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The role of size of input box, location of input box, input method and display size in Chinese handwriting performance and preference on mobile devices

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ABSTRACT

This study presented two experiments on Chinese handwriting performance (time, accuracy, the number of protruding strokes and number of rewritings) and subjective ratings (mental workload, satisfaction, and preference) on mobile devices. Experiment 1 evaluated the effects of size of the input box, input method and display size on Chinese handwriting performance and preference. It was indicated that the optimal input sizes were 30.8 × 30.8 mm, 46.6 × 46.6 mm, 58.9 × 58.9 mm and 84.6 × 84.6 mm for devices with 3.5-inch, 5.5-inch, 7.0-inch and 9.7-inch display sizes, respectively. Experiment 2 proved the significant effects of location of the input box, input method and display size on Chinese handwriting performance and subjective ratings. It was suggested that the optimal location was central regardless of display size and input method.

1. Introduction

Size and location of input box is an interesting and important research topic in human-computer interaction, both in academia and product design. Researchers aimed at establishing the connection between the size or location of the input box and the input performance (Park and Han, 2010a; Tu and Ren, 2013). It was suggested that the optimal size of the input box for Chinese characters was 14 × 14 mm while using the stylus to input on PDAs (Ren and Zhou, 2009). Chinese character, also called as Kanji, was mixed with Kana character in this study due to its similar usage.

Other input methods such as thumb input or index finger input were not fully considered in previous studies. Thumb input was critical to Chinese handwriting as there were many input scenarios when only one hand was available. For example, mobile device user might meet the situation that they had to hold the handle to keep balance when taking a bus. Other input approaches such as pinyin or voice input may not be satisfactory for some user groups. Pinyin was developed to establish the national standard of the pronunciation of Chinese character in Mainland China from 1958 and officially released in 1967 (SLC, 1967; Wu, 1958). It became an international standard in 1982 (ISO/IEC, 1982). Because of limited developing years, there was still a large quantity of Chinese who were not familiar with Pinyin. On the other hand, people enjoy Chinese handwriting. One reason was that handwriting accompanied their learning process of Chinese in the primary school. The other reason was good handwriting resembled the individuals' positive innate characteristics and won the appraisal from other people. Many people agreed to the common saying "字如其人" (i.e. "The writing is like the personality" or "The style is the man"). It was also proved that Chinese handwriting, especially calligraphy, could bring a positive effect to mental activities (Kao, 2006; Zhang, 2014). For voice input, users who have accent possibly increased the recognition difficulties, as there were a large number of Chinese dialects. Therefore, it was required to investigate the thumb input for Chinese character to provide a good alternative for the users. It was found that the general optimal size of input box on mobile phones was 25 × 25 mm when considering input method, (Tu and Ren, 2013). It was suggested that 25 × 25 mm were suitable for input with both thumb and index finger regarding of handwriting performances and subjective ratings. However, this study considered very few participants, which limited the application of its conclusion. Moreover, the location of input box had been investigated to improve the touch performance. Location of input box was essential to selection accuracy (Benko et al., 2006). It attracted attention when one-handed thumb interaction became popular

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(Park and Han, 2010a, 2010b). A research on the influence of target location on touch revealed that central area was most recommended for thumb input (Park and Han, 2010b). However, the location of input box was designed near the right down corner in the most current touch devices. A better interface design for the size and location of input box will help to improve the handwriting performance. Thus, it was necessary to investigate the optimal size and location of the input box for the Chinese handwriting system.

Current technologies bring more and more interactions on various touch-sensitive devices (e.g. tablet PCs) and make it possible to handwrite with one of three input methods (e.g. thumb input, index finger input, stylus input). However, lack of consideration on finger size and display size reflected the limitation of the general application of the optimal size of input box on mobile touch devices. The Chinese standard stated that the width of the distal joint of thumb was 17 mm and 18 mm in average for the female and male adults, respectively (SAC, 1996). Thumb covered almost 2/3 of the entry area according to the average. It was reasonable to doubt that 25×25 mm was large enough for the most Chinese adults. Moreover, very few studies have been conducted on the optimal size and location of the input box for a Chinese handwriting interface. As the thumb is shorter and larger than the index finger (SAC, 1996, 2011), the input box for thumb may not have the same size as that for the index finger. Furthermore, there are situations where one input method is preferred. For example, the most convenient way to input characters while standing on the bus is to use the thumb and hold the device with the same hand. It is also interesting to discover the effect of finger size on the optimal size of the input box. Moreover, stylus, as another mainstream input method, is extremely different with human fingers. Thus, it is necessary to study the differences in the optimal size and location of input box among thumb input, index finger input and stylus input.

Furthermore, mobile touch-sensitive devices vary in size, from 2 inches to 10 inches, which makes the interface design for Chinese handwriting system more complicated. For example, the optimal size of the input box for the larger mobile device (e.g. iPad) was not identified. It was possible that the optimal size of input box increased as the display size increased. However, the relationship between the size of the input box and display size was not clear for Chinese handwriting. Moreover, it seems necessary to explore the relationship between display size and input method. First, the various display sizes have an influence on the input method. For example, it is easy to input with the thumb with one-hand hold while using a 3-inch device, but it is impossible to do the same thing while using a 10-inch device. Secondly, the effect of display size on Chinese handwriting performance need investigation as previous studies have not focused on this area. Third, the interaction effects of size of the input box, the location of the input box, input method and display size remained unstudied. For example, it is unknown if iPad and iPhone share the same optimal size and location.

Therefore, the purposes of this study were 1) to investigate the effects of size of the input box, the location of the input box, input method and display size on Chinese handwriting performance; 2) to give out the design implications of optimal size and optimal location in Chinese handwriting system considering input method and display size.

2. Methodology

2.1. Design

Two experiments were conducted. The purpose of Experiment 1 was to investigate the effects of size of the input box, input method and display size on Chinese handwriting performance and subjective ratings. The purpose of Experiment 2 was to investigate the influences of the location of the input box, input method, and display size. The optimal size and optimal location were going to be identified for touch-sensitive devices with four different sizes when using three different input methods.

Three commonly used input methods were chosen, one-hand hold and thumb input, two-hand hold and index finger input and two-hand hold and stylus input. Four display sizes included 3.5-inch, 5.5-inch, 7.0-inch and 9.7-inch as they could represent parts of the current mainstream touch devices. The Chinese senior users showed different usage patterns of text entry on these four display sizes (Gao et al., 2013; Zhou et al., 2014). Since few previous studies researched the optimal size of the input box, this study used the percentage of the display area to determine the size of the input box. The purposes were first to investigate the real size of the input box for each display size and secondly to study whether there was an optimal percentage for any display size. The size of input box had five levels, defining as 5%, 10%, 15%, 20% and 25% of the display area. The real sizes of tested input boxes were shown in Table 1. It was suggested the optimal size of the input box for finger input of Chinese handwriting was 25×25 mm thus this study included a 23.9×23.9 mm (15% of the 3.5-inch display) to compare. Considering the average finger size of Chinese, four levels of input box size were larger than 18 mm for the 3.5-inch display size. One level of input box size was 13.8×13.8 mm (5% of the 3.5-inch display) for comparison. For larger display sizes it seemed unnecessary to set small input box as there was more space for the input box in the larger display sizes, which was consistent with the current product design. Entry shape was square as it was indicated that users performed better in square entry box than in rectangular one (Ren and Zhou, 2009). A central entry box was used in the first experiment. In the second experiment, input method and display size had the same numbers of levels and location of input box had five levels, left-up, right-up, central, left-down and right-down. Chinese handwriting was evaluated as input time, accuracy, the number of protruding strokes, the number of rewritings, mental workload, satisfaction and preference in previous studies to show the handwriting performance and subjective ratings (Chan and Lee, 2005; Chan and So, 2009; Chen et al., 2014a; Tu and Ren, 2013; Zhou et al., 2014). This study also added the number of rewritings to investigate how many times participants choose to rewrite if they were not satisfied with their writing. It was shown that

Table 1
Five levels of side length of input box in four display sizes.

Display size (inch)	Device mode	Length (cm)	Width (cm)	Side of # % area				
				5%	10%	15%	20%	25%
				Side lengths (cm)				
3.5	iPhone 4s	76.0	50.0	13.8	19.5	23.9	27.6	30.8
5.5	Samsung Note 2	124.0	70.0	20.8	29.5	36.1	41.7	46.6
7.0	Samsung Table 2-P3110	154.0	90.0	26.3	37.2	45.6	52.6	58.9
9.7	iPad 1	196.0	146.0	37.8	53.5	65.5	75.7	84.6