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Candidate Display Styles in Japanese Input

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Abstract: Typing Japanese into computers consists of typing Roman alphabet, displaying the *kana* character, converting *kana* to *kanji*, and selecting the intended *kanji* character from a list of homophonic candidates. This paper presents a study of four candidate display styles, three commonly used in commercial products ("vertical," "horizontal," and "compact-horizontal") and one novel ("matrix"), together with various manual selection methods (mouse, numeric key, spacebar, cursor key, numeric keypad and unrestricted input method). The results show that (1) when typing a single *kanji* character, about 70% of total operation time is spent on choice selection; and (2) the "compact-horizontal" and "matrix" display styles are superior to the other display styles.

Keywords: Japanese input, Chinese input, multiple choice display and selection, menu.

1 Introduction

Despite calls for greater emphasis on and sensitivity to language and culture-specific aspects of human-computer interaction (e.g. Shneiderman 1992), most of the computer interfaces used in different parts of the world today are simple conversions (aka "localization") of English master copies. Many interesting and challenging language- and culture-specific HCI research problems await in depth examination. Text input in non-alphabetical languages, such as Chinese and Japanese, is one of those problems.

The most commonly used solution to non-alphabet text input, both in Chinese and in Japanese, is to use a Roman alphabet-based phonetic system, such as *pinyin* in Chinese and *romaji* in Japanese, as an intermediary. Unfortunately, in these languages the mapping from a phonetic spelling to a written character is not one to one. The user therefore has to select the intended character from a list of homophonic choices. In a recent study of Chinese input Wang, Zhai and Su (2001) found that choice reaction alone took 36% of total input time in their experiment. The same issue may exist in Japanese text input. To type Japanese, one has to first type a set of Roman letters, which corresponds to a phonetic Japanese character (a *kana* character). When a *kanji* character (*kanji* are Chinese characters adopted in Japanese) is wanted, the user usually presses the space bar to convert the kana character to the most likely *kanji* character. If this is not the intended *kanji* character, one has to press the spacebar again to bring up a list of homophonic candidates and choose from them.

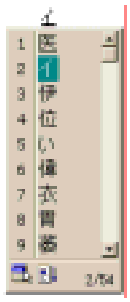
An intriguing user interface design issue here is how to display these homophonic multiple candidates. Figure 1 shows three examples of existing display styles.

From a list of candidates the user can select the intended *kanji* character by various input methods such as pressing the corresponding numeric key, using the spacebar (shifting), the cursor keys, or the mouse.

The different candidate display styles may impact on the user's experience and performance in a few intertwined aspects. First, they may change the user's visual scanning and reaction time. In the context of software menu displays in Chinese, Shih and Goonetilleke (1998) found that menu flow or menu orientation indeed had an impact on user reaction time. Second, the user's choice selection time may also depend on the manual selection methods (mouse, spacebar, cursor key, numeric keys, etc). Third, the relationship between display and input methods may differ, particularly in terms of spatial S-R (Stimulus-Response) compatibility (Fitts & Seager 1953). We investigate these issues here in an empirical study of *kanji* character input.

(a) “horizontal” display styles for Chinese input

(b) “horizontal” display style for Japanese input.



(c) “vertical” display style for Japanese input.

Figure 1: Different existing display styles in Chinese and Japanese Input

2 Method

2.1. Experimental Task

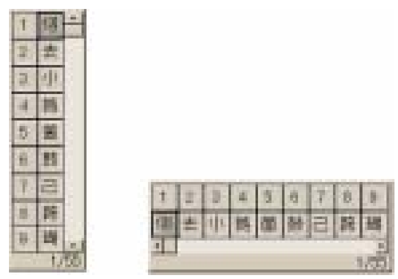
The experimental task used in the study was single *kanji* character input. In each cycle of the multi-step task, a *kanji* character and its *kana* were first displayed on the screen. Second, the subject inputted the *kana* by typing its corresponding Roman letters via the keyboard. Third, the *kana* was converted to *Kanji* by pressing the spacebar. If the resulting *Kanji* was not the intended character the subject pressed the spacebar once again, and a list of candidates (in the varying display styles described in subsection 2.2) was displayed. Fourth, if the intended character was not in the list, the subject visually scanned and located the intended character by repeatedly pressing the page down key, the space bar or the cursor key, or by mouse clicking on the scrollbar on the display style to bring up the next set of candidates, until the intended character was found. Finally, the subject selected the target *Kanji* by pressing the enter key, the numeric key, or the mouse button (depending on the input method as, described in subsection 2.3).

2.2. Display styles

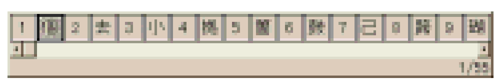
We studied four display styles, all shown in Figure 2. The first two, “vertical” and “compact horizontal”, are commonly seen in Japanese software. In both cases the numeric labels of the candidates are laid out in a column (or row) separate from the candidates themselves. The third display method, “horizontal,” lays the candidates together with their numeric labels in a single row. This is commonly seen in Chinese software.

The fourth is a novel display style we designed during this study. As shown in Figure 2 (c), the candidates are laid in a 3 by 3 matrix without numeric labels. Instead, candidates in the matrix method are selected by the corresponding 3 × 3 keys in the numeric key pad in a full keyboard. There are several key motivations to such a design. First, this method is fully S-R compatible; the display and input control share exactly the same layout. Second, unlike the numeric keys on the top of the keyboard, the numeric keypad on the side can be reliably touch-typed, as is common in accounting practices. The difficulty of touch typing calls for visual attention shifts from the screen to the keyboard: this is a major problem in Japanese and Chinese input (Wang, Zhai & Su 2001).

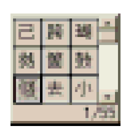
In all four cases the size of each box, a character or a number, was held constant at 0.7 cm by 0.7 cm.



(a) “Vertical” display style and “Compact Horizontal” display style.



(b) “Horizontal” display style.



(c) “Matrix” display style.

Figure 2: Four display styles tested

2.3. Selection Methods

To select the target from among many candidates, the subject used one of the following methods.

1. Spacebar: the selection cursor shifted along the candidate list when the spacebar was pressed. Selection of a target character was made by pressing the enter key.

2. Cursor key: the selected cursor was moved by the cursor key. Selection of a target character was made by pressing the enter key.

3. Numeric key: Selection of a target character was made when a corresponding numeric key, either on the top or the side of the keyboard, was pressed.

4. Mouse: the mouse cursor was moved to the target candidate. Selection was done by a mouse click.

5. Unrestricted: The subject could use any of the above input methods.

2.4 Subjects

Twelve subjects (11 males and 1 female) participated in the experiment. Their average age was 21.4 years. Subjects had an average of 3 years previous experience in Japanese typing. All had used the vertical display style and four had used the horizontal display style.

2.5 Experiment Design and Procedure

The experimental task was first explained to the subjects. Each subject was given ten practice trials (characters) with each input method and display style.

Tests consisted of typing 20 *kanji* characters with each display style and input method. The order of the display styles was randomized. With each style, except the "matrix" style where the target *kanji* character was selected via the numeric keypad alone, the subjects began with the unrestricted input method, followed by the 4 remaining input methods in random order.

These 20 *kanji* characters took 63 Roman letters to specify (40 *kana* letters). The number of page up/down operations needed in typing a character depended on the number of candidates displayed per page. An average of two page-down operations was needed for each of 9 candidates per page.

The total number of characters typed by each subject was: 4 display styles × 10 practice characters + (3 display styles × 5 input methods + 1 display style × 1 input method) × 20 characters = 360 characters.

3 Results

The total typing time, from a character being displayed to the target character being selected, was recorded as 5 segments:

t1 – from the target character being displayed to the subject's first keystroke;

t2 – from the first keystroke to the last keystroke for typing the Roman alphabet;

t3 – from finishing the last keystroke to displaying a *kanji* candidate list (including *kana* conversion processes);

t4 – from displaying a candidate list to choosing a target character;

t5 – inputting the kana once again after deleting the false character if a wrong character was chosen.

As shown in Figure 3, *t1, t2, t3,* and *t5* together only constituted only a small part of the entire operation time. Since these components did not have much to do with the candidate display style, not surprisingly there was no significance difference in *t1, t2, t3* and *t5* between the three styles in each input method. *t4* took the most time in each of the four display styles: 69.1% in the "matrix" style, 73.29% in compact-horizontal style, 76.56% in the horizontal style, and 76.64% in the vertical style. Choice reaction and selection in this study took a greater portion of the entire operation time than Wang et al's study of Chinese input, presumably due to the greater number of choices having the same Roman spelling in Japanese. Hence it is important to analyse *t4* in detail.

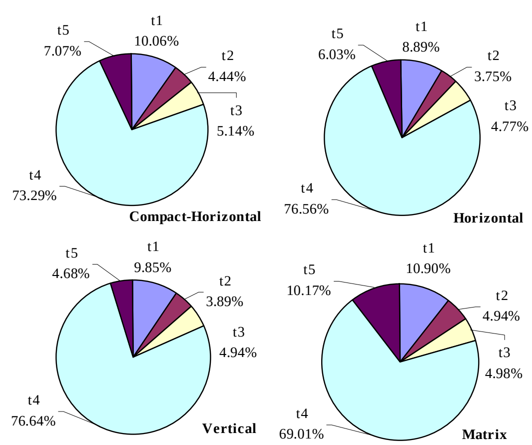


Figure 3: Time composition estimates of *Kanji* input.

Figure 4 shows *t4* in different input methods and display styles. First we examine the differences among the three existing display styles: "compact-horizontal, horizontal, and vertical." When using the mouse, there was a significant display effect, $F(2,33) = 3.67$, $p < 0.05$. The "compact-horizontal" display style was faster than the "vertical" and "horizontal" display styles, but the difference between the "compact-horizontal" display style and the "vertical" display style was not significant. When using the cursor key, the display effect was also significant: $F(2,33) = 4.62$, $p < 0.05$. The "compact-horizontal" was faster than the "vertical" and "horizontal" display styles. With the rest of the selection methods (unrestricted, spacebar, numeric key), the display effect was not significant. Overall, the compact-horizontal and vertical styles were superior to the horizontal style.

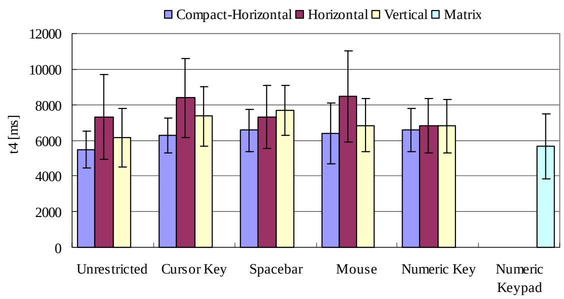


Figure 4: Time from displaying a conversion candidate to choosing a right character (*t4*).

Next we compared the new "matrix" style with the other three display styles in each of the input methods in *t4*. The "matrix" style was faster than the other three display styles, when using the cursor key, $F(3,44) = 5.77$, $p < 0.05$; when using the spacebar, $F(3,44) = 3.85$, $p < 0.05$; and when using the mouse, $F(3,44) = 4.45$, $p < 0.05$. However, there was no significant difference between the "matrix" and "compact-horizontal" display styles with the cursor key, the spacebar or the mouse. Furthermore, there were no significant differences among the four display styles when using either the unrestricted method or the numeric key input method.

After they finished the test, the participants' subjective reactions were collected. Two points stood out. Eight participants preferred the "compact-horizontal" style over the vertical or horizontal because "the numeric keys are also horizontally arranged," indicating the users' emphasis on spatial S-R compatibility. Over half of the subjects preferred the "matrix" style with the keypad input method because "the 'matrix' style corresponds to the numeric keypad".

4 Discussions and Conclusions

This study contributes to our understanding of Japanese text input. The "anatomical analysis" of single *kanji* character input reveals a major bottleneck in Japanese input. We found that, similar to Chinese input (Wang *et al* 2001), choice reaction and selection (*t4*) in Japanese input takes a great deal of time. This process is also error prone with some input methods. For example, with the numeric keys input method, errors were occasionally made when the user pressed both the target number and the number key next to it, indicating the difficulty with touch typing the numeric keys on the top row of the keyboard.

Our study also found that the display styles of candidate lists affect Japanese text input. The results showed that "compact-horizontal" and "vertical" were overall more efficient than the "horizontal" display style. Although no significant difference was found between the "compact-horizontal" and the "vertical" display styles, the subjects preferred to use the "compact-horizontal" display style. Overall, it can be said that the "compact-horizontal" display style is a good design choice.

The novel "matrix" style of selection via the numeric keypad may well be faster than the other three display styles with selection by the cursor keys, the spacebar, or the mouse. The "compact-horizontal" display style was close to the "matrix" display style in performance, but over half of the subjects preferred the matrix style. Taken together, the "matrix" display style can be regarded as the best choice. The drawback of the "matrix" display is that numeric keypads spatially compatible with the matrix display are not available in most laptop computers. There are, however, a few laptop models with keypad potentiality. This is somewhat achieved through a keypad activating function built into the system, and other times through an add-on external keypad feature. Finding S-R compatible solutions in UI design in order to match users' natural capabilities and limitations is one insight worth noting from this study.

The results of this study may also apply to text input in other non-alphabetic languages, and perhaps to multiple choice selection tasks beyond text input.

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