

Difficulties on Small-Touch-Screens for Various Ages

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Abstract. Digital products with small-touch-screens are increasingly affecting daily life, and most especially that of the elderly population in Taiwan which, at present, is over 9.9%. As people age, they find it increasingly difficult to operate digital products with small-touch-screens. The main purpose of this study was to investigate and categorize these difficulties for three groups of adult users. The fifteen participants in the investigation were classified into three groups: young adults, middle-aged adults and elderly adults. All of the adults were requested to accomplish different tasks using three digital products with small-touch-screens and then to provide their opinions on the kinds of difficulties they had encountered. The experts classifying the results found that the elderly adults were the group confronted with the most difficulties in the operation of small-touch-screen digital devices. In the digital dictionary experiment, the greatest difficulty for the three groups centered on cognitive ability; the majority of problems were related to motion in the PDA. In fact, the most notable problems for each of the participants were related primarily to motion in the PDA and to cognition. The results also indicated the common operational problems with the three digital products with small-touch-screens, including the impact of space or position of handwriting and button size on motion ability; and the impact of the size and color of the fonts or icons and screen brightness on perception ability. Lastly, regarding the difficulties with cognition, most of the participants were confronted with complex information, inconsistent with the interfaces of the digital products. Results of this study were based on the opinions from the three adult groups and, could be used in future designs for small-touch-screen interfaces.

Keywords: small-touch-screen, motion, perception, cognition.

1 Introduction

Digital products with small-touch-screens are increasingly affecting daily life, and this is particularly the case for the elderly population in Taiwan which, at present, is over 9.9% (CEPD, 2006). Young adults are no longer the sole focus of consumer product markets; more and more attention has been given to the design and development of products for elderly adults. Studies show that human ability includes three segments: perception, cognition and motion (Hotta, 1997; Okada, 1997; Fisk, et al., 2004, p15.). Elderly people often suffer degeneration in their physical abilities which affects their

lifestyle. The current generation of digital products is noted for compactness, making them easier to carry, but also with the problem of small-touch-screens.




Owing to the degeneration of human abilities, elderly adults have more difficulty operating small-touch-screen digital products than do the younger users for whom they were originally intended. For example, elderly users find it hard to press minute buttons because of the degenerated dexterity in their fingers or to operate more complex interfaces due to memory impairment (Lee & Kuo, 2001). It is important, therefore, to design accessible interfaces on digital products for elderly people. Also, additional consumers would reduce the production costs for the development of universal digital products which are easy to use by both young and old.

The main purpose of this study was to investigate and categorize the difficulties encountered by various aged users of small-touch-screens. Results of this study were based on the participants' opinions, which could be used for future designs of small-touch-screen interfaces.

2 Methods

Thinking aloud was used in this study. The first step was to request participants to operate three digital products with small-touch-screens and to describe their difficulties. The second step was to categorize these difficulties, which were recorded using a digital video camera by two experts. The experts in this study had three or more years experience studying interface designs for elderly people. These two experts categorized the difficulties in operating small-touch-screens for all users according to three human abilities: perception, cognition and motion.

Table 1. Experiment instruments

			
	Digital dictionary (CD826 pro)	PDA (ASUS A730)	Cell phone (Dopod 818)
Product Size(mm)	137.5 x 82.8 x 18.9	117.5 x 72.8 x 16.9	108x 58x 18.1
Screen Size(pixels)	3.8", 320x240	3.7", 640x480	2.8", 320x240
Weight(g)	250	170	150

2.1 Participants

There were fifteen participants: five young adults (between the ages of 21 and 35; mean age: 27.9 years, SD: 5.2 years); five middle-aged adults (between the ages of 45 and 58; mean age: 52.1 years, SD: 3.9 years); and five elderly adults (65 years old and above; mean age: 67.9 years, SD: 3.8 years). All of the participants in this study had some experiences in operating digital products before the experiments.

Table 2. Tasks of three experiment instruments

Digital dictionary	PDA	Cell phone
<ul style="list-style-type: none"> • Task 1: consulting a dictionary • Task 2: setting some individual information • Task 3: multimedia 	<ul style="list-style-type: none"> • Task 1: calculating machine • Task 2: setting some individual information • Task 3: multimedia 	<ul style="list-style-type: none"> • Task 1: dialing someone • Task 2: setting some individual information • Task 3: multimedia

2.2 Experiment Instruments

Each participant was requested to accomplish tasks with each of the three experiment instruments: a digital dictionary, a PDA (personal digital assistant) and a cell phone. Table 1 shows the specifications of each of the experiment instruments, whose main input methods were tap buttons or handwriting on a touch-screen with a stylus.

2.3 Tasks

Table 2 shows the main tasks handled with each of the instruments. For the digital dictionary, participants tasked minor items which included: consulting a dictionary by three input methods, setting some individual information and operating multimedia functions. There were minor items for the PDA and the cell phone that included: calculating or dialing, setting some individual information and operating multimedia functions. The participants had to describe their initial opinions when operating the digital products during the experiment.

2.4 Experiment Environments

The participants were asked to operate digital products in a realistic environment. The illumination of the experiment was between 600~800 lux and the brightness of the background in all experiment instruments were set at 100%.

3 Results

The experts classifying the opinions of the participant groups recorded nineteen difficulties with the digital dictionary, eighteen with the PDA and thirteen with the

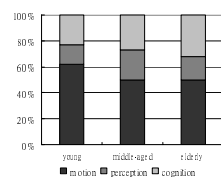
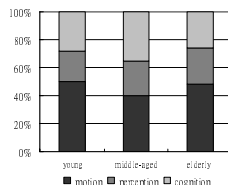
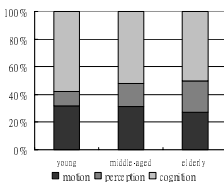


Fig. 1. Percentage of difficulties in three human abilities with the digital dictionary

Fig. 2. Percentage of difficulties in three human abilities with the PDA

Fig. 3. Percentage of difficulties in three human abilities with the cell phone

Table 3. Difficulties with the digital dictionary

	Description of the difficulties
Motion	<ul style="list-style-type: none"> • Participants made more mistakes when the buttons were minute. • The position of handwriting was under the screen which entailed hand instability. • Speed or strength of handwriting influenced the accuracy of recognition. • There was no hold button for the touch-screen of the digital dictionary. It was not stable for participants.
Perception	<ul style="list-style-type: none"> • Some of the fonts or icons were too small to be read clearly. • The contrast between font and background was not intense enough.
Cognition	<ul style="list-style-type: none"> • The icon buttons were confusingly similar. • Multiple modes of input made keyboards complex and confusing. • Increasingly frequent errors were due to inappropriate icons. • Participants could not understand the complex information.

Table 4. Difficulties with the PDA

	Description of the difficulties
Motion	<ul style="list-style-type: none"> • The area was too narrow when Chinese fonts were input, so that strokes were complex. • The position of handwriting was under on the screen which caused hands' instability. • Speed or strength of handwriting influenced the accuracy of recognition. • Some buttons were too small and increased the difficulty for participants. • The volume of PDA was too large for female participants.
Perception	<ul style="list-style-type: none"> • Some of the screen fonts were too small to read clearly. • Participants found it tiring reading complex information on the smaller screen. • The screen brightness was not sufficient for the recognition of smaller icons or fonts. • The light reflecting off the screen influenced participants.
Cognition	<ul style="list-style-type: none"> • The meaning of icons was not readily apparent and participants had more difficulty recognizing them. • The operation process was not easily remembered. • Two similar icons placed together confused participants. • Participants could not understand the complex information if they had had no past experience with digital devices.

Table 5. Difficulties with the cell phone

Description of the difficulties	
Motion	<ul style="list-style-type: none"> • The area for handwriting was too narrow to write Chinese fonts with the stylus. • The position of handwriting was under the screen which caused hands' instability. • Speed or strength of handwriting influenced the accuracy of recognition. • The cell phone was too heavy for some people to hold. • Participants found it hard to point accurately at the smaller buttons. • The interface space was too narrow to operate the cell phone. • Pointing at other buttons when the area of handwriting was full on the screen was liable to cause an error.
Perception	<ul style="list-style-type: none"> • The size and font of the touch-screen were too small to read clearly. • Participants found it tiring reading complex information on the smaller screen. • The screen brightness was insufficient for the recognition of smaller icons or fonts.
Cognition	<ul style="list-style-type: none"> • Participants easily forgot the operation process. • Participants could not understand incomplete icons and fonts. • It took more time to find the function of complex information. • The feedback of vision was insufficient for participants' perception.

cell phone for the young subjects. The middle-aged participants reported twenty-three difficulties with the digital dictionary, twenty with the PDA and twenty-two with the cell phone. The elderly participants had the most difficulties with each item: twenty-six problems with the digital dictionary, twenty-seven with the PDA and twenty-two with the cell phone. According to these results, the elderly adults were the group that was most challenged in the operation of small-touch-screen digital devices.

3.1 Percentage of Difficulties in Three Human Abilities

Each group experienced different problems in operating the three experiment instruments. Fig. 1 to Fig. 3 show the analysis of the digital dictionary, PDA and cell phone for the three groups. With the digital dictionary, the greatest number of difficulties for the three groups centered on cognitive ability. The majority of problems were related to motion in the PDA, and Fig.2 shows that the middle-aged participants also had more cognition-related difficulties. Overall, the most notable problems in all participants were related primarily to motion, and secondly to cognition.

3.2 Common Difficulties for the Three Groups

In order to investigate the common difficulties for each of the groups from a universal design perspective, the parallel problems were generalized for all of the participants. Tables 3~5 describe the main difficulties common to the three groups in their

operation of small-touch-screens as related to the human abilities of motion, perception and cognition.

4 Discussions

Pointing and handwriting were the major ways for inputting information on small-touch-screens. All participants had similar motion-related difficulties which centered on button size and space for handwriting. Lee and Kuo (2004) indicated the button size was at least 5mm x 5mm by stylus. Multifarious information on the screen affected some buttons or narrow font. In the experiments, the smallest button size of 1mm x 2mm caused participants to make increasingly frequent errors especially when attempting multi-motion tasks such as pointing & holding, or pointing & dragging. On the other hand, for the participants tasked in handwriting, the right hand was not able to maintain stability because the position was on the right side under the screen of the digital products. Space was also an important factor for handwriting performance. Table 4 and Table 5 show that the handwriting area was not wide enough to write the more complex Chinese fonts on either the PDA or the cell phone. With the digital dictionary, the area of handwriting was 25mm x 25mm (per grid) so this result was applicable to all of the groups.

According to these results, various aged users were confronted with different difficulties. Declines in visual acuity appear at about forty years old (Fozard, 1990). Fig.1 to Fig.3 shows that the middle-aged and elderly participants had more difficulties with perception than did the younger participants. Furthermore, as shown in Table 3 to Table 5, the majority of problems were related to visual perception. Empirically-derived guidelines suggest that presenting important information in 12- to 14-point font size for elderly people with a normal decline in their vision (Kurniawan et al., 2006). The font on the small-touch-screens in this study was 6-8 point, and the middle-aged and elderly participants had more vision-related problems and labored harder to operate the digital products.

The most general cognition-related problem for the three groups involved the icon or exposition on buttons. Multifarious functions made the information more complex, and many buttons were displayed by compendious icon or font which users tended to misinterpret; thus they made mistakes if they had no experience with the icon in the past. In addition, the working memory for normal young adults is seven items and for elderly adults it is five point eight items (Schieber, 2003, p 64). Schieber also indicated that the decline in working memory was related to age and to the complexity of the task. Middle-aged and elderly participants forgot the operating sequences more easily than did the young adults, especially when the procedure was complicated.

The touch-screen size of the digital dictionary was the largest and the cell phone was the smallest in three experiments. Fig. 1 to Fig. 3 show that there were more motion-related difficulties with the cell phone and that the problems centered on the size of the area for handwriting or the size of the buttons. These results show that the motion ability in older adults is an essential consideration for the development of smaller digital products in the future.

5 Conclusion

Each group experienced different operational problems with the three experiment instruments with small-touch-screens. In this study, the results have also generalized the common difficulties for the three age groups, including: the space or position of handwriting and the button size on motion ability, the size and color of fonts or icons, and the brightness of the screen for perception ability. Lastly, most participants faced difficulties with cognition when confronted with complex information inconsistent with the interfaces of the digital products. Results of this study were based on the opinions from various age groups and could be used for future designing of small-touch-screen interfaces.

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