

A Study of the Effects of Display Atmospheric and Control Mode of 3D Virtual Store on Consumer Behavior in the Elderly

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Abstract. Online shopping has become quite popular since its first arrival on the internet. Some research has indicated that the older population is growing rapidly worldwide and is becoming an increasingly important demographic to understand. However, previous studies on cognitive aging have found that certain aspects of human information-processing abilities are negatively correlated with age. This study will discuss the effects of online store atmospheric collocating with control mode applied on 3D virtual store vision displaying for improving usability and acceptability in the elderly. The objectives of this study are to evaluate the cognition and emotion of the elderly on 3D virtual store atmospheric and control mode. It was found that the recognition and presence was positively related to emotion for the elderly, and then, emotion is positively and directly related to customers' behavioral intention. There was the best effect in recognition and presence by the central-cabinet layout.

Keywords: 3D virtual stores, Elderly, Atmospheric, Control mode, Cognition, Emotion.

1 Introduction

Online shopping has become quite popular since its first arrival on the internet. It lets us buy what we want, when we want at our convenience, and helps us to imagine ourselves buying, owning, and having positive outcomes by the goods available out there on the web [1]. Shopping has been a way of identifying oneself in today's culture by what we purchase and how we use our purchases. Although the percentage of older adults (i.e. silver tsunami) using the web is less than the percentage of younger individuals, surveys indicate that this may not be the case for long. The World Health Organization estimates that by the year 2020, 24% of Europeans, 17% of Asians, and 23% of North Americans will be over the age of 60 [2]. By 2020, the world will have more than 1 billion people age 60 and over. Along with elderly society's coming, many older adults (i.e., the "silver tsunami" generation) have problems performing daily tasks because of restricted mobility, lack of transportation, inconvenience, and

fear of crime [3]. Computers with an internet connection used at home can provide this population a new channel to access to information and services, and can also be used to manage internet shopping tasks. However, the traditional web shops introduce commodities only by two dimension (2D) pictures and descriptive catalogue, which fall short in terms of reality and the interaction with goods. This kind design with poor reality and interaction will influence customers' real shopping experiences; and what is more, they minimize customers' desire to shop. Therefore, the elderly may find the barriers so great to prevent effective communication and shopping taking place [4]. Nowadays, such problems can be solved utilizing the technology of virtual environments (VEs) [5]. One of the primary advantages of VE technology applied in web shops is its ability to provide a three dimension (3D) perspective to customers for more real sense on goods and shopping environment. When the elderly is growing rapidly worldwide [6], for this population, the combination of VEs and internet would introduce a new mode in online shopping. However, previous studies on cognitive aging have found that certain aspects of human information-processing abilities are negatively correlated with age. Specifically, there are four basic mechanisms accounting for age-related decline in cognitive functions, including processing speed, working memory, sensory function and inhibition. Additionally, as the technology, hardware and software, improves, real applications become more feasible gaps in our knowledge about them become even more apparent. One need for better knowledge concerns the notion of recognition and presence. The recognition, in terms of perception, means that what we are seeing now puts us in mind of something we already know or are familiar with [7]. The presence is a desirable outcome of VEs participation, the existence of user predictable interactivity, degree of realism of the VEs and quality of fidelity of sensory input [8]. The emotion is a subjective feeling state within the individual such as pleasure, joy and excitement, and will be simulated by traditional retail store design [9]. Recognition and presence belong to perception level, emotion belongs to cognition level. Good recognition and presence will stimulate positive emotion. Furthermore, the atmospherics and control mode are important factors for designing 3D virtual store [10]. What types of atmospherics and control mode would induce better recognition and presence? Therefore, this study will discuss the effects of perception and emotion on atmospherics and control mode designed in 3D virtual store for improving usability and acceptability in the elderly.

2 Method

2.1 Hypotheses

In this study, the recognition and presence would be used to evaluate the effects of design factors of 3D virtual store on the elderly consumers' shopping decision. Related research hypotheses are described below.

1. Differences of 3D virtual store physical design factors will impact recognition of the elderly.

2. Differences of 3D virtual store ambient factors will impact recognition of the elderly.
3. Differences of 3D virtual store control mode will impact presence of the elderly.
4. Recognition positively affects emotion for the elderly.
5. Presence positively affects emotion for the elderly.
6. The elderly will be more easily accept the store shopping patterns in higher emotion.

2.2 Research Model

The research model, depicted in Figure 1, is based on literature review and resulting hypotheses illustrated in the previous section. The research constructs and corresponding interrelationships are shown in the research model.

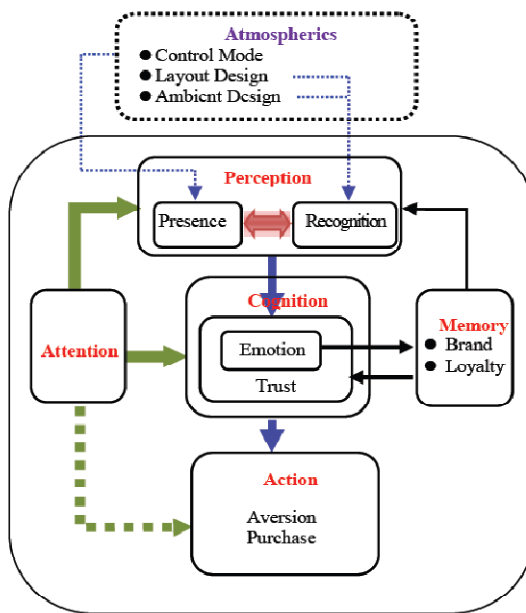


Fig. 1. Model of information decision on consumer behavior in 3D virtual store

2.3 Participants

There were 36 people (average age of 67.5 years) selected to participate in the experiment. They were paid a nominal NTD500 as compensation for their time. All participants were fully informed and had signed a consent form. Some researchers found that repeated exposure to the same virtual environment with separation of less than seven days could significantly affect the levels of cybersickness which would induce

participant's disorientation and nausea [11][12][13]. Therefore, the participants had not been exposed to the experimental VE in the previous 2 weeks.

2.4 Apparatus and the VE

The VE experiment was constructed using a virtual environment developing software (3DMax and Virtools) and presented on a 22" TFT-LCD display. The scene was designed as a retail store of automobile peripheral fitting for portable device. There are four commodity group designed in the virtual store: Brackets, Holders, Accessories and others. All objects are designed in 3D type (see Figure 2).



Fig. 2. A list of All merchandise presented in store

2.5 Experimental Design and Procedures

The study involved a 3 (Layout: central-arc type show, central-cabinet show and surround type show) \times 2 (Exhibition presentation: store plus arts billboards around and nothing and nothing) \times 2 (Control mode: operation in the role of "I" and "bystander") between-subjects experiment, resulting in a full-factorial design with 12 treatment conditions. Each participant was randomly assigned one of the 12 conditions to do the task of goods-finding. Therefore, there were three participants was randomly assigned to one of the 12 conditions.

1. Independent variables

- (a) Layout: the physical design factor to show overall layout of the exhibition area including: central-arc type show, central-cabinet type show and surround type show (Figure 1).
- (b) Exhibition presentation: the ambient design factor to show aesthetic presentation of the exhibition area including: (a) store plus arts billboards around; (b) nothing.
- (c) Control mode: operation in the role of "I" or "bystander." In the mode of "bystander," there is an avatar to be manipulated by the keyboard to find the designed goods in the virtual store.

2. Dependent variables

- (a) Recognition: Ahn et al (2004) services and commodities cognitive questionnaire was referenced to measure the elderly understanding of store and goods [14].
- (b) Presence: the ITQ questionnaire (Immersive Tendencies Questionnaire) and PQ questionnaire (Presence Questionnaire) was used to measure participant's presence of the store. ITQ questionnaire was used to measure the degree of integration into the virtual environment. PQ questionnaire was used to evaluate the sensitivity for the virtual environment [15].
- (c) Emotion: Mehrabian and Russell (1974) PAD (Pleasure, Arousal and Dominance) measurement questionnaire was used to assess the emotion during the virtual store [16].

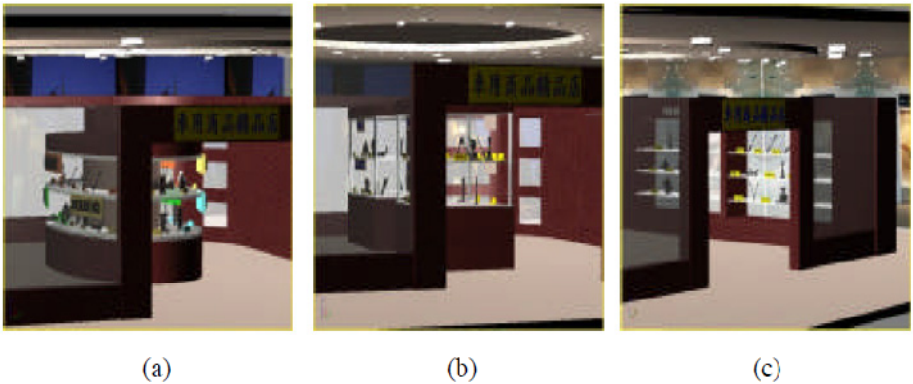


Fig. 3. Scene of the experimental 3D retail store: (a) central-arc type show; (b) central-cabinet show; (c) surround type show

3. Procedure

All participants were exposed to the same VE. During exposure, the VE was controlled by the program. First, the scene was rotated for one complete circle at the door gate along the vertical axis with a set rotating speed and angle. The scene was then moved forward along the fore-and-aft axis for 5 sec. at 0.2 units of translate vector per second before being rotated for one complete circle. Next, the scene was turned to the right and moved forward to the end of the showroom. The scene was then moved back to the door gate and rotated for one complete circle. It was then turned left and moved forward to the end of the showroom. Finally, the scene was returned to the door gate. The scene was halted for 5 sec. at each step. During the exposure period, participants were asked to search for and confirm eight goods in the store. When all eight target goods had been found, s/he was asked to complete the questionnaires.

3 Results and Discussion

3.1 Effects of 3D Virtual Store Design Factors

Via the variance analysis of 3D virtual store design factor for recognition and presence, the results showed that the main effects of physical design factor (i.e. layout) and control mode in recognition and presence are significant for the elderly, but the ambient design factor (i.e. aesthetic presentation) is not. These results provide support for hypothesis 1 and 3, but not support for hypothesis 2. Scheffe's post-hoc test, a multiple comparison statistical procedure, was used to identify differences between groups after a significant F ratio has been obtained in ANOVA (see Table 1 and Table 2). The findings indicate that there is the best effect in recognition and presence by the central-cabinet show. The reason may be that the central-cabinet show has better permeability compared with other layout; consumers could find and browse the merchandise in a short period of time. Additionally, the "I" control mode is better than "bystander" in presence. It shows that the sight will be impeded during operation in "bystander" mode, therefore, the sense of interactivity and control will not be gained to better the effect that people experience when they interact with the virtual store.

Table 1. Scheffe's post hoc tests for the effects of physical design factor on recognition

(I)Physical design factor	(J) Physical design factor	Mean Difference (I-J)	Standard Errors	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Central-arc type	Surround type	-.938*	.261	.001	-1.457	-.418
	central-cabinet type	-2.031*	.261	.000	-2.551	-1.511
Surround type	Central-arc type	.938*	.261	.001	.418	1.457
	central-cabinet type	-1.094*	.261	.000	-1.614	-.574
Central-cabinet type	Central-arc type	2.031*	.261	.000	1.511	2.551
	Surround type	1.094*	.261	.000	.574	1.614

*p < 0.05 significant level.

Table 2. Scheffe’s post hoc tests for the effects of physical design factor on presence

(I)Physical design factor	(J) Physical design factor	Mean Difference (I-J)	Standard Errors	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Central-arc type	Surround type	-.813*	.291	.007	-1.392	-.233
	central-cabinet type	-1.594*	.291	.000	-2.173	-1.014
Surround type	Central-arc type	.813*	.291	.007	.233	1.392
	central-cabinet type	-.781*	.291	.009	-1.361	-.202
Central-cabinet type	Central-arc type	1.594*	.291	.000	1.014	2.173
	Surround type	.781*	.291	.009	.202	1.361

*p < 0.05 significant level.

3.2 The Results of the SEM

Given the existence of multiple relationships between the dependent, mediating and independent variables, structural equations modeling (SEM) appears to be the most appropriate method for addressing the research question [17].The structural model designed in this study specified the physical objects design, control mode, layout design and ambient design as the exogenous constructs, while presence, recognition, emotion and behavioral intentions as the endogenous constructs, while presence, recognition, emotion and behavioral intentions as the endogenous constructs, while presence, recognition, emotion and behavioral intentions as the endogenous constructs.

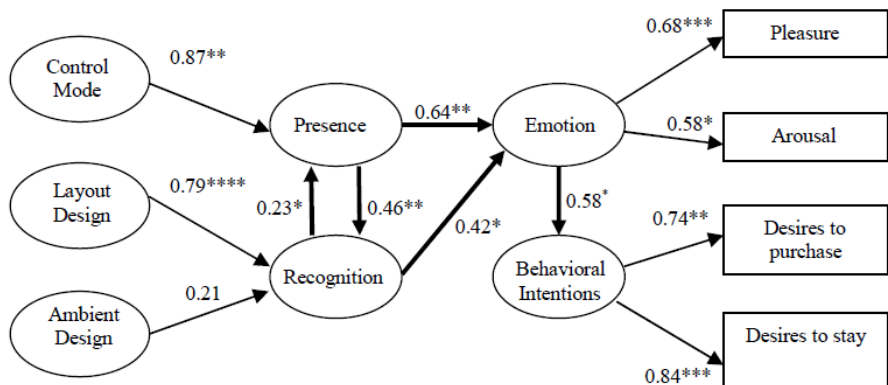


Fig. 4. The structural equation model of the full model

emotion and behavioral intentions were adopted as endogenous constructs as shown in figure 4. Hypothesis 4 posited that recognition positively affects emotion for the elderly. The analytical results, as shown in Figure 4 and Table 3, indicate that recognition is positively related to emotion for the elderly, with a standardized coefficient of 0.42 ($p < 0.01$). Thus, H4 is supposed. Additionally, presence also positively affects emotion for the elderly (i.e. Hypothesis 5 is supposed). Note that presence contributed more direct impacts to emotion than recognition toward the 3D virtual store. Finally, emotion is positively and directly related to customers' behavioral intention (i.e., desires to purchase and desires to stay), with standardized coefficient of 0.58 ($p < 0.05$). Hence, Hypothesis 6 is supported.

Table 3. The results of the full model

Measurement model				
Constructs	Type	Indicators	Loading	Critical ratios value
Presence	ξ_1	Control Mode	0.8725	31.273 ^{***}
Recognition	ξ_2	Layout Design	0.7873	22.459 ^{***}
		Ambient Design	0.2104	1.531
Emotion	η_1	Pleasure	0.6823	15.364 ^{***}
		Arousal	0.5774	11.741 ^{***}
Behavioral Intentions	η_2	Desires to stay	0.8351	4.379 ^{***}
		Desires to purchase	0.7435	2.983 ^{**}
Structural Model				
	Paths		Coefficient	Critical ratios value
Presence	→	Emotion	0.64	7.639 ^{***}
Presence	→	Recognition	0.46	4.372 ^{***}
Recognition	→	Emotion	0.42	2.643 ^{**}
Recognition	→	Presence	0.23	1.972 [*]
Emotion	→	Behavioral Intentions	0.58	2.152 [*]

4 Conclusion

The results of this study show that the main effects of physical design factor (i.e. layout) and control mode in recognition and presence are significant for the elderly, but the ambient design factor (i.e. aesthetic presentation) is not. The response of the participants in the experiment is in compliance with the proposed Model of information decision on consumer behavior in 3D virtual store, i.e. the recognition and presence was positively related to emotion for the elderly, and then, emotion is positively and directly related to customers' behavioral intention. Additionally, the "I" control mode is better than "bystander" in presence. It shows that the sight will be impeded

during operation in “bystander” mode, therefore, the sense of interactivity and control will not be gained better the effect that people experience when they interact with the virtual store. Therefore, the central-cabinet layout combined “I” control mode designed in the 3D virtual would produce the best effect in recognition and presence for the elderly.

Acknowledgement. The authors would like to thank the National Science Council of the Republic of China for financially supporting this work under Contract No. NSC101-2221-E-238-001.

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