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Immersion and Emotion: Their Impact on the Sense of Presence

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ABSTRACT

The present study is designed to test the role of immersion and media content in the sense of presence. Specifically, we are interested in the affective valence of the virtual environments. This paper describes an experiment that compares three immersive systems (a PC monitor, a rear projected video wall, and a head-mounted display) and two virtual environments, one involving emotional content and the other not. The purpose of the experiment was to test the interactive role of these two media characteristics (form and content). Scores on two self-report presence measurements were compared among six groups of 10 people each. The results suggest that both immersion and affective content have an impact on presence. However, immersion was more relevant for non-emotional environments than for emotional ones.

INTRODUCTION

THE SENSE OF PRESENCE has usually been considered the key of virtual reality (VR). Although there is not a common definition of presence, there is a consensus to define it as a multi-component construct. Most authors[1–6] agree that presence is determined by two general categories of variables: media characteristics and user characteristics. Media characteristics are divided into media form and media content variables. Media form includes the properties of a display medium (e.g., the extent of sensory information presented, the degrees of control that users have over positioning their sensors within the environment, users' ability to modify aspects of the environment). Media content includes the objects, actors and events represented by the medium. Finally, user characteristics refer to relevant individual aspects ranging from age, gender or cultural variables to users' perceptual, cognitive, motor abilities, prior experience with mediated experiences, willingness to suspend disbelief, and personality differences.

Media form characteristics have a significant impact on the sense of presence. Nobody doubts the importance of immersion, interaction, and perceptual realism. However, presence research has overemphasized these factors, and sometimes they have been used erroneously to describe the experience of presence. As Schubert et al.[7] point out, in some theoretical models, the sense of presence has been seen as the outcome, or a direct function of immersion. Therefore, it has been assumed that the more inclusive, extensive, surrounding, and vivid the virtual environment (VE), the higher the sense of presence.[7]

There have been some attempts to distinguish presence from immersion. Slater[8,9] defined immersion as an objective description of the technology, while the sense of presence is a subjective experience and only quantifiable by the user experiencing it. Likewise, Kalawsky[4] states that presence is essentially a cognitive or perceptual parameter, whilst immersion essentially refers to the physical extent of the sensory information and is a function of the enabling technology.

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However, it would be misleading to assume a one-to-one relationship between immersion and presence.[7] The other characteristics (media content and user characteristics) must be also taken into account. Some VR studies have proved that users can feel present even in the impoverished environments world that some VR currently provides.[10] For example, Pausch et al.[11] analyzed a sample of Walt Disney World's Epcot, and their results showed that the aspects of immersive interfaces (displays, graphics, and control device quality) were important to the users; significantly, however, the background stories and goals as well as the "physics fidelity" (e.g., motion) of the rides had even more impact on the users experience.

The present study is addressed to test the role of immersion and media content in the sense of presence. Specifically, we are interested in the affective valence of the virtual environments. Huang and Alessi,[12] point out that emotions are an essential part of how people experience the world, and their study could have important implications for a better understanding of the virtual experience. These authors stated that definitions of presence have mostly been cognitively or environmentally based, generally ignoring the emotional aspects of presence. However, emotions play an important role in our subjective judgments and automatic responses, influencing our learning as well as how we understand, describe and react to the world and ourselves. In two studies,[13,14] we found important differences in the responses to VR environments between non-patients and (mental health) patients that proved the importance of emotions for clinical users. Emotions may play a role both as determinants and consequences of presence.

Factorial studies using self-report measures of presence have also shown the importance of emotional engagement. In particular, studies by two different teams reveal very similar factor structures. Lessiter et al.,[5] using ITC-Sense of Presence Inventory (ITC-SOPI) questionnaire, reported a four-factor solution for presence: physical space, engagement, naturalness, and a fourth attenuating factor, negative effects. Schubert et al.,[7] using their self-report presence survey, arrived at a three-factor solution for the presence construct almost identical to the ones identified by Lessiter et al.: spatial presence, involvement, and realness. According to these factorial structures, it seems that presence is not only related to a sense of a physical, spatial environment (the sense of "being there"), but also to a personal evaluation of the appeal, and the naturalness/believability, of both the displayed environment and its content.[5] As Lessiter et al.[5] point out, these dimensions may contribute to the sense of presence in an additive way, or in a more complex, interactive manner.

The goal of the present study is not to test whether people have similar emotional responses in the virtual environment and in similar circumstances in the real world. The goal is to test whether presence can be enhanced in less immersive virtual environments by using emotional content. Three immersive systems will be compared: a head-mounted display (HMD), a rear projected video wall, and a PC monitor. According to Kalawsky,[4] if the display presents a full 360º information space, then it is a "fully immersive system"; if the extent of the display is less than 360º, it is a "semi-immersive system." The term "non-immersive system" is usually reserved for desktop VR systems. This study compares the sense of presence on these three immersive systems between two different virtual environments; one involves emotional content and the other does not. The specific questions addressed are as follows: (1) Does an emotional virtual environment elicit a higher "subjective" sense of presence than a non-emotional virtual environment? (2) If so, does this depend on the immersive characteristics of the system?

MATERIALS AND METHODS

Experimental design

In order to study the role of immersion and affective content on the subjective sense of presence, the following variables will be manipulated:

- Immersion: three conditions were considered: a HMD, a semi-immersive system video wall, and a PC monitor.
- Affective content: Two virtual environments were designed, one to induce sadness (emotional condition) and another in which no mood changes were expected (neutral condition).

A 2 × 3 between groups design was used, with six experimental conditions.

Participants

Sixty participants were recruited for the study from the Polytechnic University of Valencia, University of Valencia and University Jaume I of Castellon. There were 37 females and 23 males. The mean age was 24.78 (SD = 5.847), with a range between 18 and 49. Groups of 10 participants were

randomly allocated to one of six experimental conditions. All participants fulfilled the following inclusion criteria: (a) non-history of neurological disease, head injury, learning disability or mental disorders; (b) non-history of psychological disorders; (c) non-use of any medication for psychological or emotional problems; and (d) scoring lower than 18 in BDI (Beck Inventory Depression).[15]

Measures

Beck Depression Inventory. The BDI[15] is the most widely used self-report instrument for measuring depressive symptom severity in both research and clinical settings. It is a 21-item self-report questionnaire. Scores less than 18 are considered normative.

ITC–Sense of Presence Inventory (ITC-SOPI). The ITC-SOPI is a post-test subjective presence measure composed of 44 items, divided in two parts.[5] Part A (6 items) refers to a respondent's impressions/feelings *after* a media experience has finished. Part B (38 items) refers to a respondent's impressions/feelings *during* a media experience. A 1–5-point Likert scale (from Strongly Disagree to Strongly Agree) is used for responding to both parts. Factor analysis showed that this questionnaire measures four dimensions: Physical space, Engagement, Ecological Validity, and Negative effects. ITC-SOPI: internal reliability coefficients (alpha) were computed for each of the four factors. Alphas were high, ranging from 0.94 (Physical Space) to 0.76 (Naturalness).

Reality judgment and presence questionnaire (RJPQ). RJPQ[13] is a post-test subjective presence and reality judgment measure. A short version of this questionnaire, with 29 items, was used. A 1–10 Likert scale was used for responding to all items. The following factors were considered: "Quality/Realism" (11 items regarding the quality and congruence of the images and sounds, and the influence of quality on the sense of presence and realness); "Reality Judgment" (4 items related to the realness of the environments, the objects and the experience); "Presence: Positive" (8 items related to the sense of being in the virtual environment); "Presence: Negative" (3 items related to the difficulties of feeling presence); "Interaction/Navigation" (7 items related to movements and interactions); "Emotional engagement" (3 items related to the emotions felt in the virtual environment); and "Emotional Indifference" (3 items related to boring and disappointing feelings). The alpha reliability (internal consistency) for the questionnaire was 0.82.

FIG. 1. One view of the neutral park.

Virtual environments

A Mood Induction Procedure (MIP) using VR was used. MIPs are experimental procedures whose aim is to provoke a transitory emotional state in an individual in a non natural situation and in a controlled manner. The mood induced should be specific and ideally is an experimental analogue of the mood that would occur in a natural situation.[16] MIPs include a broad diversity of methods and have proven to be effective in achieving changes in the target mood.[17–19]

The VR-MIP consists of a neutral environment (Fig. 1) that progressively changes depending on the mood state to be evoked in the user. The scenario is a park, that is, a natural and urban ambient that can be found easily in any city or culture in the real world. We chose this environment because it includes elements of nature (trees, flowers, water, etc.), and because changing some of the light parameters (tone, direction, brightness) easily modifies the aspect of these elements, inducing different moods in the user. For example, in the case of sadness, the park is grey, it is a cloudy day, the trees have no leaves, there are no people in the park and the music that is heard is very sad. In Figure 2, some views of the "sad park" are showed.

For the present study, two variations of this VR-MIP were used. The goal of one was to evoke sadness (emotional condition), and the goal of the other one was to not evoke any specific mood (neutral condition). In order to build the different environments, variations of every one of following elements were included: music, narratives, Velten

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FIG. 2. One view of the sad park.

Table 1. Velten Self-Statements

Neutral sentences	*Sad sentences*
Japan is a set of islands.	Life seems sad and senseless to me.
The house is for sale.	I make people unhappy.
The train travels from Madrid to Sevilla.	I fail in everything.
The ship was ancient.	I have no future.
The doorkeeper was dressed in red.	I am worthless.

self-statements*,[20] as well as pictures (selected from International Affective Picture System IAPS[21]), movies, and autobiographical recalls.

The environment content is as follows: Users listen to a short history corresponding to the emotional experimental condition (sadness versus neutral). A woman's voice guides users through a virtual walk. From the beginning, a piece of music is heard (emotional condition: "Adagio for Strings-Choral" by Samuel Barber; neutral condition: "Nothing Spectacular" by Michael Lindh, which was composed by Michael Lindh from Interactive Institute and was validated as a neutral MIP in the EMMA project.). The initial appearance of the environment is the same for all users. However, the aspect changes shortly thereafter, depending on the intended emotional condition. Users have two minutes to freely explore the park.

Then, they are asked to go to the center of the park, where a bandstand is located. On five of the sides of the stand (it is an eight-faced polyhedron), a statement of the Velten[20] technique appears in a disordered manner and users must order it. The content of the statements depends on the emotional condition (Table 1). For each sentence, users have to choose a picture from four options, the one that best represents (according to them) the meaning of the sentence (selected from IAPS[21]). Users are asked to get involved in the contents of each sentence for 45 seconds, and to think about the personal meaning of each statement. After that, they can walk around the virtual park again for two minutes. Then, users are asked to go to the cinema to watch a short film (scenes from "The Champ"; emotional condition: scenes from "A True Story" for neutral). Once the cinema session is finished, users are asked to produce an autobiographical recall in a loud voice, similar to the experiences they encountered in the park.

Hardware

The workstations for running the virtual environments were PC based computers with high-end graphics capability, with 128 Mb of memory for graphics and textures. Regarding the interaction device, a joystick was used. This device was configured to have different modes of use, so that pressing a button alternated between the navigation and interaction modes. The display's devices included the following:

- *PC monitor:* 17-inch monitor with a resolution of 1024×768 pixels.
- *HMD:* A HMD (model 800 from Fifth Dimension Corporation, Irvine, CA) with a head-tracking device (model intertrax2 from Intersense, Bedford, MA)
- *Big screen:* A rear projected video wall setup was created using a metacrilate retro-projected screen of 400×150 cm. The retro-projection option allowed users to walk near the screen without blocking the image or projecting shadows on the screen. Resolution projectors were 1024×768 pixels with a power of 2000 lumens; however, it was limited to a power of 1000 lumens in order to make users feel more comfortable.

Procedure

Participants were given the following description of the study: "This is an experiment about virtual reality. First of all, I am going to ask you a few ques-

*This is a MIP developed by Velten,[20] wherein mood induction is achieved by means of statements written in first person, relative to the mood. Subjects are asked to read the statements, and to try to feel a mood similar to the one described in them.

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tions. After that you will practice in a training virtual environment. During this time I can help you if you have any doubts. Later, you will stay alone in another virtual environment. When virtual experience finishes you have to fill in some questionnaires." Participants were provided informed consent to take part in the study, and were asked to complete a short screening interview and BDI, in order to ask about exclusion criteria. Then they were randomly assigned to one of six experimental conditions, and practiced in the training virtual environment. After the VR-MIP, participants completed the two presence questionnaires. All participants were debriefed following the experiment.

RESULTS

Means and standard deviation for the questionnaires can be found in Table 2. Analysis of variance was conducted on the presence measures, with emotional conditions (sadness versus neutral) and immersive conditions (Monitor, Big screen, and HMD) as between-groups factors. The dependent variables were the various factors of presence questionnaire measures (ITC-SOPI and JRPQ).

Regarding ITC-SOPI, a main effect of "emotional condition" was found for engagement ($F(1.53) = 3.99$, $p < 0.05$), and ecological validity ($F(1.53) = 3.98$, $p < 0.05$). A main effect of "immersive condition" was only found for negative effects ($F(2.53) = 6.06$, $p < 0.004$). An interaction effect emotional × immersive conditions was found for engagement ($F(2.53) = 3.59$, $p < 0.03$) and ecological validity ($F(2.53) = 3.12$, $p < 0.05$). No other significant effects were found. In general, the sad group scored higher in engagement and ecological validity than the neutral group. The HMD condition provoked more negative effects than the other two immersive conditions. Finally, with respect to interaction effects, post-hoc analysis revealed that monitor conditions produced a different pattern in sad and neutral conditions. The sad group using a monitor scored higher on engagement and ecological validity than the neutral group.

Regarding JRPQ, a main effect of "emotional condition" was found for reality judgment ($F(1.54) = 3.77$, $p < 0.05$), emotional engagement ($F(1.54) = 20.15$, $p < 0.000$), and emotional indifference ($F = (1.54) = 8.44$, $p < 0.005$). Quality/realism ($F(1.54) = 3.6$, $p < 0.06$) almost reached statistical significance. In general, sad groups scored higher on reality judgment, emotional engagement and quality/realism than neutral groups, while neutral groups scored higher on emotional indifference. A main effect of "immersive condition" was found for quality/ realism ($F(2.54) = 4.85$, $p < 0.012$); and interaction/navigation ($F = (2.54) = 4.41$, $p < 0.017$). Big screen groups scored higher on quality/realism and interaction/navigation. No other significant effects were found. However, an interaction effect emotional × immersive conditions was almost statistically significant for reality judgment ($F(2.54) = 2.95$, $p < 0.06$); and presence positive ($F(2.54) = 2.91$, $p < 0.06$). Post-hoc tests revealed that there were no differences between sad and neutral conditions

TABLE 2. MEANS AND STANDARD DEVIATIONS

	Monitor				*Big Screen*				*HMD*			
	Sad		*Neutral*		*Sad*		*Neutral*		*Sad*		*Neutral*	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
ITC-SOPI												
Physical space	3.34	0.72	2.68	0.66	3.09	0.57	3.08	1.27	2.85	0.39	2.96	0.68
Engagement	3.45	0.55	2.70	0.71	3.55	0.46	3.22	0.53	3.01	0.43	3.17	0.52
Ecological validity	3.64	0.64	2.60	0.67	3.16	0.81	3.00	0.85	3.21	0.56	3.12	0.84
Negative effects	1.78	0.85	1.68	0.69	1.72	0.62	1.67	0.93	2.41	0.81	2.60	0.94
JRPQ												
Quality/realism	7.46	1.68	6.36	1.52	7.58	0.53	7.18	1.14	6.30	1.47	5.74	1.70
Reality judgment	6.53	1.62	3.85	1.06	5.70	1.21	5.63	2.76	5.48	2.29	5.33	1.05
Presence positive	6.71	1.74	4.51	1.31	6.04	1.25	6.05	1.63	5.11	1.64	5.16	1.36
Presence negative	3.47	1.74	4.40	1.96	4.27	1.63	3.67	2.19	5.17	1.27	4.40	1.81
Interaction/navigation	7.09	1.38	6.44	1.43	7.54	0.47	7.09	1.60	6.23	1.15	5.86	1.74
Emotional engagement	8.30	1.93	5.30	1.65	8.30	1.18	5.37	2.33	7.37	2.76	5.30	1.56
Emotional indifference	2.60	2.22	4.30	1.22	1.83	1.22	3.93	1.40	3.00	2.71	3.93	1.42

when participants were immersed using a HMD. When they were immersed using the big screen, there were differences between sad and neutral conditions for emotional engagement and emotional indifference (sad group scoring higher on emotional engagement and lower on emotional indifference). However, there were many differences when participants were immersed using only a monitor. The sad group using this less immersive system scored higher than the neutral group on reality judgment, presence positive, and emotional engagement, and lower on emotional indifference.

DISCUSSION

Results of this study show that both affective content and immersion have an important effect on the sense of presence. First, regarding immersion, ITC-SOPI results revealed that the only difference among the three immersive conditions was in the category of "negative effects." Not surprisingly, the HMD provoked more undesirable effects (dizziness, disorientation, nausea) than the other immersive systems. However, this questionnaire did not reveal other significant differences among the three immersive systems. RJPQ data revealed that the big screen elicited higher "Quality/realism" and "Navigation/interaction" subjective scores than the other two conditions. Although HMD is considered a fully immersive system, because it displays a 360º information space, the size of the screen seems to be more relevant in order to achieve realism. Nevertheless, it is interesting to note that big screen users rated higher on "navigation/interaction," although the same navigation device (a joystick) was used by all participants. However, HMD users were also provided with a head tracking device (Intertrax II). It might be that the negative effects of this device made the navigation more difficult.

Regarding affective content, results show differences between emotional and neutral environments in presence measurements. Both ITC-SOPI and RJPQ results show that the emotional environment seems to be more engaging, natural, believable and real to users than the neutral environment.

We believe that the most interesting results of this study are those of interaction effects among affective content and immersive systems. According to data, the sense of presence in the non emotional environment depends mainly on immersion. Both a HMD and a big screen elicited a higher sense of presence than a non-immersive system, namely, a PC monitor. However, in an emotional environment a PC monitor was able to elicit a high sense of presence, in the same way that a big screen was. On the other hand, the HMD condition was not the most presence-enhancing technology; as stated previously, these data could be explained by the less comfortable HMD setup.

Our results illustrate that presence is not a direct function of immersion alone. It is misleading to assume a one-to-one relationship between immersion and presence.[7] As Ijjselsteijn[22] states, although the breadth and depth of sensory experience is important in improving the media experience, intensity does not equal quality. "The basic appeal of media still lies in its content, the storyline, the ideas and emotions that are being communicated."[22] This does not mean to ignore the media form altogether; "the psychological impact of content, both good and bad, exciting and boring, depends to a large extent on the form in which it is represented."[22]

Nevertheless, our results indicate that efforts must not be solely focused on technology. As Heeter[23] points out, "presence research has emphasized engineering the senses more strongly that it has engineering the mind . . . Sensory realism is certainly an important influence on presence, but there is more to the story". It is important to remember, as Biocca[24] does, that Munsterberg, the first psychologist to study media in 1916, hinted at an issue which sometimes have been not taken into account: media obey laws of the mind. Presence is a user experience and it is not intrinsically bound to any specific type of technology, but is rather a product of the mind.[2] Biocca[24] also reminds us of the celebrated phrase of Bricken, from the 1990 SIGGRAPH conference: "Psychology is the physics of virtual reality." According to Biocca, this sentence implies that, like physics, psychology holds a key to our understanding of reality. Therefore, VR "has less to do with simulating physical reality *per se*; rather it simulates how the mind 'perceives' physical reality."[24] Therefore, presence research will have to extend beyond a search for realism or fidelity only.[2]

Our study has been focused in only one of the media form characteristics, immersion, but there are other media form variables that are also very relevant, one of which is interaction. According to Ijsselsteijn,[25] interactivity appears to be a more important factor than immersion. Interactive, nonrealistic displays are able to engender substantial levels of presence. Therefore, it would be also important to test a possible interaction effect between interactivity and affective content of virtual environments. "Being there" has been considered the ability to "do there,"[25] but this study also adds the possibility of "feeling there." Thus it can be said, "I

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can do here, therefore I am here," but also, "I feel here, therefore I am here."

It is important, from both theoretical and applied perspectives, to determine the most critical elements in feeling presence for different VR applications. One of these VR applications is psychological treatments. Results in this area have been promising and presence research must contribute to answering important questions such as: What elements are fundamental in order to achieve the sense of presence in therapeutic applications? Our results indicate that if the focus is on eliciting emotions with the goal of reducing or modifying them, immersion factors could be less important than a carefully content design. This content design would have to include those elements relevant for every specific emotional problem, that is, those elements with the potential of activating emotions. Therefore, the focus must be on the psychological aspects more than on the technical aspects.

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