Sense of Presence in Emotional Virtual Environments

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Abstract

Most definitions on presence have been based on cognitive or environmental aspects. However, we think that presence, like all human experiences, is influenced by emotions. EMMA project (IST-2001-39192) is aimed to study the nature of this relationship between emotions and presence. One of the main hypotheses proposed by EMMA is that emotions may enhance presence. In this line, the main objective of the present paper is to study the differences in presence between "emotional" environments and "neutral" environments. In order to achieve this objective, we have designed a Mood Induction Procedure using VR (VR-MIP, to induce different moods (sadness, joy, anxiety and relax) in experimental subjects. Our results point out that VR-MIPs are able to induce different moods in the users. Regarding the role of mood on the sense of presence, our results show differences between emotional and neutral environments in some presence measurements.

Keywords--- **sense of presence, mood induction, emotions**.

1. Introduction

One of the main characteristics of Virtual Reality (VR) is that allows the users to explore and to interact with an artificially created environment. Thus, the users "have the feeling" of being in a different place from where they physically are, and this feeling has been named as "sense of presence". Up to now, definitions on presence have been based on cognitive or environmental aspects. However, we think that presence, like all human experiences, is influenced by emotions. Emotions play an important role in the way we make our subjective judgments, we react to the world and we learn things about it. It has been demonstrated that this variable is especially important in order to generate and enhance presence in Mental Health applications of VR, e.g., [1] [2] [3] [4] [5] [6]. In this sense, Hoorn, Konijn & Vand de Veer [7], in a paper entitled "Virtual Reality: Do not augment realism, augment relevance" argue that VR experience gains more from increased emotional relevance than from higher realistic solutions. These authors claim that to design VR, experience instead of technology is the key word, and they recommend that VR designer focuses on developing features that sustain relevance to the goals and concerns of the user. According to them, "The sophisticated technology of VR may be powerful but it is not enough to initiate a reality-experience that is true-to-life. Basic to reality-experiences that are true-to life is that the experience is emotionally loaded (…). The basis of emotion psychology is personal meaning: without relevance no emotion occurs. Thus, VR needs personal relevance for the user to arrive at the intended (total) involvement as manifested in the experiences of immersion and presence".

Taking into account this line of thinking, we think that emotions may play a role on the sense of presence. From this point of view, the focus would lay on designing affectively significant environments. In order to achieve this, it would be necessary to include elements with the potential of activating emotions. This is especially true for Clinical Psychology, because the goal is to achieve important changes in the users. But this relationship between emotion and presence is not only of interest for Clinical Psychology, but also for the whole research on presence. So, many authors point out that a central question in this research is the role of presence in the satisfaction with, and the enjoyment of mediate experiences. Furthermore, this relationship could help researchers to define the parameters for the minimum requirements-relevance of presence and to generate alternative methods to define and measure the sense of presence.

In short, presence is determined by a complex variety of characteristics of the medium, the user and the context. Regarding users, emotions can play an important role in the sense of presence, and EMMA project (IST-2001-39192) is aim is to study the nature of this relationship between

emotions and presence. One of the main hypotheses proposed by EMMA is that emotions may enhance presence. It is more likely that an environment able to elicit anxiety, sadness, joy, etc. could provoke the user to feel more present in that environment. Therefore, it could even be possible to consider emotions as an indicator of the degree of presence. In this line, the main objective of the present paper is to study the differences in presence between "emotional" environments and "neutral" environments. In order to achieve this objective, we have designed a Mood Induction Procedure using VR (VR-MIP), to induce *different moods* (sadness, joy, anxiety and relax) in experimental subjects.

The specific hypotheses that have been tested are: 1) VR- MIPs will be able to induce moods in the users; and 2) Sense of presence will be greater in the "emotional" environments than in the "neutral" environment

2. Method

2.1. Participants

Sample was composed of 80 university students volunteers (30 men and 50 women). Their age range was from 18 to 49. Before the experiments, all participants were screened, using an interview and several questionnaires, in order to detect any of the following exclusion criteria: history of neurological disease, head injury, learning disability or mental disorder; history of psychological disorders; use of any medication for psychological or emotional problem; scoring 18 or higher in BDI (Beck Inventory Depression, [8].

2.2. Measures

- *Visual Analogue Scale (VAS):* A variation of the original measure [9] has been used. Participants were asked to rate in a 1-7 points Likert Scale (1 = Not feeling the emotion at all, 7= Feeling the emotion extremely), how they felt at that moment in every one of the following emotions: sadness, joy, anxiety, and relaxation.

- *The ITC-Sense of Presence Inventory* (ITC-SOPI) [10]. This subjective measure is divided in two parts. Part A is composed by 6 items and it is referred to the impressions of the user after the virtual experience has finished. Part B is composed by 38 items and it is referred to the impressions of the user during the virtual experience. A 1-5 points Likert scale is used in both parts. Factor analysis of this 44 item questionnaire showed it measured the following components/dimensions of presence: physical space; engagement; ecological Validity, and negative effects

- *Reality Judgement and Presence Questionnaire* (RJPJ) [1] This questionnaire is composed by 57 items. A 1-10 Likert scale is used to answer all items. The following factors were taken into account: Quality/Realism, Reality Judgment; Presence: Positive issues; Presence: Negative issues; Interaction/Navigation, Emotional engagement; Emotional Indifference.

2.3. Experimental conditions.

Participants were randomly assigned to one of the five virtual environments (VR-MIPs): sad, happy, anxious, relax and neutral. "Neutral" condition is included as a control condition where no mood changes are expected

2.3. Virtual Environment (VR-Mood Induction Procedures)

Virtual environment consists of a neutral environment that will progressively change depending on the mood state that we need to evoke on the user. The chosen scenery was a park, because it is an environment where nature elements are present (trees, flowers, water, etc...), and by changing some light parameters (tone, direction, bright) it is possible to modify the aspect of these elements achieving a set of different moods on the user.

The virtual experience starts with a narrative. The user listens to a woman voice (representation of the EMMA avatar) that gives an introduction of the virtual environment. Then, the user starts walking through a park. The initial appearance of the environment is the same for all users. However, the aspect changes soon depending on the emotion. 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 a very sad piece. After two minutes walking through the park, the user finds a band stand. He/she can find five statements in the lower side of five of the sides of the stand (it is an eight-faced polyhedron). They are statements from the Velten technique [11], and they change depending on the emotion condition. EMMA asks the user to think about personal meaning of the state for some time in every statement. At the same time, an image is shown over the sentence. After that, the user returns to the park and continues walking, until he/she finds a summer cinema. EMMA voice invites the user to see a movie. These movies are film scenes of short duration with sad, happy, anxious, neutral and relaxing contents. Finally, EMMA asks the user to think about a similar personal situation (autobiographical recall) and to explain the experience/situation in loud voice (if he/she agrees to). Then, EMMA congratulates the user for his/her experience.

2.4. Hardware devices

As open immersive display we have used a metacrilate retro-projected screen of 400x150 cm. The retro-projection option allowed the user to walk near the screen with-out blocking the image and projecting shadows on the screen. Projectors had a resolution of 1024x768 pixels and a power of 2000 lumens. However, we have regulated them for a power of 1000 lumens in order to not be molest for the user.

Regarding interaction device, a Wireless Pad was used: This device has two special features; it has no wires so the

		GROUPS									
		Sad group		Happy group		Anxious group		Relax group		Neutral group	
		MOMENT		MOMENT		MOMENT		MOMENT		MOMENT	
		before	after	before	after	before	after	before	after	before	After
VAS	Joy	4,7	3,3	4,7	5,5	4,9	3,4	4,7	4,8	4,5	4,7
SCORES		(0,7)	(1,2)	(0,7)	(1,3)	(0,9)	(1,7)	(0,7)	(1,3)	(0,7)	(0,9)
	Sadness	1,6	4,4	2,4	2,2	1,8	3,2	1,5	2,3	2,0	1,7
		(0,5)	(1,6)	(1,3)	(1,4)	(1,0)	(1,8)	(0,5)	(1,9)	(1,0)	(0,9)
	Anxiety	2,3	1,8	2,8	2,1	2,2	3,0	2,2	1,5	2,2	1,9
		(1,2)	(1)	(1,9)	(1,1)	(1,2)	(1,7)	(1,1)	(0,7)	(1,3)	(1,4)
	Relaxation	4,5	4,2	4,5	5,0	4,8	4,0	3,9	5,4	4,3	4,8
		(0,9)	(0,8)	(1,5)	(1,2)	(0,9)	(1,5)	(0,5)	(0,9)	(1,4)	(0,9)

Table 1.: *VAS scores (before and after the trial): Means and (standard deviations) ratings*

user can stand (for example in front of the big screen), and it has two small joysticks one is used to navigate and the other one to interact.

2.5. Procedure

The experimental session started with participants filling in the pre-induction VAS measure. Then, participants entered into a room where the virtual system was placed. The user practised, with the help of an experimenter, in a brief training environment how to move and how to interact with virtual objects. After that, they were stayed alone in the room and the virtual session started. It took 30 minutes to complete the virtual walk. After that subjects filled in emotion (VAS) and presence (ITC-SOPI and PRJQ) measures

2.6. Results

2.6.1. Mood Induction: Means and standard deviations can be found in Table 1. Analysis of variance was conducted on the mood measures, with emotional groups (sad, happy, anxious, relax and neutral) as between-group factor, and time of testing as the within-group factor (before vs. after). The dependent variables were the mood state measures (VAS).

A main effect of time of testing was found for sadness mood ($F_{(1,45)}$ 14,545 *p<.001*), No other main effects of time were found. A main effect of group was found for joy mood ($F_{(4,45)}$ 2,742 *p<.040).* Post-hoc tests revealed that both happy and relax groups scored higher on joy mood, followed by the neutral group, being the sad and anxiety groups who scored lower compared to the other groups. No other main effects of group were found. More important was the fact that the higher order interactions of group x moment were statistically significant for joy mood ($F_{(1,4)}$ 6,212 *p<.001)*, sad mood ($F_{(1,4)}$ 5,854 *p<.001)* and relax mood ($F_{(1,4)}$ 3,849 *p<.009)*. Post hoc analyses results showed that the "sad", "happy" and "relaxation" emotional environments had induced the mood in the predicted directions for every single environment. That means that the sad environment induced more sadness, the happy environment induced more joy, and the relaxation environment induced more relax. Furthermore, there were not differences in the neutral condition. Regarding the "anxiety" environment, it was the only condition where participants scored higher on anxiety mood at the end of the trial, but this result did not reach statistical significance.

2.6.1. Sense of Presence: Means and standard deviations can be found in Table 2. Analysis of variance was conducted on the presence measures, with groups (emotional versus neutral) as between-groups factor. The dependent variables were the presence measures (ITC-SOPI, RJPQ). As it can be seen in Table 2, ANOVAs showed a group effect for Engagement and Ecological Validity from ITC-SOPI, and most of PRJQ factors.

	Emotional group	**Neutral group**	**Group differences**
ITC-SOPI			
Spatial presence	3,12 (0,69)	2,90 (0,96)	N.S.
Engagement	3,47 (0,57)	3,19 (0,45)	$F_{(1, 78)}$ 4,056 *p< .047*
Ecological validity	3,41 (0,74)	2,99 (0,77)	$F_{(1, 78)}$ 4,726 *p< .033*
Negative effects	1,73 (0,76)	1,67 (0,73)	N.S.
RJPQ			
Quality /realism	7,48 (1,19)	6,73 (1,46)	$F_{(1, 78)}$ 5,29 *p< .024*
Reality /judgment	6,12 (1,96)	5,06 (2,14)	$F_{(1, 78)}$ 4,16 *p< .045*
Presence (positive)	6,64 (1,68)	5,86 (1,36)	$F_{(1, 78)}$ 3,51 *p< .065*
Presence (negative)	3,43 (1,96)	3,63 (1,83)	N.S.
Interaction/ navigation	7,28 (1,48)	6,91 (1,32)	N.S.
Emotional engagement	8,13 (1,87)	5,85 (2,23)	$F_{(1, 78)}$ 20,23 *p< .001*
Emotional indifference	1,47 (1,96)	3,60 (1,45)	$F_{(1, 78)}$ 5,512 *p< .021*

Table 2: *ITC-SOPI and RJPQ factors scores: Means (and standard deviations) and significance ratings*

2.7 Discussion

Regarding the hypothesis, our results point out that VR-MIPs are able to induce different moods in the users. Data from subjective mood state measurements show that the 4 emotional environments (sad, joy, anxiety, and relax) are able to produce mood changes in the users. The changes in mood were produced in the predicted directions for every single environment. As for the neutral environment no changes are observed. Results from VAS measurements are robust for sadness, happy, and relaxation inductions, but are less conclusive for anxious induction. The anxiety environment was not designed to induce fear, but anxiety. Fear is an emotional response provoked by a "present" and specific threat, while anxiety is a more diffuse emotion. In general, the core element that is called on to distinguish between fear and anxiety is the presence of identifiable cues. Anxiety usually is defined as an emotional distress characterised by worry and tension, whereas threat is not so easy to define. Using Barlow's [12] words, anxiety is "a diffuse, objectless apprehension" (page, 7). In this sense, our "anxiety environment" include elements about a "possible" danger, trying to provoke an apprehensive and negative expectation. Results indicate that it is more difficult to induce this mood than other negative (sad) or positive (joy, relax) moods. So this environment should be improved, and perhaps it might be useful to design a "fearful" environment in order to test possible differences in the capability to induce "fear" and "anxiety

These results are important since they reveal the utility of the VR-MIPs as mood devices and, therefore, the possibility of using them in the future from both an applied and experimental perspective. For example, they could be used as a therapeutic tool to induce specific moods (relaxation or joy) in people who need it, or as mood induction procedures in experimental psychopathology. Most important is the fact of having achieved a "neutral" mood induction procedure that permits to make comparisons with the motional mood devices in latter works.

Regarding the role of mood on the sense of presence, our results show differences between emotional and neutral environments in some presence measurements. Regarding ITC-SOPI, there were differences between groups in "Engagement" and "Ecological validity" scales, indicating that emotional environments seemed more natural, believable and real to subjects than the neutral environment. Furthermore, regarding PRJQ, statistically significant differences are observed between the emotional and the neutral environment in most of the factors. The participants report a higher degree of realism, they also judge the experience as more real, they feel more present, and they experience a higher emotional involvement.

In conclusion, our results point out that the "new technologies" are useful to create mood devices that are able to induce emotions in the users; it is possible to induce "specific emotions" since the different mood devices that have been created allow the induction of an specific "target" emotion. Furthermore, the sense of presence is related to the emotion. From these results it is possible to argue that emotions may enhance presence. It is more likely that an environment able to elicit anxiety, sadness, joy, etc. could provoke the user to feel more present in that environment. Therefore, it could even be possible to consider emotions as an indicator of the degree of presence. It seems that sense of presence is determined by the emotions that a virtual environment is able to provoke in the user, and emotional issues are important variables in order to enhance presence. Further investigation is however needed, especially as far as objective measures are concerned.

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