

A Study of the Effects of Spatial Arrangements and Interactive Medias on Presence, Involvement and Emotion in Senior Visitors within a Virtual Art Gallery

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Abstract: *With the rapid development of the Internet, an increasing number of art activities are being carried out online. Therefore, the elderly can visit an online art gallery from home to enjoy browsing various exhibitions and artworks. This study aimed to evaluate the influence of spatial arrangements and interactive medias on presence, involvement, and emotion to propose better principles for senior visitors in virtual art galleries. A virtual art gallery containing paintings, pottery and statues was established. A hypothesized model was constructed for evaluating the effects of spatial arrangements and interactive Medias on presence, involvement and emotion in senior visitors, and a three-step mediation analysis using regression was applied while accounting for the hierarchical structure of the data. The results showed that spatial arrangement and interactive media are essential factors in designing virtual art galleries for senior visitors. A virtual art gallery with thematic arrangement based on historical background can help senior visitors construct the spatial cognitive map quickly; additionally, interactive oral Medias provide easy semantic recognition and understanding, which can easily increase positive feelings of presence. When the degree of immersion increases, senior visitors feel interested, excited and satisfied, and resulting in positive involvement and emotion.*

Keywords: Spatial arrangement, Interactive media, Presence, Involvement, Emotion, Virtual art gallery

1. Introduction

In recent years, with the rapid development of the Internet, the World Wide Web has become the most popular form of media globally and has also driven a wave of art and culture. Simultaneously, due to the reduced activity levels of the elderly, Internet browsing has become another way for them to experience life. Through the presentation of stereoscopic images and fictional scenes in virtual environments, people can interact freely with the environment, creating another valuable means of experiencing [1]. Therefore, older people are more active on the Internet [2]. It is a gift for the elderly who cannot move easily and thus have another way to experience their lives. Although the percentage of older people using the Internet is still lower than that of younger people, some research has shown that this phenomenon will change significantly in the future, and the elderly will become the fastest-growing Internet user group[3,4]. Virtual art galleries were established to disseminate art-related information to the public through the Internet. Smiraglia (2015) [5] found that single-visit object-based museum outreach programs for older adults may elicit positive psychosocial outcomes. Therefore, the development of a virtual art gallery is more meaningful for the elderly. In particular, elderly individuals with limited mobility can freely access Internet virtual art galleries to enjoy browsing

exhibitions and viewing artworks from various angles, thus improving the sense of fun in their lives.

1.1 Spatial arrangements

The primary purpose of a museum or art gallery is to collect, protect, and study artworks and display them for visitors. The spatial arrangement of the artwork is the concrete expression of the museum's exhibition characteristics, so it is as important as the artwork itself. Mallapragada et al. (2016) [6] found that spatial arrangement has a significant impact on consumer behavior in both traditional and online environments. Al-Sallal et al. (2018) [7] claimed that better spatial arrangements enhance the overall lighting environment and minimize risks to artifacts and increase visual comfort. Smith and Foote (2017) [8] argued that the spatial arrangements of text, media, and artifacts shape narrative storylines and suggest sequences, connections, progressions, and pathways within and between exhibits. That is, the spatial arrangement of the "collection" of an art gallery is connected with the theme and artistic conception of the exhibition. Therefore, the design of spatial arrangements in an art gallery will profoundly influence visitors. The spatial arrangement across art gallery spaces can enhance or detract from the intended exhibit themes.

The spatial arrangement of an art gallery can be divided into two major categories: architecture and theme. The architectural arrangement is how the building space creates viewing sequences through the organization of objects and how circulation paths form the essence of a gallery visit experience [9]. Architectural design may enrich the museum visit experience by diversifying the organization of displays and circulation paths. The thematic arrangement involves grouping artworks in a room according to topic. Through thematic arrangement, visitors can recognize and appreciate artworks in an orderly manner. Hubbard (2014) [10] emphasized that selecting a particular theme affects the way a visitor reads the artwork, and visitors can be frustrated by an inappropriate theme being assigned to artwork. In a virtual world, the purpose of an art gallery's spatial arrangement is to create an environment that encourages visitors to spend more time there and enjoy the experience. Therefore, in a virtual art gallery, the thematic arrangement is more important than the architecture arrangement.

For the selection of an exhibition theme, Panourgias (2003) [11] mentioned that retrospective exhibition of the works of an individual artist, chronological display of a particular period, and national or regional collections could all be considered as having themes and being displayed accordingly. In general, these themes can be divided into two major categories: historical background and artistic characteristics. For the historical background category, the theme is almost entirely historical in its conception and interpretation. For the artistic characteristics category, theme classification is based on the type of artwork, such as paintings and bronzes.

In this study, the impact of the differences effects of historical background and artistic characteristic thematic arrangements on presence, involvement, and emotion in a virtual art gallery will be discussed. Because the exhibition of artwork is less restricted by space in virtual art galleries, the artwork displays can be numerous and include more content. Therefore, more artwork, including paintings, porcelains, and silverware created in Europe and Asia will be collected and displayed in the virtual art gallery.

1.2 Interactive medias

For the art gallery, interpretation includes how meaningful information is used to tell the stories associated with the artwork. It involves grouping objects for display, the historical and other supporting information provided with them, and how his information is presented. Additionally, an interactive media can achieve the purpose of interpretation. Mujtaba et al. (2018) [12] claimed that an interactive design applied to interactive medias would foster positive cognitive, affective, and social outcomes for students visiting a museum. Harvey et al. (1998) found [13] that interactive components, multisensory stimulation, and dynamic medias influenced flow and immersion in physical museums. Gallery visitors are no longer content with the mere sight of archaic treasures. An increasing number of art galleries have introduced interactive medias to attract visitors. A valid interactive media goes beyond technology within exhibits and installations and includes more pervasive uses of technology to create interactive experiences for visitors

throughout an art gallery, as well as remote experiences for those who cannot physically be there.

Augmented reality (AR) technology provides direct interaction between users and objects. Virtual information or virtual objects are overlaid on real-world images to provide context-aware integrated multimedia user interaction [14]. Through interactive applications, users often experience feedback-based two-way interaction rather than merely receiving a unidirectional flow of information. Moreover, interactive applications enable users to control what they wish to see/hear and how the information is delivered [15]. By incorporating AR technology into an exhibition scene, the user can experience much richer interactions. Therefore, AR shifts the mode of interaction from input via conventional devices to using actions directed at virtual objects, thus eliminating the need for users to come into contact with a standard input device, such as a keyboard, mouse, or touch screens. Additionally, AR can display and illustrate contextual information about artwork to users in real time to complement the virtual art gallery experience. In this work, an interactive AR media was developed for introducing historical artwork into a virtual art gallery. This study will construct experiments to evaluate the effects of AR media versus those of traditional general medias.

1.3 Presence

Presence has been discussed in the virtual environment for many years. Presence is the idea of "being there," that is, being inside a space even when not physically located in that space [16]. Additionally, a sense of presence can also be found in non-immersive virtual environments [17]. Therefore, presence gives rise to the feeling that events in the virtual environment are happening [18]. Tussyadiah et al. (2018) [19] also mentioned that presence could explain the effectiveness of VR as a substitute for and/or simulation of the real world. Since presence is a subjective psychological feeling, the impact of various designs of a virtual environment on the operator can be evaluated through presence [20-23]

When an operator immerses in a VE, she/he does not pay attention to the external world or the technology but to the objects, events, and roles depicted in the VE [16]. Therefore, it is a challenge for virtual art gallery designers to create the sensation of presence to attract visitors by refreshing the objects, events, and roles of the VE [24]. Liu and Uang (2016) [25] concluded that presence is an essential evaluation index for construction characteristics and design goals during the VE development process.

However, people of different ages may experience different degrees of presence in the same virtual environment because the difference in perception induced by age allows people to have different sensitivities to the feeling of presence in VEs. Slater and Wilbur (1997) [26] noted that to increase the sense of presence and thus establish immersion in a VE, the environment must a) offer high-fidelity simulations through multiple sensory modalities, b) finely map users' virtual actions to their physical bodies, and c) remove participants from the external world through vivid environments and self-contained plots and narratives. In this study, spatial

arrangements and interactive Medias will be evaluated to determine whether they can provide a vivid environment and independent plots and narratives for senior visitors. Therefore, it is essential to assess their impacts in terms of the sense of presence experienced by senior visitors within a virtual art gallery.

1.4 Involvement

Involvement is a person's engagement with and attention paid to a specific situation, thing, or situation for a period of time [27]. It is a person's focus on an activity, which has a special feeling to him/her. Involvement can come from previous experience or the environment [28]. Therefore, involvement partially depends on sensory experience. In addition, a person with high antecedent involvement may be most interested in technology applications (e.g., an enjoyable VE). Contextual involvement, by contrast, can be spurred through more significant sensory input: the extent to which a user's real senses are engaged by a VE directly influences their engagement with the overall experience [29], especially when this engagement leads to flow. McIntyre (1989) noted [30] three dimensions related to involvement: attraction, centrality, and self-expression. Attractiveness is the degree of fun and satisfaction experienced through activities. Centrality is the degree of centering on individual activities. Self-expression is the degree of self-identity had during activities. Understanding the critical role of enduring involvement in tourists' judgments and intentions is critical in cultural tourism [31]. Wang and Wu (2011)[32] claimed that museum visitors might notice changes in museum images and compare them with remembered images of museums they have visited in the past, thereby creating a subjective sense of involvement in the museum. Andreacola et al. (2015) [33] found that involvement is the impetus for museums to develop a digital strategy. As indicated by Lu et al. (2015) [34], the relationship between tourists' involvement and the spatial arrangement and image design of a destination is still unclear and understudied. Previous studies have found that the degree of involvement is an extension of a specific type of perception in a VE [35]. Therefore, presence in perception may have a more significant positive effect on involvement in a virtual art gallery.

1.5 Emotion

Mehrabian (1976) [36] claimed that emotions constitute one of the key elements of people's psychological responses and were developed to assess whole environments and people's responses to them. A specific environment can cause some emotional reactions in an individual, which causes the individual to approach or avoid the environment. Mehrabian and Russell (1974) [37] proposed three factors that influence emotional response: pleasantness, arousal, and dominance. Pleasantness is an individual's level of feeling happy, joyful, content, or satisfied. Arousal is one's degree of activity, excitement, stimulation, or alertness. Dominance is the extent to which an individual feels unrestricted and in control of a situation. Westbrook and Oliver (1991) [38] reported that emotion is a key driver of a holistic

understanding of post consumption behavior. Therefore, emotional states can operate as signs or information for judging one's feelings about an encountered environment.

An exhibition (e.g., museum) promotes essential and relevant dialogue through its collections and makes these objects accessible and meaningful to a variety of visitors [39]. The primary purpose of any exhibition is to help visitors feel happy and experience positive emotions. In addition, it can be reasonably expected that the more positive an emotion is, the higher the likelihood visitors revisit a destination [40]. Accordingly, visitors who feel positive emotions are more satisfied [41]. This explains why recent research strongly recommends that a visitor's emotional experience should be considered when measuring her/his behavior at an exhibition [42]. Therefore, it is important to investigate visitors' emotions to understand their feelings after visiting an exhibition [43]. The emotions of visitors are influenced not only by the value of the artwork in a virtual gallery but also by their subjective feelings associated with the environment [24]. Evaluating visitors' emotions can help us clearly understand the pleasantness, arousal, and dominance of visitors in a virtual art gallery. As mentioned in the previous section, presence is a subjective psychological feeling of "being there", and emotion or involvement is an extension of a specific type of perception in a virtual environment. Presence should have a certain degree of influence on senior visitors' involvement and emotion while visiting a virtual art gallery. It is worth exploring whether these factors interact with each other.

2. Material and Methods

2.1 A hypothesized model for evaluating spatial arrangements and interactive Medias

According to the literature reviewed and resulting hypotheses illustrated in the previous section, a model has been proposed to account for the behaviors associated with the impact process of spatial arrangement and interactive medias in a virtual art gallery and was used to generate testable hypotheses, as shown in Fig. 1. There are three stages between stimulus presentation and subsequent human response during information processing. First, the spatial arrangement and interactive media of the virtual art gallery, which is an external stimulus, is detected by the sensory organs. Via these virtual environmental stimuli, the information of the virtual art gallery images is organized at the perceptual stage. The appropriate images and information might be extracted and communicated to enhance spatial identification and form a subjective experience (i.e., presence) of being in one place or environment. Thus,

H1: The spatial arrangements in virtual art galleries affect senior visitors' presence.

H2: The interactive Medias in virtual art galleries affect senior visitors' presence.

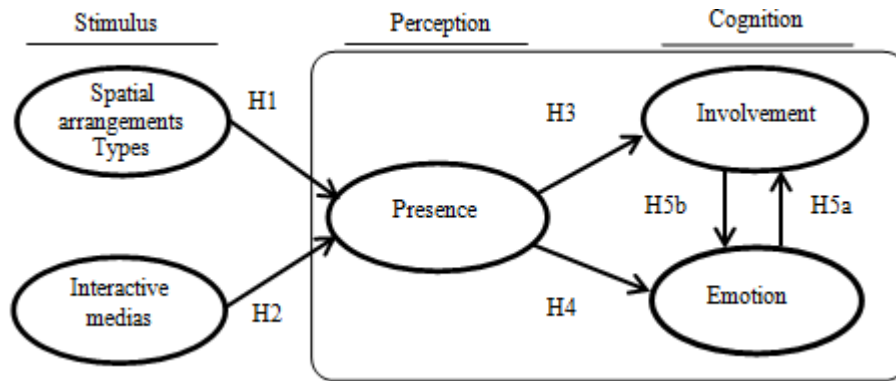


Figure 1: A hypothesized model of the impact process of spatial arrangements and interactive Medias within the virtual art gallery

Perception is the foundation of information processing, and its function is to build an internal representation of the information presented by the virtual art gallery. This is achieved by first converting a stimulus into a neural code and then by hierarchically extracting information from this code. Cognition involves highly integrated processes. It helps build a meaningful representation (i.e., involvement and emotion) from perception by providing knowledge of the environment [44]. In the transition from perception to cognition, presence might be an essential subjective sensation that would allow the elderly to be immersed in the visiting experience to produce positive involvement and emotions. Thus,

H3: The presence experienced by senior visitors of a virtual art gallery has a significant positive effect on involvement.

H4: The presence experienced by senior visitors of a virtual art gallery has a significant positive effect on emotion.

Involvement occurs when a person engages in and pays attention to a specific situation, thing, or situation for a period of time. Emotion is a psychological reaction of an environment. When a person visits a virtual art gallery and pays attention to a particular situation due to certain stimuli, will it produce an approach or avoidance emotional reaction in the individual? Alternatively, because certain stimuli produce more obvious emotional reactions, will it influence involvement to be given to certain specific situations? Therefore, we were concerned about the correlation between involvement and emotions. Thus,

H5: The relationship between senior visitors' involvement and emotion is reciprocal.

H5a: A senior visitor's emotion in visiting a virtual art gallery positively affects involvement.

H5b: Senior visitors' involvement in visiting virtual art galleries positively affects emotion.

To test whether the effect of involvement was mediated by emotion or the effect of emotion was mediated by involvement, we conducted a three-step mediation analysis using regression while accounting for the hierarchical structure of the data [45, 46]. Fig. 2 displays the overarching mediation models we tested along with the relative paths we used to assess the direct and indirect effects for each of these analyses. Two models were constructed. The first model included emotion as the mediator and involvement as the outcome; the second model included involvement as the

mediator and emotion as the outcome. In the first step of the mediation analysis, we assessed the effect of the predictor (presence) on the outcomes (involvement (model 1: path c1) and emotion (model 2: path c2)), as shown in Fig. 2. In the second step, we assessed the effects of the predictor on the mediators (emotion (model 1: path a1) and involvement (model 2: path a2)). In the third step of the mediation analysis, we assessed the effects of the predictor condition and the mediator on the outcomes (involvement (model 1: paths b1 and c1') and emotion (model 2: paths b2 and c2')). Via mediation analysis, we can clearly understand the correlation between involvement and emotion.

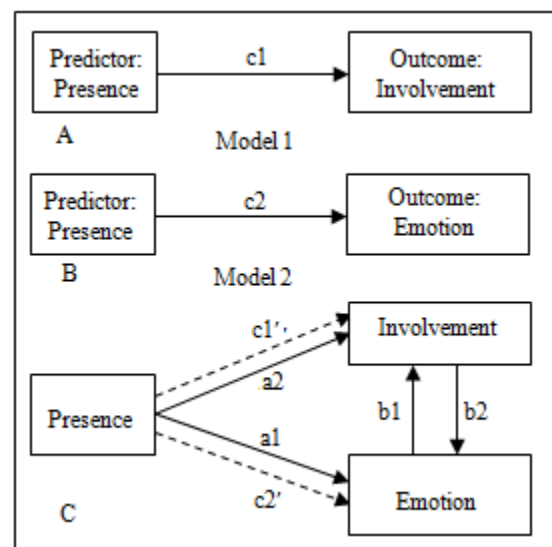


Figure 2: Mediation model tested. Panels A and B show the direct effect from presence to involvement (model 1: path c1) and emotion (model 2: path c2) for the first step in the mediation analysis. Panel C shows the second step (model 1: path a1; model 2: a2) and third step (model 1: paths b1 and c1'; model 2: b2 and c2') in the mediation analysis (based on Zhang et al., 2009 [46]).

2.2 Apparatus and the VE

This study focused on the effect of spatial arrangement and interactive media on the sense of presence, involvement, and emotions of the elderly when a virtual art gallery was visualized through a handheld mobile device with a screen size of 5.5" and a tablet with a screen size of 15.1". The VE scene for this study was an art gallery containing paintings (20 PCS), pottery (25 PCS) and statues (10 PCS). The

building was designed as a museum to increase the aesthetic view of the virtual art gallery, as shown in Fig. 3.



Figure 3: The building was designed as a museum to increase the aesthetic view of the virtual art gallery.

2.3 Experimental design

2.3.1 Independent variables

The study involved a 2 (Spatial arrangements: thematic arrangement by historical background and artistic characteristics) × 3 (Interactive medias: interpretation board, oral, and interpretation with AR) between-subjects

experiment, resulting in a full-factorial design with six treatments. In the variable of spatial arrangements, there are two levels of the spatial arrangement variables involved: thematic arrangement by historical background and artistic characteristics. The thematic historical background was designed with three independent areas-Ancient Egypt, Roman Empire, and the Renaissance-as shown in Fig. 4 (a), (b), and (c), respectively. Fig. 5 shows the exhibition site with artistic characteristics for three categories of art: painting, statues, and pottery. Additionally, for the interactive media variable, there are three types of interactive Medias: interpretation board, oral, and interpretation with AR, as shown in Fig. 6. For the interpretation board type, the text description of artwork is presented in the form of a board under the artwork (Fig. 6(a)). Visitors can read the text description on the board by freely zooming in and out. For the oral type, when the visitors click the button in front of the artwork, the artwork's verbal description plays automatically (Fig. 6(b)). In the AR type, when the visitors use the mobile phone to view paintings or artwork images in the form of AR identification codes, the text description of the artwork can be immediately displayed with a voice introduction on the mobile phone (Fig. 6(c)).

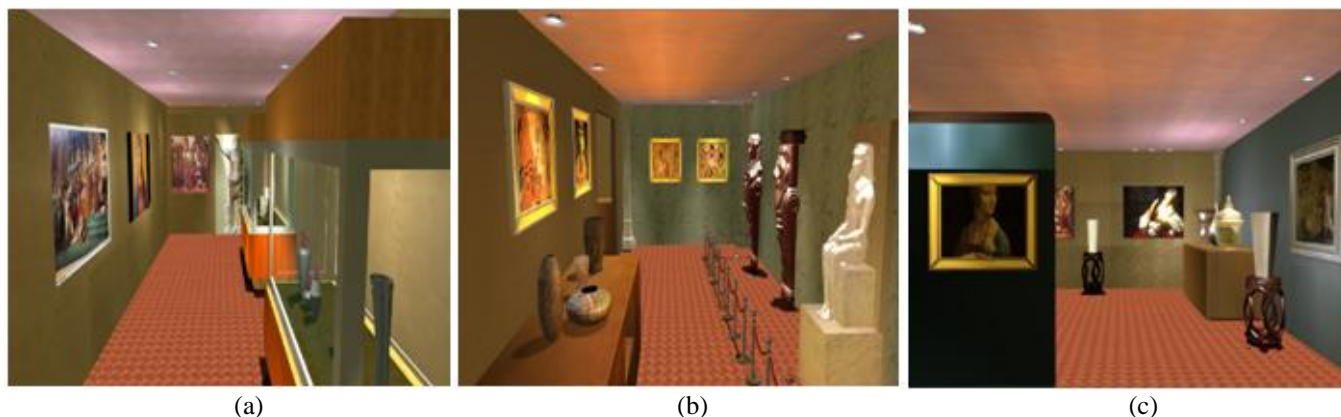


Figure 4: The spatial arrangements with themes by historical background: (a) Ancient Egypt; (b) Roman Empire; (c) the Renaissance.

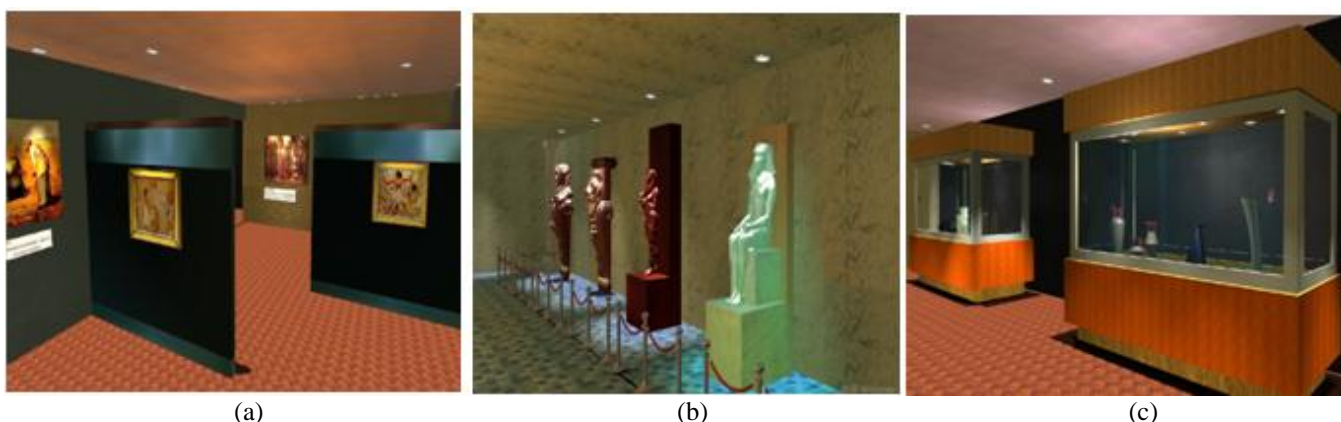


Figure 5: The spatial arrangements with themes by artistic characteristics: (a) painting; (b) statues; (c) pottery.

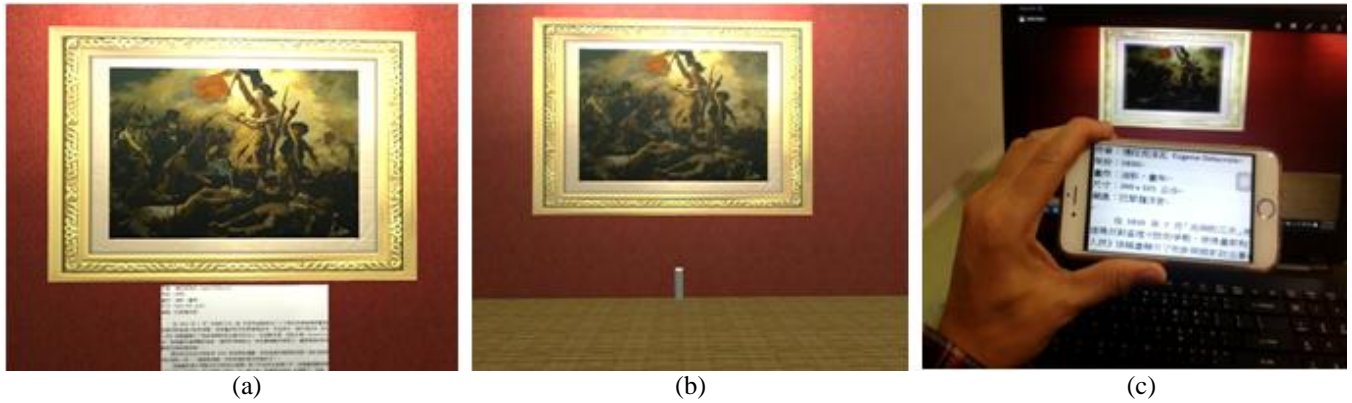


Figure 6: Three types of interactive medias in the virtual art gallery: (a) interpretation board; (b) oral interpretation; (c) interpretation with AR

2.3.2 Dependent variables

2.3.2.1 Presence

There are various subjective and objective measures of presence. The former category includes questionnaires, continuous ratings, qualitative measures, psychophysical measures, and subjective corroborative measures, whereas the latter category is grouped into psychophysiological measures, neural correlates, behavioral measures, and task performance measures [47]. Wissmath et al. (2010)[48] reviewed the existing presence measures and found that subjective verbal ratings (i.e., in the first place, subjective post exposure rating scales) are still the most frequently used presence indicator. To assess presence, Schneider et al. (2004) [49] developed a single-presence item representing the sensation of spatial presence in a mediated environment. This pictorially anchored presence assessment technique includes verbal instruction. Wissmath et al. (2010) [48] evaluated the validity of this item and empirically found that it requires less mental work; it is administered faster and assesses the sensation of presence more directly than verbally anchored items. Due to these advantages, pictorial scales could be especially useful when assessing presence during exposure. Three items were taken from Schneider et al. (2004) [49]: “While visiting the gallery, how much did you feel like you were really ‘there’ in the art environment?” (1 = “not there,” 5 = “there”), “While visiting the gallery, how much did you feel like the art environment was a real place?” (1 = “not real,” 5 = “real”), and “While visiting the gallery, how much did you feel like other characters in the gallery were real?” (1 = “not real,” 5 = “real”). These items were combined to form a single “presence” index, which yielded acceptable reliability (Cronbach’s alpha = .79) and unidimensionality (all items loaded on a single factor in exploratory factor analysis and explained 71.04% of the variance).

2.3.2.2 Involvement

The originally published measure of involvement, the Personal Involvement Inventory (PII) of Zaichkowsky (1985) [50], treats involvement as a unidimensional construct; its 20 items are summed to produce a single score. The questionnaire has been used successfully by researchers looking to capture and categorize motivations to explain differences in individual consumer behaviors (e.g., Peck & Johnson, 2011) [51]. Some years later, the original PII, which was published in the Journal of Consumer Research

in 1985, was improved upon, and a 10-item measure scored on a 1 to 7 scale (Revised Personal Involvement Inventory: RPII) was published in the Journal of Advertising [52]. Specifically, it assesses involvement in terms of respondents’ verbal assessments of their judgments of the environment as “unimportant” (as opposed to “important”); “boring” (“interesting”); “irrelevant” (“relevant”); “unexciting” (“exciting”); “means nothing” (“means a lot to me”); “unappealing” (“appealing”); “mundane” (“fascinating”); “worthless” (“valuable”); “uninvolving” (“involving”); and “not needed” (“needed”). This new scale balances cognitive and affective items and can be easily applied to measure involvement with advertising, products, or purchase situations. In their report, Cronbach’s alphas of the ten items ranged from .91 to .95 for advertisements and .094 to .96 for products. Because the artwork itself can be regarded as the product of an artist, visitors browsing the artwork in the virtual art gallery can be seen as a product-introducing tour. In addition, the introduction of the artwork can be regarded as another type of advertisement, so the RPII is very suitable to measure the involvement of participants within a virtual art gallery.

2.3.2.3 Emotion

Mehrabian and Russell (1974) [37] introduced the dimensions of pleasure, arousal, and dominance (PAD) to evaluate emotion in the field of psychological environments. In PAD, “pleasure” is a feeling that lies on a continuum ranging from unhappiness to extreme happiness, which they evaluated with word pairs such as “pleased-annoyed” or “happy-unhappy.” They considered pleasure to be easily assessed (e.g., by self-reported ratings on SD scales or behavioral indicators such as smiles, laughter, etc.). “Arousal” is a mental activity that can be described along a single dimension ranging from sleep to excitement and linked to adjectives such as “stimulated-relaxed” and “excited-calm.” “Dominance” is related to feelings of control along a continuum from dominant to submissive, with adjectives such as “controlling-controlled” and “important awed” [53]. The PAD is composed of 18 items scored on a scale ranging from +4 to -4, with 0 representing the center of the scale [37]. The terms used to assess pleasure are “happy” (as opposed to “unhappy”), “pleased” (“annoyed”), “satisfied” (“unsatisfied”), “contented” (“melancholic”), “hopeful” (“despairing”), and “relaxed” (“bored”). Arousal is assessed by “stimulated” (as opposed to “relaxed”), “excited” (“calm”), “frenzied” (“sluggish”),

“jittery” (“dull”), “wide-awake” (“sleepy”), and “aroused” (“unaroused”). Finally, dominance is assessed by “controlling” (as opposed to “controlled”), “influential” (“influenced”), “in control” (“cared-for”), “important” (“awed”), “dominant” (“submissive”), and “autonomous” (“guided”). The internal consistency reliability coefficients computed by Cronbach’s alpha was 0.72) for pleasure, 0.69 for arousal and 0.77 for dominance. The reliability coefficients of each of the three dimensions are acceptable. In the last four decades, the model has been used and is still used by numerous researchers in the field of environmental psychology and virtual environments [54-56]. Therefore, the PAD questionnaire was used to measure the emotions of the participants.

2.4 Participants and procedure

Thirty participants with an average age of 66.4 years (19 men and 11 women) were recruited and randomly assigned to each of the six treatments to complete an art-searching task (five people in each treatment) (Note: This research involving human subjects had obtained formal approval from the “Research Ethics Committee for Human Subject Protection, National Chiao Tung University, Taiwan” (Approval number: NCTU-REC-105-033). All participants had normal or corrected-to-normal vision (i.e., they scored between 0.83 and 1.11 on a visual acuity test, had no cataracts and had normal color vision). Additionally, they all had experience operating computers. During the exposure period, each participant was required to search for eight target artworks. However, only six artworks were exhibited in the exhibition room. The characteristics of these artworks were described verbally. When the participant found a target artwork, she/he had to place a “O” in the blank field above the art image in the checksheet. If the participant confirmed that a particular target artwork was not exhibited in the gallery, she/he should place an “X” in the corresponding column. When all six target artworks were found and the other two artworks were confirmed not to be shown in the gallery, the experiment was finished.

3. Results and Discussion

3.1 The effect of spatial arrangement and interactive media on presence

In this study, ANOVA was used to analyze the differences among group means in spatial arrangements and interactive medias. The results showed that there were marginally significant differences across spatial arrangements ($F = 4.551$, $p = 0.043$) and significant differences across interactive medias ($F = 12.898$, $p < 0.000$) on presence. Hence,

H1: The spatial arrangements in virtual art galleries affect senior visitors’ presence: supported.

H2: The interactive medias in virtual art galleries affect senior visitors’ presence: supported.

The presence score was higher for the historical background theme (Mean: 11.330) than for the artistic characteristic theme (Mean: 9.067). The reason may be that the “historical background theme” links artworks of the same era. The

stories of these artworks are interlinked. Therefore, it is easier for visitors to participate in a comprehensive historical exhibition. However, in the “artistic characteristic theme,” the stories between the artworks are fragmentary. However, this exhibition type may attract professional art visitors who want to compare artworks of different eras.

Additionally, there is a need for further investigation into the effects of various types of interactive medias on presence. Tukey’s post hoc test was used for pair wise comparison of interactive medias, and the results are shown in Table 1. The results showed that the effect of presence on the oral interactive media was superior to those of board and AR. The reason may be that although oral, board, and AR are all verbal medias, oral is a form of “speech,” whereas board and AR are forms of “print.” Both speech and print use working memory to encode and store linguistic forms. However, speech medias are more directly compatible with vocalization, which suggests that speech should be used for verbal tasks, particularly if the verbal material can be displayed for only a short interval. However, people have to read the “print” forms, whether board or AR. Reading requires more than just acuity and letter recognition. The reading process involves complex eye movements that are affected by the physical characteristics and content of what is being read. It is quite laborious for the elderly. Therefore, oral interpretation had the best effect on the elderly’s sense of presence in the virtual art gallery.

Table 1: Tukey’s post hoc tests for the effects of interactive medias on presence

(I) Media types	(J) Media types	Mean difference (I-J)	Std. error	P value
Board	Oral	-3.30*	0.651	.000
	AR	-1.50	0.651	.074
Oral	Board	3.30*	0.651	.000
	AR	1.80*	0.651	.028
AR	Board	1.50	0.651	.074
	Oral	-1.80*	0.651	.028

Notes: *Significant at 0.05 level

For the measurement of presence, there were three items on the questionnaire. To better understand the effect of spatial arrangements and interactive medias, the participants’ perceived presence for artworks clustered by spatial arrangements (i.e., historical background and artistic characteristics) was analyzed using three items. Table 2 shows the mean values (centroid) of each of the three presence items for the two spatial arrangements. The findings showed that the three presence scores for the spatial arrangement using the historical background theme were not significantly different from those for the artistic characteristic theme. However, the participants felt more “there” for the spatial arrangement based on historical background. Additionally, whether thematic arrangements are based on historical background or artistic characteristics, the feeling of the art environment as a real “place” was relatively low. Table 3 shows the mean values (centroid) of each of the three issues of presence for the three types of interactive medias. The results showed that the participants scored all three items of presence highest in the oral interpretation condition. The feeling of the art environment being a real “place” was also the lowest. Overall, these findings showed that most participants feeling really “there”

was easier than feeling like the environment was a real "place." It also showed that there are some difficulties in presenting the environment as a real "place." In this study, thematic arrangement (i.e., historical background) and interactive media (i.e., oral interpretation) were able to attract the participants through vivid environments and self-

contained plots and narratives to feel like they were truly "there" in the visual art environment. However, the virtual art gallery did not offer high-fidelity simulations through multiple sensory modalities. Therefore, the participants might not have felt the art environment to be a real "place."

Table 2: Evaluating the effect of spatial arrangements in two clusters based on presence at a virtual art gallery

Presences	Historical Background (N= 15)	Artistic Characteristics (N= 15)	t	Significance
While visiting the gallery, how much did you feel like you were really "there" in the art environment? Not there or there?	4.13	3.67	1.640	0.056
While visiting the gallery, how much did you feel like the art environment was a real place? Not real or real?	3.53	3.07	1.488	0.074
While visiting the gallery, how much did you feel like other characters in the gallery were real? Not real or real?	3.60	3.60	1.701	0.500

Table 3: Evaluating the effect of interactive medias in three clusters based on presence at a virtual art gallery

Presences	Board (N= 10)	Oral (N= 10)	AR (N= 10)	F	Significance
While visiting the gallery, how much did you feel like you were really "there" in the art environment? Not there or there?	3.40	4.30	4.00	3.910*	0.032
While visiting the gallery, how much did you feel like the art environment was a real place? Not real or real?	2.60	4.10	3.20	14.119*	0.000
While visiting the gallery, how much did you feel like other characters in the gallery were real? Not real or real?	3.00	4.40	3.40	5.239*	0.012

Notes: *Significant at the 0.05 level; italics and bold indicate the highest mean values

3.2 The influence of presence on involvement

According to the correlation analysis, there was probably a positive relationship between presence and involvement ($R = 0.802, p < 0.000$). The result shows that

H3: The presence experienced by senior visitors of a virtual art gallery has a significant positive effect on involvement: supported.

Slater and Wilbur (1997) [27] stated that immersion depends on the quality of a system's technology and can be counted as an objective measurement of the extent to which the technology can present a vivid virtual environment while shutting out the physical world. With this idea, the level of the vividness of an immersive VE or a system's immersive level thereby affords and facilitates a sense of psychological presence to the user [57]. Immersion has been defined as "a form of spatiotemporal belonging in the world characterized by a deep involvement in the present moment" [58]. When the degree of immersion increases, people feel interesting and excited and find the environment relevant and appealing. This is also a phenomenon of high involvement. Additionally, Cummings & Bailenson (2016) [57] found that the vividness of an immersive VE or the immersive degree of an operation thereby affords and facilitates a sense of psychological presence to the user. Therefore, presence is often associated with immersion. As the sense of presence increases, immersion also increases and participants have a higher sense of involvement. This result also verified the behavior of elderly people when visiting a virtual art gallery.

3.3 The influence of presence on emotion

According to the correlation analysis, there was probably a positive relationship between presence and emotion ($R = 0.775, p < 0.000$). The result shows that

H4: The presence experienced by senior visitors of a virtual art gallery has a significant positive effect on emotion: supported.

McCarty et al. (2014) [59] described presence as making players in a virtual game react to emotion-eliciting events as if they were real. Similarly, in this study, we found that the visitors' emotions in the virtual art gallery were influenced not only by the valuable aspects of the artworks themselves but also by their subjective feelings such as presence. When presence gives rise to the feeling that events in the virtual art gallery are happening, the visitors approach the environment to a higher degree. Of course, if the environment gives the visitor a bad feeling, the sense of presence decreases. Visitors may become dissatisfied and unhappy in the environment and then consider leaving early. Therefore, we can make the following inference: presence is an essential subjective feeling that allows senior visitors to immerse in a virtual art gallery, thereby generating positive emotions.

3.4 Correlation between involvement and emotion

Table 4 presents the results of the hierarchical mediation analysis. For model 1, we found that the predictor (presence) in the first step was positively and significantly associated with the outcome (involvement) ($\beta = 0.802, t = 7.109, p < 0.000, R^2 = 0.644, F = 50.543, p < 0.000$). In step 2, the total effect of the predictor (presence) on the mediator (emotion) was also positive and significant ($\beta = 0.775, t = 6.497, p < 0.000, R^2 = 0.601, F = 42.208, p < 0.000$). In step 3, the mediator (emotion) was found to be positively and significantly associated with the outcome (involvement) ($\beta = 0.877, t = 9.673, p < 0.000, R^2 = 0.770, F = 93.565, p < 0.000$). Finally, the relationship between predictor (presence) and outcome (involvement) decreased ($\beta = 0.306, t = 2.284, p = 0.03$) when the mediator (emotion) was added. However, the results showed that the mediator (emotion) still had a

significant effect on the outcome (involvement) ($\beta = 0.640$, $t = 4.782$, $p < 0.000$), and R^2 was improved. These results indicated a partial mediation effect of emotion on the

relationship between presence and involvement, thus supporting hypothesis H5a.

Table 4: Mediation analyses to test the proposed mechanism

Outcome	Mediator	PC	β	SE	t	R^2	F
Involvement	Emotion	c1	0.802	0.218	7.109**	0.644	50.543***
		a1	0.775	0.447	6.497***	0.601	42.208***
		b1	0.877	0.047	9.673***	0.770	93.565***
		c1'+b1	0.306 0.640	0.259 0.069	2.284* 4.782***	0.644 0.807	50.543*** 56.432***
Emotion	Involvement	c2	0.775	0.447	6.497***	0.601	42.208***
		a2	0.802	0.218	7.109**	0.644	50.543***
		b2	0.877	0.176	9.673***	0.770	93.565***
		c2'+b2	0.201 0.716	0.561 0.290	1.341 4.782***	0.601 0.784	42.208*** 49.014***

Note. PC, path coefficient relevant to the mediation analysis in Fig. 2

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

We repeated this three-step process to determine mediation effects for involvement on the relationship between presence and emotion. Table 4 displays the coefficient values for each step of the mediation analysis for the relevant paths. For model 2, the first step revealed that presence was a significant predictor of the outcome (emotion) ($\beta = 0.775$, $t = 6.497$, $p < 0.000$, $R^2 = 0.601$, $F = 42.208$, $p < 0.000$), and the second step revealed that presence was a significant predictor of the mediator (involvement) ($\beta = 0.802$, $t = 7.109$, $p < 0.000$, $R^2 = 0.644$, $F = 50.543$, $p < 0.000$). In the third step, the coefficients of the predictor (presence) predicting outcome (emotion) were not significant ($\beta = 0.201$, $t = 0.561$, $p = 0.191$) when including the mediator (involvement). However, the results showed that the mediator (involvement) still had a significant effect on the outcome (emotion) ($\beta = 0.716$, $t = 4.782$, $p < 0.000$), and R^2 was improved. These results indicated a full mediation effect of involvement on the relationship between presence and emotion, thus supporting hypothesis H5b.

According to these results, the correlation between involvement and emotion is significant. However, in the mediation analysis, we found that involvement fully mediates emotion, but emotion has a partial mediation effect on involvement. This means that the effect of involvement on emotion is stronger than the effect of emotion on involvement. As broadly acknowledged, emotions are affective variables characterized by their intensity and are formed in response to a specific referent or appraisal one makes of something [60]. Jeong and Lee (2006) [61] showed that a museum's environmental attributes (for instance, the methods of exhibition, content of exhibits, illumination and rest areas) influence a consumer's emotions. Additionally, involvement, especially enduring involvement, encompasses people engaging in and paying attention to a specific situation, object or thing for relatively long periods of time [27]. If a virtual art gallery environment provides an excellent exhibition environment (for instance, thematic arrangement of artworks and oral interpretation), it would let the participant feel a better level of emotion and involvement. In particular, involvement means a person engaging in and paying attention to a specific situation, thing, or situation for a period of time [27]. Good involvement reveals a virtual art gallery to be relevant and exciting to the visitor. Visitors, especially the elderly, feel a

pleasant emotion of being happy, joyful, contented, or satisfied.

4. Conclusions

In the specific context of a virtual art gallery, – spatial arrangement and interactive media have not been previously discussed in the literature. Using an experimental design and hierarchical mediation analysis, we confirm that spatial arrangement and interactive media are essential factors in designing virtual art galleries for senior visitors based on presence, involvement and emotion. This study has taken a step toward evaluating the effects of spatial arrangement and interactive media on presence for the elderly in virtual art galleries. The results indicated that the measurement scores of presence were best in the oral interpretation and historical background thematic arrangement conditions. The results also showed that presence significantly influenced involvement and emotion, and there was a high degree of correlation between involvement and emotion in the senior visitors. It is worth noting that the effect of involvement on emotion is stronger than that of emotion on involvement. Therefore, a virtual art gallery with an excellent thematic arrangement based on historical background can help senior visitors quickly construct a spatial cognitive map; additionally, interactive oral medias are easy to use for semantic recognition and understanding. Thus, senior visitors will be easily able to increase the positive feelings of presence, involvement, and emotion.

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