinese words in addition to the common practice of translating the menu and help items into Chinese.

More generally, the study also showed that it will be fruitful to perform usability testing using the prospective users of a human-computer interface. This study and various previous studies had revealed that there is a different perception between Chinese users and English users or, in general, different user populations. Understanding who the prospective users are might contribute to the success of the designed interface.

There are some limitations of the study. The present study was done with bilingual subjects which consider English and Chinese words to have the same degree of representation in their daily life. It would be interesting to test the same sets of icons to Chinese subjects from countries where English is not as extensively used as daily language as it is in Hong Kong.

Even though in this study there is an indication that the quality of information might affect subjective ratings of icon, the quality of information was not quantified nor obtained from subject's data. Rather, the result was analytical. Further research focusing on quantifying the quality of information might bring a useful contribution to this area.

Further research should be directed toward finding out why certain types of modalities and the use of Chinese characters were considered more appropriate and meaningful by Chinese users. Finally, this study is a

preliminary study that would hopefully trigger similar studies in the future, considering the numbers of Chinese computer users have increased significantly in the past years (Freedman, et al, 1999). More generally, this study intends to contribute to the area of universal access. By finding out what common ground computer users from different cultures consider important in determining the appropriateness and meaningfulness of computer icons, it might be possible to accommodate the majority of users in the user interface design.

5 References

- Bernsen, N.O. (1996). Foundations of multimodal representations: a taxonomy of representational modalities. Interacting with Computers, 6(4), 347-371.
- Brewster, S.A., Raty, V. & Kortekangas, A. (1996). Enhancing Scanning Input with Non-Speech Sounds. Proceedings of 2nd Annual ACM Conference on Assistive Technologies, (pp. 10-14). New York, NY: ACM.
- Brown, M.L., Newsome, S.L., & Glinert, E.P. (1989) An Experiment into the Use of Auditory Cues to Reduce Visual Workload. Proceedings of ACM CHI'89 Conference on Human Factors in Computing Systems, (pp. 339-346). New York, NY: ACM.
- Choong, Y.Y. and Salvendy, G. (1997). Design of Computer Interfaces for the Chinese Population. Proceedings of the 7th International Conference on Human-Computer Interaction, (pp. 173-176). New York, NY: Elsevier Science.
- Choong, Y.Y. & Salvendy, G. (1998). Design of icons for use by Chinese in mainland China. Interacting with Computers, 9, 417-430.
- Edigo, C. & Patterson, J. (1988). Pictures and category labels as navigational aids for catalog browsing. Human Factors in Computing Systems: CHI '88 Conference Proceedings, (pp. 127-132). New York, NY: ACM.
- Freedman, L., Bloom, L., Why, N., & Hitchen, P. (Nov 3, 1999). Asia/Pacific's Internet Users Demand Localized Web Content, IDC Finds [online]. Available: <http://www8.techmall.com/techdocs/TS991104-4.html> (January 26, 2001)
- Gittins, D. (1986). Icon-based human-computer interaction. International Journal of Man-Machine Studies, 24, 519-543.
- Guastello, S.J., Traut, M., & Korienek, G. (1989). Verbal versus pictorial representations of objects in a human-computer interface. International Journal of Man-Machine Studies, 31, 99-120.
- ISO (International Organization for Standardization). (1989). ISO DIS 9186: Procedure for the Development and Test of Public Information Symbols. Geneva: ISO.
- Krull, R. (1988). If icon, why can't you? In S. Doheny-Farina (Ed.), Effective documentation: what we have learned from research. Boston, MA: MIT Press.
- Lodding, K.N. (1983). Iconic interfacing. IEEE Computer Graphics and Applications, 3(2), 167-189.
- Sacher, H. (1998). Interactions in Chinese: designing interface for Asian language. Interactions, 5(5), 28-38.
- Selcon, S.J., Taylor, R.M., & Shadrake, R.A. (1992). Multi-Modal Cockpit Warnings: Pictures, Words, or Both? Proceedings of the Human Factors Society 36th Annual Meeting, 1, (pp.57-61). Santa Monica, CA: HFS.
- Stephanidis, C. & Akoumianakis, D. (1997). Preference-based human factors knowledge repository for designing user interfaces. International Journal of Human Computer Interaction, 9 (3), 283-318.
- Strijland, P. (1993). Icon Design Tutorials. Adjunct Proceedings of ACM INTERCHI'93 Conference on Human Factors in Computing Systems, (pp.232). New York, NY: ACM.
- Tudor, L.G. (1994). Growing an Icon Set: User Acceptance of Abstract and Concrete Icon Styles. In B. Blumenthal, J. Gornostaev, & C. Unger (Eds.), Lecture Notes in Computer Science: Human-Computer Interaction, 4th International Conference, EWHCI '94, St. Petersburg, Russia, August 2-5, 1994, Selected Papers, (876, pp. 56-63). Heidelberg, Germany: Springer.
- Young, S.L. & Wogalter, M.S. (1988). Memory of Instruction Manual Warnings: Effects of Pictorial Icons and Conspicuous Print Safety: Product Safety Warnings and Devices. Proceedings of the Human Factors Society 32nd Annual Meeting, 1, (pp.905-909). Santa Monica, CA: HFS.