Effect of Cultural Background when Searching Chinese Menus

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With the rapid globalization of Information Technology, it is important to understand the performance of users with different cultural and linguistic backgrounds when using computer interfaces. In this study, the search performance of three different groups of users (Mainland Chinese, Hong Kong Chinese and non-native Chinese readers) was assessed. A full screen Chinese menu was used to evaluate the effect of (i) layout and (ii) word complexity. The analysis showed that there are significant differences in search performance among the different population groups. *Post-hoc* analysis showed that Hong Kong Chinese had significantly better search performance on the top horizontal area of the full screen menu, while Mainland Chinese had better search performance on the left vertical area of the menu. The results did not show any "preferred" areas for the non-native Chinese speakers. Thus, it may be concluded that designers ought to pay special attention to customize the graphical user interfaces for optimum performance even when the same information is being searched/read by different populations.

1. INTRODUCTION

The widespread availability of computers, fueled by the globalization of the Internet, brings users with very diverse cultural and linguistic background to interact with graphical user interfaces (GUI) on a regular basis. With the increasing complexity of these interfaces, visual search becomes an important user sub-task (Scott & Findlay, 1993). The rapid growth of B2B and B2C commerce and the recent trend in designing for global markets (Prabhu and del Galdo, 1999; del Galdo and Nielsen, 1996) has triggered the necessity for understanding the visual search patterns of users from diverse cultures. Differing language background of users can affect the search pattern and thus influence visual search performance (Nielsen, 1990). As a result, we attempted to evaluate the search strategies and overall performance when using Chinese menus of three groups of users having a diverse background in the Chinese language.

Due to the differences among differing languages, the general guidelines for interface design (Mayhew, 1992) based on the English language may not be applicable to interfaces using Chinese. For example, contrary to existing guidelines, Shih and Goonetilleke (1998) found that Hong Kong Chinese users had significantly better performance when using horizontal menus. They attributed their finding to the common writing style difference and suggested a "matrix transposition" to break the flow when displaying menu items written in Chinese. Their study was limited to a tool-bar type of menu and the validity of their results to a full-screen menu has great importance in an age where web-based screens are ubiquitous.

With the exception of the Korean and Japanese languages, written Chinese is very different from most other languages. Unlike English, Chinese text is commonly written and read in two orientations: horizontal ('Z' type orientation, starting in the top left corner of the paper) or vertical (inverted 'N' type of orientation, with text starting in the top right corner of the page). Since both of these orientations appear in various publications, it is hypothesized that item arrangement (layout) can affect the visual search performance of Chinese users. Even though Chinese readers are familiar with both orientations, their exposure level to these two formats could be very different. For example, in Mainland China common publications like newspapers, textbooks use predominantly horizontal "Z" orientation, while in Hong Kong vertical "N" orientation predominates.

Every Chinese character is formed by a sequence of "strokes", which varies from 1 to 3 strokes for very simple words up to 26 strokes for very complex words. In addition, each Chinese word in a text is written within a fixed square area, thereby contributing to the perceptual complexity of the words. Complexity of the targets and display noise has been found to affect the detectability of a target (Scharroo *et al.*, 1994). Hence, it may also be hypothesized that word complexity (or the number of strokes of each character) can also affect visual search performance.

The objective of this study was to assess visual search performance of three population groups (Mainland Chinese, Hong Kong Chinese, and Non-native Chinese speakers) with two word complexities and three layouts.

2. HYPOTHESES

The hypotheses investigated were as follows:

1. There is significant interaction between Population groups and Layout on search performance
2. Word complexity has a significant effect on search performance

3. METHODOLOGY

3.1 Experimental Task

The experimental task was to find a given Chinese word in a full screen search field. The participant was first presented with a target screen having the same layout as the search screen. In the target screen, all the words were the same: the target word. Figure 1 shows a target screen with the character (琱) as the target word. The reason for filling the screen with the target word was to prevent any bias in the starting position of the search.

Once the participant understood/memorized the target word, the search screen (Figure 2) was shown and the participant had to then search the target word in a "noisy" display of words. The font size of the Chinese words was 0.9cm*0.9cm, equivalent to a visual angle of 1^{o}.

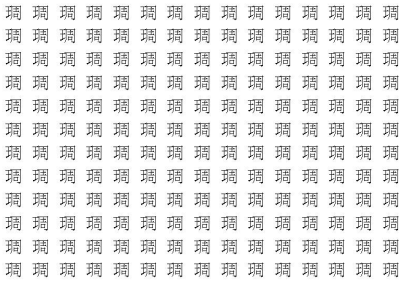

Figure 1. Example of Target screen

Figure 2. Example of Search screen

3.2 Experimental design

The experiment was a 3-population (Hong Kong Chinese, Mainland Chinese, and Non-native Chinese) × 3 - Layout (Row, Column and Uniform) × 2-Word-complexity (High and Low) × 10-trial design. The two independent variables of Layout (Row, Column and Uniform) and Word complexity (High and Low) formed 6 experimental conditions. The trials were blocked by these 6 experimental conditions. Each block had 10 trials. The six conditions formed a Latin square like design and the sequences were balanced among participants.

The three layouts of Rows, Columns and Uniform were created by varying the separations between the columns and rows of words. In the Uniform condition, the distance between rows and columns was the same and hence there was no dominant direction. The search screen in each of the layouts had nearly the same dimension, but with different number of rows and columns. The number of words in the three layouts was also very similar. The Row layout was similar to a horizontal writing orientation ("Z" type) while the Column layout resembled a vertical writing orientation ("N" type). The numbers of rows and columns in all three layouts were a multiple of three, allowing each of the layouts to be divided into 9 equal areas (Target position areas). The target location was balanced among these 9 target positions.

The Chinese words used in the experiment were categorized as low complexity or high complexity depending on the number of strokes. '*Low complexity*' words were those that comprised 10 to 12 strokes. Words with 16-18 strokes were categorized as *'High complexity'* words. The words were selected from the word index of 漢語大字典 Chinese dictionary (Hu-pei tzu shu chu pan she, 1989). Low Complexity words were within the15-34 percentile, while High complexity words were chosen from the 60-81 percentile of the word complexity distribution. All selected words were in a left-right format (example, 講 for "Talk"). Words with a top-down format (example, 葉 for "leaf") were not used as Chinese words with a left-right format can be depicted much clearer on a computer display. Furthermore, by using only one word format, the screen was "consistent" and any secondary cues of search with peripheral vision were eliminated.

3.3 Participants

A total of 18 participants were tested. All participants were paid for their time. The age range of the participants was 13-36 years. Three groups of six participants were chosen based on their "cultural" background: Hong Kong Chinese, Mainland Chinese who had lived in Hong Kong for less than 1 year and Non-native Chinese speakers. All 18 participants were able to recognize the Chinese words used as stimulus material in the experiment. Average time for experiment completion was 1 hour.

3.4 Materials and apparatus

The experimental program was coded in Visual Basic 6.0. The program was run on a Pentium 200MHz computer in the Microsoft Chinese Windows98 environment. A touch screen monitor and two external push buttons (Continue and Give-up) were used to obtain participant response. The ASL 5000 eye tracking system from Applied Science Laboratories was used to record the eye movement of participants during the search task. The eye tracking data are reported elsewhere.

3.5. Procedure

Each participant was given three practice trials before the actual experiment. In each experimental trial, the target screen (Figure 1) was first shown. After the participant understood/memorized the target word, he/she would press the “continue” button to signal that he/she was ready to proceed with the search task. The search screen (Figure 2) was then shown and the participant had 90 seconds to find the target word. When the participant found the word, the participant was required to touch the word on the touch-sensitive screen. Some search screens did not have the required target. If the participant thought that the target word was not present in the search screen, he/she was required to press the external “give-up” button to terminate the trial.

4. RESULTS

The dependent variables were *Percentage Correct* and *Search Time*. Percentage correct represents the percentage of trials having “Hits” or "Correct Rejections" within each experimental condition. These represent the trials in which the target word was found or where the participant correctly gave up a search when the target was not present in the search field.

The three-way (Population x Layout x Word complexity) ANOVA on percentage correct showed a significant effect for Population ($F(2, 90)=10.49$, $p<0.0014$). The *post-hoc* Student Newman Keuls (SNK) analysis showed that Non-native Chinese had a significantly lower percentage correct than both Mainland Chinese and Hong Kong Chinese. There was no significant difference between Mainland Chinese and Hong Kong Chinese. In addition, Layout ($F(2,90)=0.21$, $p<0.81$), Word Complexity ($F(1, 90)=0$, $p<0.94$) and all interactions were not significant at the $p < 0.05$ level.

Search time was the time taken to locate the target. A square root (SR) transformation was used to normalize the search time (ST) data. The Population * Layout * Word complexity * Target position ANOVA for square root transformed Search time (SRST) showed that Population ($F(2, 709)=24.6$, $p<0.0001$), Target position ($F(8, 709)=5.5$, $p<0.0001$), and the Target position * Population group interaction ($F(16, 709)=5.5$, $p<0.0001$) were all statistically significant (Figure 3). Word complexity ($F(1, 709)=3.35$, $p<0.0676$), Layout ($F(2, 709)=0.91$, $p<0.402$), and the other interactions were not significant at the $p < 0.05$ level.

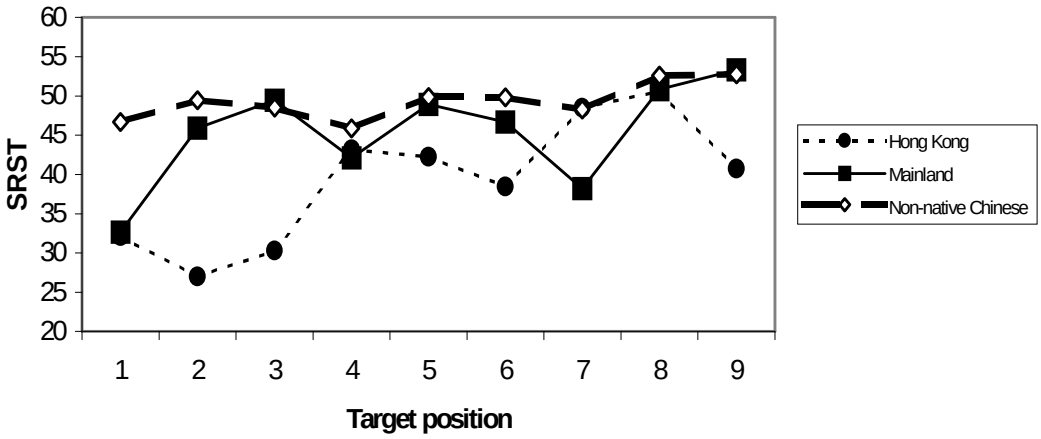

Figure 3. POPULATION * TARGET POSITION interaction on SRST.

A simple effects ANOVA on the interaction effect showed some interesting results (Table 1).

Table 1 Simple effects ANOVA for each population group using SRST

Population group	F- value (df) (Probability)	SNK grouping for Target Position* *SRST increases from left to right (→)*
HK Chinese	F (8, 257) = 10.89 (0.0001)	2 3 1 6 9 5 4 7 8
Mainland Chinese	F (8, 243) = 4.44 (0.0001)	1 7 4 2 6 5 3 8 9
Non-native Chinese speaker	F (8, 209) = 0.29 (0.9704)	4 1 7 3 2 6 5 8 9

* Levels sharing the same underline indicate no significant difference.

5. DISCUSSION

Word complexity did not have any significant effect on accuracy or search time. This shows that word complexity has no effect when searching full screen Chinese menus. That is, reading a complex Chinese word, with a high number of strokes is unlike reading an English word composed of many characters. Once a Chinese word is learnt, the time to recognize the word may not depend on the word complexity.

Layout and the Population * Layout interaction were also not significant at the $p < 0.05$ level. This result shows that the search performance as measured by percent correct and search time isn't different among the three layouts. A possible explanation follows. For the trials with 'Hits' on target, the total eye movement is the distance that the eye travels from the starting point to the end point (or target point) and is an indirect measure of search time. The distance traveled is determined by several factors, including the subject's starting position of the search process, target position, the layout, the subject's search pattern. Different combinations among these factors will result in large variations. In addition, if the search

strategy changes during the experiment, it can also result in large variations in search time. If such variations are not "balanced", the differences in search time might be so large as to mask any small effect due to Layout related search factors such as fixation duration, saccadic distance, and so forth.

The significant interaction between Target position and Population group for search time reflects potential differences in search strategies among the three population groups. The SNK grouping for the Hong Kong Chinese group (Table 1) showed that target areas 2, 3, 1 (i.e., the top rows) were grouped together with the lowest search time. Besides, areas 2, 3, 1 were significantly different from areas 4, 5, 7, 8, 9. This shows that Hong Kong Chinese tend to search the top horizontal area first, regardless of the layout of the menu. For Mainland Chinese, areas 1, 7, 4 (i.e., the leftmost columns) were grouped together and had the lowest search time. The search time of Area 1 was significantly lower than areas 2, 3, 5, 6, 8, 9. This shows that Mainland Chinese start their search at the left top area of the menu. The search time results of Non-native Chinese speakers did not show any difference between the nine target positions. These results are in good agreement with the Shih and Goonetilleke (1998) study for 1-row and 1-column menus where Hong Kong Chinese subjects showed a faster search when using a horizontal menu. The present study also indicates that the “natural” search pattern for Hong Kong Chinese is horizontal. In Mainland China, most published information follow the "Z" pattern and the matrix transposition rule proposed by Shih and Goonetilleke suggests that the Mainland Chinese would have a better search performance with a vertical menu. The results of this study agree with this theory, as the Mainland Chinese favored a vertical search.

From an application standpoint, the results can be used when designing full screen menus. If the search time for an item is to be reduced (such as frequently used items), they should be positioned closer to the starting point of the search path. To minimize search time, items should be placed at the top horizontal area for Hong Kong Chinese. The ideal location for Mainland Chinese is somewhat more difficult to predict even though the results indicate that they have a bias towards a vertical search strategy.

6. CONCLUSION

By evaluating the search performance of Hong Kong Chinese, Mainland Chinese and Non-native Chinese speakers with Row, Column, and Uniform layouts, the differences in search behavior among the three groups were demonstrated. Hong Kong Chinese had better search performance on the top horizontal area of the menu. Mainland Chinese generally had better performance on the left top area of the menu. Non-native Chinese speakers did not show any significant preference on search area. In addition, word complexity and layout showed no difference in user performance. The results of this study may be used in the design of screens to optimize user performance.

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REFERENCES

1. Del Galdo, E. M. and Nielsen, J. (1996). *International user interfaces*. New York: Wiley.
2. Mayhew, D. (1992). *Principles and guidelines in software user interface design*. Englewood Cliffs, NJ: Prentice-Hall.
3. Nielsen, J. (1990). Usability testing for international interfaces. In J. Nielsen (Ed.), *Designing user interfaces for international use* (pp39-44) Amsterdam: Elsevier.
4. Prabhu, G. V. and delGaldo, E. M. (1999). *Designing for Global Markets*. Rochester, NY, USA Backhouse Press
5. Scharroo, J., Stalmeier, P. F. M. and Boselie, F. (1994). Visual search and segregation as a function of display complexity. *Journal of General Psychology*, 121(1), 5-17.
6. Scott, D. and Findlay, J. M. (1993). Visual Search and VDUs. In: Brogan D., Gale, A., Carr, K.(Ed.) *Visual Search 2* (pp. 301-307) London: Taylor and Francis.
7. Shih, H. M. and Goonetilleke, R. S. (1998). Effectiveness of menu orientation in Chinese. *Human Factors*, 40 (4), 593-576.