

# Effects of Interface Button Styles on the Usability of Product Interfaces for Older Adults with and without Cognitive Impairment

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## Abstract

Cognitive decline affects older adults' ability to use of products in their daily lives. The aim of this study is to investigate the effects of interface button styles on the usability of product interfaces for older adults with and without mild cognitive impairment (MCI). Older adults with and without MCI were invited as the subjects to participate in an evaluation of the usability of electronic rice cooker interfaces with different styles of touch buttons. The task completion time and touch traces of the participants were recorded. The results revealed that the participants without MCI could use the interfaces more efficiently than could those with MCI. Of the various styles of buttons, the circular buttons were the most usable for the participants without MCI. The use efficiency levels of participants with and without MCI were nearly equal when the participants used the interface with pictures aligned with text. The results would be contributive for designing product interfaces for older adult users as design references.

**Index Terms**—About four key words or phrases in alphabetical order, separated by commas.

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## I. INTRODUCTION

Because of population aging, older adults have emerged as a major population of technology users to whom product designs must be tailored. Unlike young people, older adults often cannot use complex devices intuitively because of the decline in their cognitive and behavioral functions [1], [2]. Dementia profoundly affects older adults' cognitive ability and short-term memory [3], [4], impeding their use of products in daily life. Mild cognitive impairment (MCI) is considered a transitional phase between general aging and dementia and has been identified as a major risk factor for dementia. Because of population aging, the prevalence of MCI has increased [5]; the annual rate of progression from MCI to dementia is 10%–15%, whereas the incidence of dementia among the general older adult population is 1%–2% [6]. Although people with MCI experience memory decline, they do not have dementia; therefore, MCI does not strongly affect people's daily lives or skills. Nevertheless, MCI limits an individual's ability to carry out complex activities of daily living [7], such as cooking or using an automated teller machine to withdraw money.

Because people with MCI are still able to live independently and may live with their families, they often use various products in their daily lives. Within the past decade, opportunities to encounter and use technology products in daily life have increased greatly. The market has shifted its focus from hardware

interfaces to software interfaces (e.g., touch screen interfaces), taking user-product interactions to the next level [8]. This has affected users with cognitive impairment. The related studies [9], [10] have demonstrated that older adults with MCI perceive the difficulty of using technology in daily life differently than do healthy older

adults and older adults with mild dementia. Compared with older adults with MCI, healthy older adults have a considerably lower error rate and are more efficient when using technological products in their daily lives [11]. Electronic rice cookers are commonly used by older adults, and buttons are key elements of the interface designs of such rice cookers. This study explored the effects of different styles of electronic rice cooker touch buttons on the usability of the interfaces of the rice cookers for older adults with MCI.

## II. METHOD

The user interface of an electronic rice cooker was applied as a sample for older adults with MCI to test. The test procedure, operational tasks, and participants are as follows:

### A. Test Procedure

Interfaces with five different touch buttons styles, namely text only, pictures aligned with text, underlined text, text in squares, and text in circles, were evaluated (Table 1). To prevent the results from being influenced by the colors of the buttons, the interfaces were drawn in black-and-white frames with illustration software and displayed on a 10-inch computer touch screen. During the test, a single random interface and task instructions were simultaneously displayed on the touch screen. Each participant sat in front of the screen to perform the specified tasks. The interface was programmed to record the participant's task completion time and track their touches. Before the test, the participants were asked to practice operating two to three simulated interfaces and to perform a specified task on the interfaces according to the task instructions. If the participants were confused or unable to perform the task, they were provided with appropriate oral hints until they were able to complete the task.

Table 1 Test interfaces






A. Text only	B. Pictures aligned with text	C. Underlined text	D. Text in squares	E. Text in circles
				

Table 3 Results of ANOVA of task completion times of participants without MCI

Interface	Mean	SD	N	Significance					p
				A	B	C	D	E	
A	5.8	2.8	31	-	-	-	-	0.016*	0.110
B	7.9	11.1	31	-	-	-	-		
C	7.5	6.5	31	-	-	-	0.016*		
D	6.1	4.6	31	-	-	-	-		
E	4.5	3.0	31	-	-	-	-		

(\* : P< 0.05 , \*\* : P< 0.01 , \*\*\* : P< 0.001 , -: no significant difference)

Table 4 Results of ANOVA of task completion times of participants with MCI

Interface	Mean	SD	N	Significance					p
				A	B	C	D	E	
A	10.6	6.1	30	-	-	-	-	-	0.123
B	11.6	6.9	30	-	-	-	-		
C	11.7	6.5	30	-	-	-	-		
D	16.1	16.0	30	-	-	-	-		
E	14.9	15.7	30	-	-	-	-		

(\* : P< 0.05 , \*\* : P< 0.01 , \*\*\* : P< 0.001 , - : No significant difference)

Table 5 Results of ANOVA of task completion times of participants with and without MCI for each test interface

Button style	Interface	Participants	Number of participants	Mean	SD	p
Text only	A	No MCI	31	5.8	2.8	0.000***
		MCI	30	10.6	6.1	
Pictures aligned with text	B	No MCI	31	7.9	11.1	0.131
		MCI	30	11.6	6.9	
Underlined text	C	No MCI	31	7.5	6.5	0.015*
		MCI	30	11.7	6.5	
Text in squares	D	No MCI	31	6.1	4.6	0.002**
		MCI	30	16.1	16.0	
Text in circles	E	No MCI	31	4.5	3.0	0.001**
		MCI	30	14.9	15.7	

(\* : P< 0.05 , \*\* : P< 0.01 , \*\*\* : P< 0.001 , - : no significant difference)

## B. Operational Tasks

The specified tasks involved executing one randomly selected cooking function of the five functions of the rice cooker: cooking rice, cooking porridge, boiling soup, steaming rice, and heating rice. To complete the tasks, each participant was required (1) to press a button to select the designated cooking function and (2) to press the start button. The test interfaces recorded each participant's task completion time and tracked their touches. The times at which the participant the first touched the screen and pressed the start button marked the start and end of the tasks, respectively.

## C. Participants

A total of 31 older adults without MCI from the University of Third Age of Fu Jen Catholic University were recruited for this study. These participants were physically and mentally healthy, were experienced in using home appliances, and had no problems with oral communication. The average age of the health

participants was  $67.8 \pm 3.8$  years. In addition to the healthy participants, 30 older adults with MCI who were also experienced in using home appliances and had no problems with oral communication were recruited as participants; the average age of the participants with MCI was  $70.9 \pm 6.1$  years. The participants with MCI were selected by an attending physician; MCI was operationally defined as a Clinical Dementia Rating of 0.5. After these participants were referred by the attending physician, the investigator directly communicated with the participants and their families regarding their willingness to participate in this study. The data of both groups of participants is presented in Table 2.

Table 2 Participant data

Sex	No MCI	MCI
Male	12人 ( 39% )	13人 ( 43% )
Female	19人 ( 61% )	17人 ( 57% )
Total	31	30

### III. RESULTS

#### A. Task Completion Times of Participants Without MCI

Table 3 presents the results of the analysis of variance (ANOVA) performed on the task completion times of the 31 participants without MCI. No significant differences were identified in the participants' average task completion times when different interfaces were used ( $p > 0.05$ ), but a post hoc comparison revealed that the average completion time when the participants used Interface E (which had circular buttons) was the shortest and was significantly shorter than those when the participants used Interfaces A and B ( $p = 0.016$ ).

#### B. Task Completion Times of Participants With MCI

Table 4 presents the results of the ANOVA performed on the task completion times of the 30 participants with MCI. No significant differences were identified in the participants' average task completion times when different interfaces were used ( $p > 0.05$ ). Accordingly, button style was determined not to significantly affect the interface use efficiency of the participants with MCI.

#### C. Comparative Analysis

Table 5 presents the results of the ANOVA performed on the task completion times of the participants with and without MCI for each of the five test interfaces. The participants with MCI had longer task completion times for all five test interfaces than did those without MCI. Moreover, the task completion times of the participants with and without MCI differed significantly when they used Interfaces A, C, D, and E ( $p < 0.05$ ) but not Interface B (on which the buttons were styled as pictures aligned with text;  $p > 0.05$ ).

#### D. Interface Touch Tracing Analysis

Table 6 presents images of the touch traces left by the participants with and without MCI when they were performing the assigned tasks. The traces of the participants without MCI were more concentrated than were those of the participants with MCI on all the interfaces, and the participants without MCI touched unrelated areas less frequently, indicating that the participants with MCI experienced greater difficulty in performing the assigned tasks efficiently.

Table 6 Touch traces of older adult participants and participants with MCI

Interface	No MCI	MCI
A		
B		
C		
D		
E		

#### IV. DISCUSSION

The results indicated that the participants without MCI used the interface with the circular buttons the most efficiently, which may have been because circular buttons are commonplace in product design and may therefore have been the most familiar to the participants. According to the interface touch tracing

analysis, the participants with MCI experienced greater difficulty in accurately operating the test interfaces than did those without MCI. Consequently, the participants with MCI required more time to complete the assigned tasks than did those without MCI.

According to Castilla et al. [12], individual with MCI frequently touch areas of an interface other than the buttons to learn the functions of the buttons they press. This behavioral characteristic explains the challenges the participants with MCI faced when performing the assigned tasks. Furthermore, the pictures aligned with text clarified the functions of the buttons for the participants with MCI, which have contributed to the nearly equal use efficiency levels of the participants with and without MCI.

## V. CONCLUSION

This study investigated the usability of electronic rice cooker interfaces with five styles of touch buttons for older adults with and without MCI. The results revealed that the participants with MCI generally required more time to complete the operational tasks than did those without MCI. Furthermore, the participants with MCI experienced greater difficulty in performing the tasks than did those without MCI. These results suggest that MCI does affect people's ability to use products in their daily lives. MCI is prevalent among older adults, and most patients with MCI are still able to live independently. The usability of everyday products for such patients and its implications for product design warrant further investigation.

This was a preliminary study, and only one type of electronic rice cooker was tested. Furthermore, the buttons on all of the interfaces were arranged in straight lines. Because other button arrangements appear on the interfaces

of commercial rice cookers, in future studies, researchers should evaluate the usability of electronic rice cooker interfaces with different button arrangements for older adults with and without MCI.

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