



# Usability Analysis of the Novel Functions to Assist the Senior Customers in Online Shopping

Xinjia Yu<sup>1</sup>(✉), Lei Meng<sup>1</sup>, Xiaohai Tian<sup>1</sup>, Simon Fauvel<sup>1</sup>,  
Bo Huang<sup>1</sup>, Yunqing Guan<sup>1</sup>, Zhiqi Shen<sup>2</sup>, Chunyan Miao<sup>1,2</sup>,  
and Cyril Leung<sup>1,3</sup>

<sup>1</sup> Joint NTU-UBC Research Centre of Excellence in Active Living  
for the Elderly, Singapore, Singapore

{XYU009, lmeng, xhtian, sfauvel, bo.huang, yunqing.guan,  
ASCYMIAMIAO}@ntu.deu.sg

<sup>2</sup> School of Computer Science and Engineering,  
Nanyang Technological University, Singapore, Singapore

ZQShen@ntu.deu.sg

<sup>3</sup> Department of Electrical and Computer Engineering,  
The University of British Columbia, Vancouver, BC, Canada

cleung@ece.ubc.ca

**Abstract.** Online shopping provides a convenient and diverse shopping experience. However, elderly customers are unable to leverage such benefits due to their age-related impairments or lack of computer knowledges. To solve this problem, we extend our previous e-commerce website design with novel assistance functions including multimodal search and personalized speech feedback. In this paper, we evaluated the usability of these functions through a phenomenography based qualitative study. From the results, we found out several biases which affect senior users' interaction with the assistance functions. Firstly, there is a gap between the icon metaphor and the senior users' real world experience. Secondly, consistency is more important than flexibility in e-commerce website design for the elderly. Thirdly, senior users tend to show less interest to explore the website than younger ones. These findings and considerations will guide us in the following rounds of age-friendly assistance function designs to improve the senior user's online shopping experience.

**Keywords:** E-commerce · Multimodal search · Speech feedback  
Age-friendly · Usability

## 1 Introduction

Shopping through websites has been a popular life style in the recent years. It improves the shopping experience with convenience, diversity and richness. However, while the younger generation enjoys the benefits from their online shopping experience, the elderly customers show less interest due to their age-related impairments or lack of familiarity with computers. In the past decades, the world population has been aging at

an unprecedented rate. According to the report of the United Nations [19], the number of older people aged over 60 has reached 1 billion in 2017. The aging population will continue to grow in the following decades. By 2050, this number will expand to 2.1 billion, which is more than double the size of the current elderly population in 2017. Hence, how to adapt the E-commerce systems for the elderly to improve their quality of life has become an important research topic.

To solve this problem, we need to provide assistance functions to the senior users on the pain points during their online shopping experience. Our previous work [12] developed the following novel assistance functions [18]: (1) a multimodal search engine. The searching engine accepts image, speech, text and the combination of them as inputs to help the elderly find products easily and accurately. This function assists the elderly with problems in literacy or typing. (2) A personalized speech feedback engine with the aim of reducing the elderly's visual burden when browsing the website.

The interface of our website is shown in Fig. 1. To provide a better experience to the senior users, bigger font sizes with high-contrast colors (i.e. white text on dark backgrounds) are chosen to improve the visibility of our web browser, and fewer items are listed in a single page for simplified layouts.

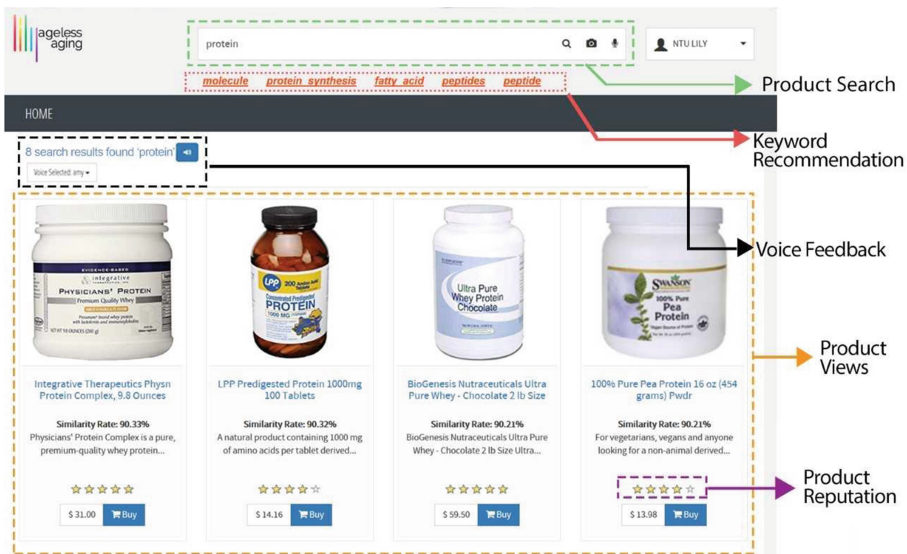


Fig. 1. The interface of our targeted website in this study

Additionally, to make the UI of our system more intuitive use, we chose icons to indicate the multiple search functions. In our system, a user can search by using a part of speech, an image from a camera or the Internet. As such, the user is able to find the desired products more accurately with comparable time of simple search function.

Furthermore, a personalized voice can be generated by the engine for the old users to better understand the speech feedback. In practice, the inexperienced users may miss

some important information about the search results. In order to access the full information of search results for these users, a personalized speech feedback engine is developed. When the product search is finished, the summary of the search results will be presented to the user through voice. A personalized speech engine is built on voice conversion technology, which can transform one speaker's speech as if it was uttered by another speaker with limited training data. Although text-to-speech (TTS) can also realize the similar function with better speech quality, long recording of the target speaker is required to build such a system. Hence, voice conversion is a more cost-efficient way to achieve this goal. After the product searching, a summary of search result is showed in the web page. In the example shown in Fig. 2, there are 77 results found. However, the inexperienced users, especially the elderly, may believe the products are all shown on the existing screen without the mental model to roll down the progress bar or turn to the next page. This speech feedback function can help them to avoid this situation. Moreover, the elderly can also choose or create the voice they prefer for better understanding. They can also replay the speech by clicking on the audio button.

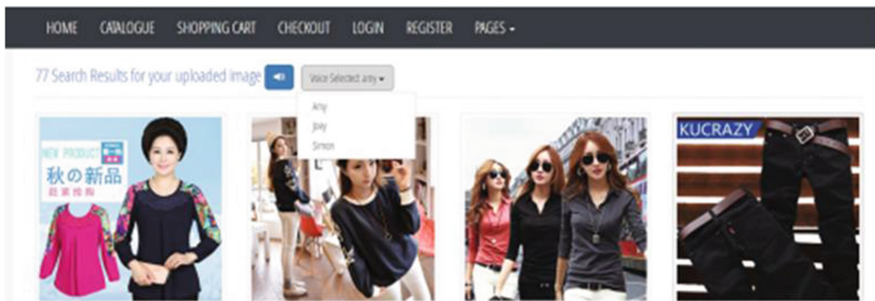


Fig. 2. The interface of the personalized speech feedback function

Do these functions really meet the age-friendly goals? In this paper, we use a lab experiment based qualitative study to analyze the usability of these novel assistances as a follow-up study.

## 2 Related Work

There are several barriers preventing the elderly from using E-commerce. One of the most important is the declining physical and cognitive functions of the elderly [1]. A number of previous studies are focus on the evaluation and development of age-friendly browser designs [1, 4, 5, 8–11, 14, 20]. In [9], the age-friendly design principles in terms of the usability were introduced. In [7], 36 websites were evaluated by older adults in items of 25 “senior-friendly” guidelines recommended by the National Institute of Aging.

Some other barriers root from the inexperience of the senior users in online shopping. To solve this problem, some researchers and developers developed age-friendly functions to assist the elderly in their interaction with the E-commerce websites [3]. In [2, 16], speech technology was adopted for products search. In [7], a study on using voice commands for the elderly when browsing websites was presented. In [12], our team designed three age-friendly functions, crowd-improved speech recognition, multimodal search and personalized speech feedback, to improve the elderly's online shopping experience.

Based on these studies, we extend our previous work in [12, 18] with the following aspects: (1) An age-friendly UI following the human factor designs for the elderly, such as simplicity and intuitiveness, is designed for our E-commerce system; (2) we integrate the previous developed functions, namely multimodal search engine to assist the senior users with problems in visual or typing; (3) a personalized speech feedback is also imbedded into our proposed system to help the inexperienced users. As well as its assistance effect, this function can also enhance the senior users' psychological experience by providing familiarity in voice. With these integrated functional modules, our age-friendly E-commerce system provides the users with less computer or online shopping experience a more understandable online shopping platform.

### 3 Methods

In this study, we use phenomenography as a qualitative method to analyze the participants' experience with the assistance functions based on the e-commerce website. Phenomenography is "a research method for mapping the qualitatively different ways in which people experience, conceptualize, perceive, and understand various aspects of, and phenomena in, the world around them" [13]. It is a methodology with the aim of seeking and describing the variations in the ways people experience. In this study, we observe and analyze the experiential differences of the interaction experience with our online shopping platform between the senior users and young users. Besides the performance observation, we also use semi-structured interviews and comments recording to collect data.

#### Participants

According to Jakob Nielsen [15], 5 users are enough to find about 80% of potential issues while with 10–12 users, we are able to find out 100% of the problems. In this study, we recruited 5 senior participants aged over 60 and 11 younger participants under the age of 40. The younger participants are all Chinese while the senior ones include 3 Chinese, 1 Malaysian Singaporean, and 1 Caucasian from the U.S. All of them can speak English. The details of the participants are displayed in Table 1. The participants' self-rated computer and online shopping experiences can help us to understand the reasons behind their various performances by cross comparison analysis. These participants are volunteers of this study. Ethical clearance to conduct this study was obtained from the Nanyang Technological University Institute of Research Board.

**Table 1.** Participant profile

No.	Age group	Gender	Computer using experience	Online shopping experience
1	30–39	F	3	4
2	20–29	M	4	5
3	20–29	F	5	5
4	>60	M	1	3
5	20–29	F	5	5
6	20–29	M	5	4
7	30–39	M	4	4
8	30–39	F	2	3
9	20–29	F	3	5
10	20–29	F	5	5
11	20–29	F	3	5
12	20–29	F	4	5
13	>60	M	5	1
14	>60	F	4	5
15	>60	F	3	2
16	>60	M	5	4

**Table 2.** Pre-experiment interview questions

1. Which year were you born in?		
2. Are you retired?	If “Yes”	May I know what your occupation was before retiring?
	If “No”	May I know what your current occupation is?
3. Who are you currently living with?		
4. Do you use a personal computer in your daily life?	If “Yes”	How often do you use a computer?
		What do you usually do with your computer?
		How do you rate your computer skill with the scale 1–5
5. Have you ever shopped online?	If “Yes”	Did anyone help you with it? If so, who?
		How frequently do you shop online?
		How do you rate your online shopping experience with the scale 1–5
		Which online shopping websites have you used?
		Do you like online shopping, and why?
	If “No”	What are the major obstacles that stop you from online shopping?
		If you could shop online, what types of goods would you want to buy online?

## Procedure

In this study, each participant used the targeted online shopping website individually under the guide of our researchers. Before the experiment, they were interviewed by in a semi-structured interview with the questions listed in Table 2. Then, the participants experience the platform for about 15 min. Firstly, they browsed the website randomly as their previous online shopping habit. Secondly, they performed a task to search a targeted product by the multimodal search functions. At last, they tried the personalized speech feedback function. During the experiment, the participants were encouraged to think out aloud while their comments and feedbacks were recorded by the researcher. They can also seek help from the researcher any time during the study. After their experience, the participants were invited in a post-experiment interview about their feelings and preferences.

The experiment was conducted on a laptop running Windows 10, and viewed at a  $1280 \times 1024$  pixel using interactive prototype version published in May, 2017.

## Data collection

The following data were collected from this study:

- Interview: The two parts of interviews were both conducted individually. The pre-experiment interview helped us to collect the participants' demographic information, computer knowledge and online shopping information. While the post-experiment interview aimed to collect information about participants' subjective perceptions.
- Phenomenon observation: During the experiment, our researchers were observing the participants' performance and recording their comments. Each participant's task finishing speed, error rate, and operation behaviors were recorded.
- Comment: The participants were encouraged to think out aloud. Their oral comments were recorded by the researcher during the experiment.

## Data Analysis

- Thematic coding: we used the thematic coding method to analyze the text material collected from the interview replies and comments as well as the observation results of the participants' performance.
- Phenomena categorized: the themes generated from the thematic coding analysis provides categories. These efforts helped us to understand the variety phenomena between different age groups.

## 4 Results

Based on the observation and interview results, we found that though both the younger group and the senior one met some problems during their operations, their reactions and subsequent behaviors differed. The error of mis-clicking buttons happens equally in the two groups. However, the majority (7 of 11) of the young participants can fix their mistakes by multiple tries independently. At the same time, the senior participants were swamped in the usability biases, especially in their interactions with the assistance

functions. None of the 5 of our senior participants finished the tasks by themselves for the first time. This phenomenon also happened on 4 of the younger participants with little computer knowledge.

Based on the thematic coding analysis of the comments we collected during the experiment, we revealed the following biases of the elderly which affect the effectiveness of the assistance functions:

(1) Incomprehension of the icon.

In this study, the website used the icons of camera and microphone to represent the image search and voice functions. The aim of this design is to assist the novice users with little computer experience in input process.

In the experiment, each participant was asked to “search products by the given image”. The majority of the younger participants finished this task without problem. However the senior ones met difficult from the beginning. They asked questions like “what should I do?”, “Where should I start?” and “How can I put an image into the system?” In this situation, the researcher showed them the image search function step by step from clicking the camera icon on the searching bar. After the demonstration, 4 of our senior participants finished their tasks following the demo way. The last 1 (Participant NO.15) met other problems in uploading an image. At last, she finished the task under the researcher’s oral guide. Since all of the participants browsed the platform before this task, the researcher asked whether they noticed the camera icon during their browsing. All of them answered “yes”, but none of the senior participants realized that the icon was related to image searching. They even did not realize that they can click it.

Following the image searching task, the participants were asked to search products by speech searching. At this time, both the senior and the younger participants noticed that they should click the microphone icon. To the senior participants, a mental model about icons is established.

There is a gap between the icon design and the users’ real world experiences. The metaphor of icons cannot match the senior users’ real world experience. However, the effect of this metaphor critically depends on the users’ computer culture mental model. The end users, such as the elderly who really need this help, can hardly understand these iconic communications.

(2) Confusion of the multiple paths.

In the task of searching a specific product, at the first time, the researcher introduced the task involving all the possible ways to achieve the goal. We told the participants “please find some pants on the platform by searching. You can use key word searching, image searching, or speech searching.” Nine of the younger participants understood this idea immediately and started their journey. Two of them lost in the requirement with all the 5 senior participants. They asked for a repeat with a common theme: confusion over information. Their responses conclude the following keys: “lost”, “not catch up”, “fail to follow”, and “no idea about what should I do.” When be asked about the reason, their answers flocked around the keys like “too much information” and “too many searching words”. One of the participants mentioned that he “tried to distinguish and understand the XX searching and XX searching and missed the following sentence.” Four of the

senior participants mentioned “separately” or “one by one” in the conversations when they wanted the researcher to repeat the requirement.

To solve this problem, we split the task introduction into three parts as “Please find some pants by key word searching”, “please find some pants by image searching”, and “please find some pants by voice searching”. Each requirement was thrown out after the participant finish the previous one. The 5 senior participants and the 2 younger ones who failed in the first round understood their tasks at this time. One of the senior participants showed a little confusion and asked “why do I need to finish the same task three times using different methods?”

To the senior users, consistency is more important than flexibility. Many website designers provide multiple routes to achieve one single goal to enrich the users’ personalized experience. This design philosophy is demonstrated to be powerful to benefit the skilled users. However, for the novice users such as the elderly, they feel confused and lost facing so many operational options.

### (3) Ignore of the assistance function.

Comparing with the younger generation, the senior ones tend to show less impulse to explore the website. In this case, the website provides a voice feedback to assist the users who have visual bias during browsing. The users can activate this function easily by clicking the icon. However, the senior participants ignored the icon and the function. Unlike the younger participants who showed curiosity to each button and could hardly stop from clicking randomly, the elderly followed the researcher’s guide strictly for they are afraid of damaging the system by wrong operations.

We asked the senior participants whether they noticed the button to activate the speech feedback. Three of them answered “no”. Their reasons include “my attention was fully on your words”, “I was attracted by the product list”, and “I did not think of activating anything manually”.

## 5 Discussion

In this study, we found several obstacles in the novel assistance functions designed for the elderly to make their online shopping experience convenient. These findings show us several directions to improve the usability of assistance functions in e-commerce website design.

- (1) The senior users need more clues other than a simple metaphor icon. In the instance of image searching, we can use an image as a key clue through the whole interface design. When the functions such as product category are all displayed based on images, it will help the users to establish a mental model and lead them to accept searching products by an image. When the users are “thinking with images”, they can find the path to search by images easily. We call this principle “image thinking” design. Furthermore, we can change the position of the traditional searching bar to produce a consistent idea bridge from image browsing to image searching. Figure 3 shows a proposed interface of the “image thinking” design. Besides the existing searching bar design, we display the image searching



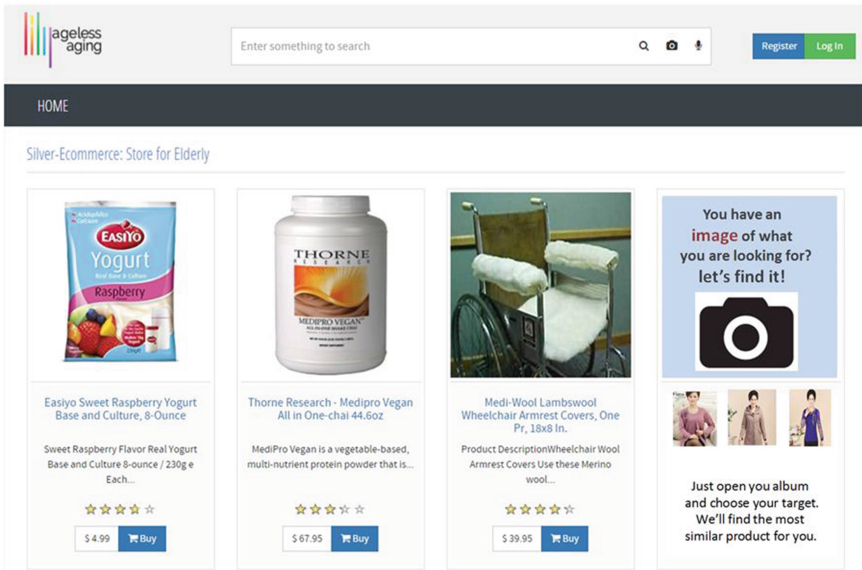


Fig. 3. The proposed image search interface

icons in the cluster of product images. Text introduction and image recommendation are leading the users further as clues. This design idea can also apply to the voice searching function. If we display the voice searching icon and guide under an environment with system voice feedback, the user may learn to use it quickly.

- (2) The simpler the better is an important principle. For the senior users with less familiarity of the computer and weaker memory, a single path to a specific goal is an easier concept to be accepted in control designs. When the system guides the users to achieve a specific goal, the existing personalized design always provide several paths to enhance the users' self-control experience. The introduction is always like "to achieve this goal, we provide Option A, Option B, and Option C, you can choose anyone you like based on your personalized consideration." The process in Fig. 4 is showing an example of this multiple path task introduction.

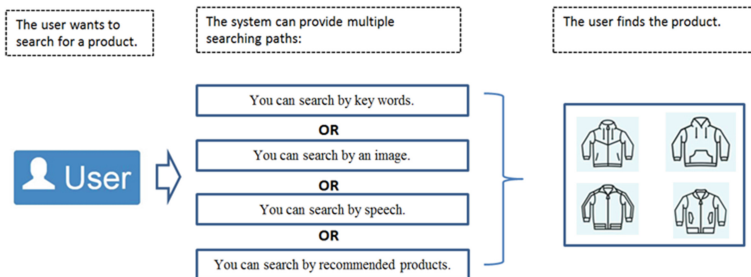
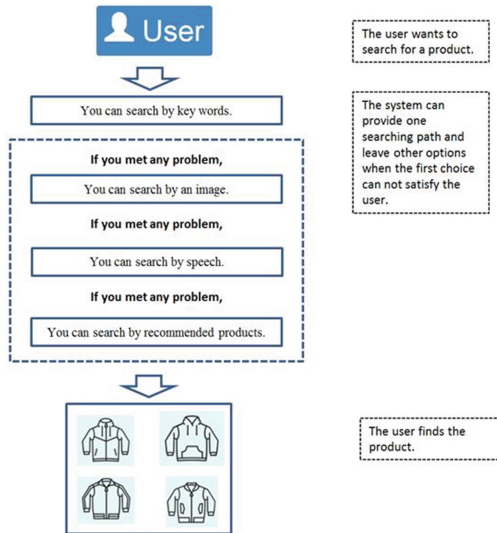


Fig. 4. The process of multiple path task introduction

However, from this study, we found out that for the inexperienced users especially the senior ones, this considerable design lead to confusion in both learnability and memorability. The users may confound various paths together into a way heading nowhere. This confusion also enhances the users' belief of task difficulty level and weakens the users' self-confidence at the same time. To solve this problem, a single path flow may introduce the task better as shown in Fig. 5.



**Fig. 5.** The process of single path task introduction

Under the single path task introduction flow, the experienced users can still choose personalized task achievement routes by trimming the flow in their own way. Meanwhile, the inexperienced users can learn one way to finish this task quickly without many distractions.

- (3) We should take the initiative to show every function, but not depend on the users' exploration. The traditional HCI design tends to leave the users the authority to turn on non-necessary functions. However, in this study we found that the senior users are too easy to be satisfied by the basic system which leads to overlooking the novel functions. In this case, we consider turning on every function as default and leaving the option to turn them off for the senior users instead of the opposite way for the younger ones.
- (4) Age vs. mental model, which is the most critical obstacle in the senior users' interaction experience with online shopping? In this study, the younger participants with less computer experience met the same problems as the senior ones. This situation highlights the critical idea about various mental model considerations in online shopping website design. The decline of cognition ability caused by age and the mental model lack of computer experience are both preventing the

elderly from enjoying online shopping. However, since the mental model problem is not as visible as the former one, it is easy to be ignored in HCI design. Just like the findings in this study, sometimes, the assistance functions may cause usability problems because of the misunderstanding by the senior users.

- (5) The elderly may overrate their computer knowledge and experience. This is a new problem cropping up from the analysis unexpectedly. Two of our senior participants marked their computer experience as 5 which was the highest score. They explained that they worked on personal computer everyday with the Microsoft Office and other software. Meanwhile, the younger participants with the same computer operation level only mark their ability as 3 or 4. Only the developers and students major in computer science marked their computer experience as 5. Based on the concept understanding range in both breadth and depth, the senior participants look more optimistic about their ability. This phenomenon inspires that in user study involving various age groups, a simple self-rated experience, knowledge, or ability mark may not reveal the real situation. More detailed information is needed to assess their self-evaluation.

## 6 Conclusion

Providing novel functions in the e-commerce website to improve the senior users' online shopping experience is a popular attempt in both website design and usability study. However, the lack of computer and online shopping experience by the elderly may weaken the effect of these novel functions. In this study, we found out several obstacles which affect the senior users' online shopping experience with the assistance functions. Firstly, the senior users have problems understanding the widely accepted metaphor icons. Helping the users to establish a "thinking environment" may bridge this gap. Secondly, consistent introduction or guide is more convenient to the elderly than flexible ones. In task introduction design, we should provide one way to finish the task and leave other personalized options for later, but not to push them all together at the same time in front of the user, especially at the first time. Thirdly, the elderly show less curiosity in exploring the system than the younger generation. If the system wants to persuade them to use any function, it should activate it as a default but leave the option to turn it off. These findings and considerations will guide us in the following age-friendly assistance function designs to improve the senior users' online shopping experiences.

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