Cyberpsychology, Behavior, and Social Networking
Volume 13, Number 6, 2010

DOI: 10.1089/cyber.2009.0412

Presence and Emotions in Playing a Group Game in a Virtual Environment: The Influence of Body Participation

Laura Aymerich-Franch, M.A.

Abstract

This study assesses the influence of body participation on the sense of presence and emotions, and the relationship between the two dependent variables in playing a group game in a virtual environment. A total of 56 volunteers were asked to play a virtual game in a 360-degree stereoscopic immersive interactive visualization environment using either body movement or a joystick. Presence was measured with the post hoc SUS Presence Questionnaire. The pictorial tool of Self-Assessment Manikin was employed for measuring emotions of arousal and valence. Both arousal and valence positively correlated with presence. However, body participation did not significantly affect reported presence or the above-mentioned emotions.

Introduction

Effective virtual environments (VEs) entail the creation of the sense of "being there," in the VE, to the users. This subjective sensation of "being there" experienced during immersion in the VE has been repeatedly defined as presence.[1] Undergoing this sensation is a necessary condition for a successful experience in a VE, and so measuring and improving the sense of presence during immersion has received much academic attention. However, whereas the ever-expanding range of multi-player virtual games reveals the potential of shared VEs in entertainment,[2] most studies related to presence in virtual reality (VR) and VE have focused on individual performance. Thus there is a need to observe the role of presence in shared VEs, in which multiple individuals sharing the virtual location play at the same time.

Furthermore, active usage of a participant's body in interactive game playing is emerging as one of the main tendencies in video gaming, and previous research works have already suggested that this activity may affect the sense of presence of a participant in an immersive VE.[3–6]

On the other hand, presence has been found to be mediated by human, context, and medium characteristics. Amongst the human factors, a possible relationship between presence and emotions has been noted.[7,8] This potential relationship is a crucial aspect that should be taken into account in the development of presence theory. Moreover, the study of emotions in the context of VE is of great importance, since emotions should be considered in any attempt to generate models seeking to explain human behavior in VEs.

In connection with all these aspects and with the belief that one of the clearest functions for VEs will be their use as advanced spaces for game playing, this study explores whether the participation of the body in game playing in a shared VE exerts influence on presence and emotions, and whether these dependent variables are related.

The Influence of Body Participation on the Sense of Presence

The relationship between body movement and presence in a VE has been assessed in several studies, suggesting a positive relationship between reported presence and the degree of body movement of participants.[3–6] Slater et al.[3] tested a technique to simulate body movements associated with walking in VR. These studies were carried out using two groups: the test group or "walkers" had to "walk in place" to move through the VE, whereas the control group navigated the environment using a 3D mouse, initiating movement by pressing a button, with direction of movement controlled by pointing. The studies suggested that subjective rating of presence was enhanced by the walking method, provided that participants associated subjectively with the virtual body provided in the environment. The authors also applied the technique to climbing and descending steps and ladders. Usoh et al.[5] replicated Slater et al.'s[3] study, adding real walking as a third condition. The other two conditions

GRISS, Image, Sound and Synthesis Research Group, Department of Audiovisual Communication and Advertising I, Universitat Autònoma de Barcelona, Barcelona, Spain.

consisted of “walking-in-place” and “flying.” The reported sense of presence was higher for virtual walkers than for flyers, and higher for real walkers than for virtual walkers.

Slater et al.[4] later tested the influence of body movements on presence in a VE in an experiment where participants were asked to walk through a virtual field of trees and count the trees with diseased leaves. The field with greater variation in tree height required participants to bend down and look up more than in the field with lower variation in tree height. The SUS (Slater–Usoh–Steed) Presence Questionnaire was employed to measure reported presence subjectively. The results revealed a significant positive association between reported presence and the amount of body movement—in particular, head yaw—and the extent to which participants bent down and stood up.

Following the idea that appropriate whole-body movements are associated with higher sense of presence, Slater and Steed[6] carried out further investigations with 20 subjects to assess the relationship between presence and body movement in an immersive VE. The researchers required the active group to reach out and touch successive pieces on a three-dimensional chessboard, whereas the control group only had to click a handheld mouse button. To measure presence, the authors implemented a presence counter that measured the number of transitions from the virtual to the real world to estimate the relative time the person was present in the virtual world. Presence was also measured using a version of the SUS Presence Questionnaire that followed the one introduced by Slater et al.[9] The results revealed a significant positive association in the active group between body movement and presence. The work did not determine the direction of causality, but the authors pointed out a possible two-way relationship: high presence leading to greater body movement and greater body movement reinforcing high presence.

The above-mentioned findings suggest that an active usage of the body may enhance experienced sense of presence. Accordingly, it is expected that:

H1: Participants using their body to play will report a higher sense of presence than participants using a joystick.

Presence and emotions in virtual environments

This study follows the dimensional theory of emotion, which suggests that emotions are all placed in a two-dimensional (2D) space as coordinates of valence and arousal.[10,11] While valence indicates the level of activation ranging from very negative to very positive, arousal reflects the intensity of an emotion, ranging from very calm to very excited. This 2D approach to emotions has been adopted in previous studies measuring emotional response in interactive media[12] and the relationship between presence and emotions in interactive media.[8,13] Although it is unclear whether a higher sense of presence causes stronger emotions or vice versa, previous studies support the existence of a relationship between presence and emotions in a VE.[1] In a study regarding the possibility of using VR as a medium capable of eliciting different emotions, Riva et al.[14] found a relationship between presence and emotions. Using a repeated-measures design, participants experienced a neutral and two affective VEs. The results showed a circular interaction between presence and emotions: the feeling of presence was greater in the affective VE, but also the emotional state was influenced by the level of presence. In another study examining the differences in presence between emotional and neutral VEs, Baños et al.[7] concluded from their results that emotions may enhance presence and that the sense of presence is determined by the emotions that a VE is able to provoke in the user. Ravaja et al.[13] examined the relationship of self-reported presence with emotion-related psychophysiological responses to success in a video game. In particular, with regards to arousal and valence, the study found that presence was positively related to arousal as measured by electrodermal activity (EDA) and related to the valence dimension as measured by facial electromyography (EMG). Also, in relation to valence, high presence was associated with increased positive affect and decreased negative affect. The study concluded that presence exerts an influence on both the valence and arousal dimensions of emotions.

These previous findings lead to consider that:

H2: Participants using their body to play will report feeling more aroused and positive than participants using a joystick.

Besides this:

H3: A positive correlation between presence and arousal is expected.

H4: A positive correlation between presence and valence is expected.

Correlation with valence is expected to be positive in view of the fact that the game was designed to elicit positive feelings and amusement.

Method

Participants

Fifty-six students from an Australian University voluntarily took part in the experiment, ranging in age from 18 to 44 years ($M = 22.6$). Fourteen of them were doing studies related to engineering or computer science. Half of the sample played video games at least once a month. Twenty-three had never experienced VR/VE before, and two had experienced “a great deal” of it. They were randomly organized into groups of four, and assigned to one of the two experimental conditions (body condition or joystick condition). All groups contained male (32) and female (24) participants. No payment was made for participation.

The virtual environment

The experiment took place in a 360-degree stereoscopic immersive interactive visualization environment with an integrated motion tracking system, multi-channel audio, four meters high and ten meters in diameter (Figure 1). Subjects within the visualization environment were tracked by a system of infrared cameras and tracking software. Both the virtual location and the physical space were shared by participants during immersion in this environment.

Procedure

Written instructions on how to play the game were given to the participants before starting the experiment. No other special training was given to them before they played the

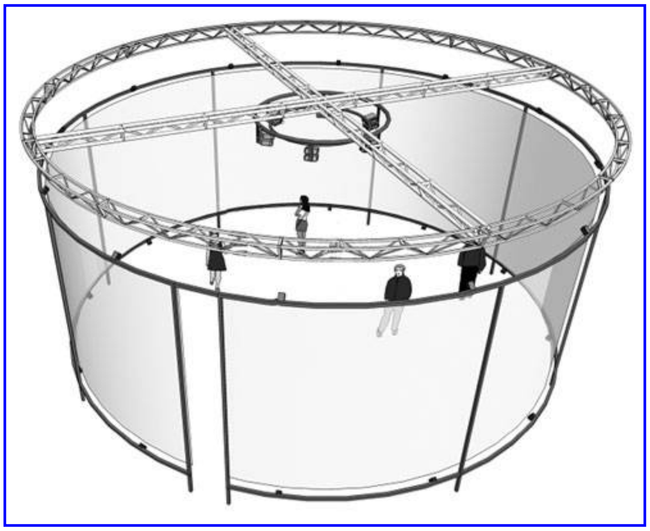

FIG. 1. 360-degree interactive visualization environment.

game. Participants entered the VR theater one by one in groups of four each time. They wore polarized 3D glasses so they could see the stereoscopic images projected on the cylindrical screen. The vertical field of view of the VE was approximately 40 degrees standing at the center of the spherical theater. Students could move freely inside the theater at all times; no wires were attached to them. The VE consisted of a green floor with four holes and a background wall made of large green blocks. A block then appeared on the screen for each participant. Blocks were different in shape and color in order to be identified by the players. Participants were given 2 minutes to adapt themselves to the VE and subsequently the game began. Each player controlled his/her block with the objective to place the block in a specific hole. This was a 3D task using passive stereoscopy. In the *joystick condition* (JC), participants controlled the movement of the block with a joystick, whereas in the *body condition* (BC) they controlled the movement of the block by moving their own body (they were being tracked by the system). A virtual character for each player made the task more difficult by kicking the block (Figure 2). The big dimensions of the theater allowed participants to walk freely. However, they could occasionally bump into each other if they coincided in the physical space, especially in the body condition, where more body movement was required. The group had 8 minutes to achieve the general objective of the game. To reach this general goal, all participants had to put the block in the correct hole. Whenever a participant achieved the individual objective, a floating ball appeared on the screen. When other participants also achieved the objective, the control of this ball became shared between them. They could momentarily electrocute the opponents with the powers of this ball in order to help other participants. If the group achieved the objective before running out of time, sounds of victory were heard and the game finished. Otherwise, the VE suffered a simulated explosion after 8 minutes. The seven groups in the joystick condition achieved the objective of the game. In the body condition, just three out of seven groups achieved it. No other elements were modified in the game between the two experimental conditions. Following the game, the participants filled out a PC-based questionnaire.

FIG. 2. Image of the virtual environment: the four blocks and an opponent trying to kick them.

Pretest

A pretest was conducted with four students to contrast the level of difficulty to achieve the objective in both conditions. The participants in the pretest played the game twice, with the joystick and with the body. They achieved the objective in both cases. No troubles in understanding the instructions, playing the games, or answering the questionnaire were reported.

Measures for presence

The most commonly used measures in presence research are based on subjective ratings through questionnaires.[1] Slater et al. developed a questionnaire to measure the construct of presence that has been widely used in previous studies.[4–6,15,16] This post hoc questionnaire has been referred as SUS. The version used in the present study is based on six questions that are all variations on one of three themes: the sense of being in the VE, the extent to which the VE becomes the dominant reality, and the extent to which the VE is remembered as a "place."[17] The questions were adapted as follows, according to the particular conditions tested in the experiment:

1. Please rate your sense of being in the virtual game on the following scale:
   I had a sense of "being there" in the game …
   (1) Not at all. (7) Very much.
2. To what extent were there times during the experience when the virtual game became the "reality" for you, and you almost forgot about the "real world" in which the whole experience was really taking place?
   There were times during the experience when the virtual game became more real for me compared to the "real world" …
   (1) At no time. (7)Almost all the time.
3. When you think back to your experience, do you think of the virtual game more as something that you saw on the screen, or more as a place that you were in?
   The virtual game seems to me to be more like …
   (1) Something that I saw on the screen. (7) A place that I was in.

4. During the time of the experience, which was strongest on the whole: your sense of being in the virtual game or of being in the real world of the interactive cinema?
   I had a stronger sense of being in …
   (1) The real world of the interactive cinema. (7) The virtual environment of the game.
5. Consider your memory of being in the virtual game. How similar in terms of the structure of the memory is this to the structure of the memory of other places you have been today? By "structure of the memory" consider things like the extent to which you have a visual memory of the virtual environment in the game, the extent to which the memory seems vivid, its size, location in your imagination, the extent to which it is panoramic in your imagination, and other such structural elements.
   I think of the virtual game as a place in a way similar to other places that I've been today …
   (1) Not at all. (7) Very much so.
6. During the time of the experience, did you often think to yourself that you were actually just in the interactive cinema or did the virtual game overwhelm you?
   During the experience, I often thought that I was really in the interactive cinema …
   (1) Most of the time I realized I was in the interactive cinema.
   (7) Never because the virtual game overwhelmed me.

The questions were rated on a 1 to 7 scale, where the higher score meant higher reported presence. As Slater et al. suggest,[4] to analyze data, a conservative measure of subjective presence was constructed as the number of high responses (scores of 6 or 7) in the answers to the six questions—resulting in a binomially distributed count (number of high responses out of 6) as the response variable—and logistic regression was used to analyze the responses.

The SUS questionnaire also includes a free-response final question:

Please write down any further comments that you wish to make about your experience. In particular, what things helped to give you a sense of "really being" in the virtual game, and what things acted to "pull you out" and make you more aware of "reality"?

Since the game was played in a shared VE, with other participants playing at the same time, the following question was added to the questionnaire:

During the game, did you perceive the rest of the players more as real people in the room or more as virtual objects in the game?

During the game, I perceived the rest of the players more as …

(1) Real people in the room. (7)Virtual objects in the game.

Results for this last question were independently explored to obtain data related to the sense of presence in a shared VE, and they were not added to the presence questionnaire in the analysis.

Measures for emotions

Physiological measures, behavioral observation, and self-reported measures are the major methods that have been used for measuring emotions. Along with self-reported scales, Self-Assessment Manikin (SAM)[18,19] stands out for being a pictorial tool having the advantage of being easily understandable, culture-free, and language-free in comparison to verbal measures. SAM visually represents the pleasure, arousal, dominance model (PAD) developed by Mehrabian and Russell.[20] It depicts each PAD dimension with a graphic character arrayed along a continuous 9-point scale.[21] For the purposes of this research, valence and arousal scales resembling Lang's SAM were employed. The valence scale consisted of five graphic depictions of human faces in expressions ranging from a severe frown (most negative) to a broad smile (most positive). For arousal ratings, there were five graphical characters varying from a state of low visceral agitation with eyes closed to that of high visceral agitation with eyes opened.

Results

Table 1 shows presence data. The first column reports the mean and standard deviation of the count of six or seven scores among the six questions, whereas the second column shows the mean score of the six questions. Both conditions obtained exactly the same mean, and so logistic regression did not find body participation to significantly affect presence at the 5% significance level ($x^2 = 4.544$ on 5 df, $p = 0.474$). Thus H_1 is not supported. The third column shows means for the presence question related to *perceive the rest of the players more as real people or more as virtual objects in the game* (SVE). Both conditions also obtained very close means, and so body participation did not noticeably affect the perception of the players in this regard (independent sample t test at 5%: $t = -0.076$, $p = 0.940$).

Table 2 accounts for presence results in more detail. Mean results by condition are expressed for each of the individual questions of SUS Presence Questionnaire. It can be seen that both groups obtained very close means in all comparisons.

Means and standard deviations for emotion measurements are listed in Table 3. Both conditions obtained very similar results. Consequently, an independent sample t test at 5% did not report significant differences between BC and JC either for arousal ($t = -0.819$, $p = 0.417$) or valence ($t = 0.088$, $p = 0.930$). Body participation did not significantly affect emotions and hence H_2 is not supported.

Table 4 summarizes Pearson correlations between presence and emotions. A positive correlation was found between presence and arousal when presence was the count of 6 and 7 scores among the six questions. However, previous studies have considered 5, 6, and 7 as high responses for presence measure.[22–25] In doing so, presence and valence and also presence and arousal were positively correlated. H_3 is fully supported, both considering 6 and 7 or 5, 6, and 7 as high responses as a measure of presence. H_4 is supported when presence is the count of 5, 6, and 7 scores.

Finally, an independent sample t test was also carried to examine whether gender or accomplishment of the objective

Table 1. Presence Data

	SUS count	*SUS mean*	*SVE mean*
Condition	M (SD)	M (SD)	M (SD)
Joystick ($n = 28$)	0.89 (1.26)	3.70 (1.05)	2.71 (1.80)
Body ($n = 28$)	0.89 (1.34)	3.70 (1.23)	2.75 (1.73)

Table 2. Means and Standard Deviations for Individual Presence Questions

	Q1	Q2	Q3	Q4	Q5	Q6
Condition	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)
Joystick ($n=28$)	4.29 (1.27)	3.00 (1.76)	3.75 (1.65)	4.18 (1.56)	3.57 (1.05)	3.43 (1.64)
Body ($n=28$)	4.71 (1.33)	3.61 (1.77)	3.61 (1.70)	4.00 (1.80)	3.18 (1.23)	3.11 (1.57)

of the game could affect sense of presence or emotions. The results did not report statistically significant differences.

Discussion

The main goals of this study were to analyze the influence of body participation on the sense of presence and emotions, and to test whether presence and emotions are related in game playing in a shared VE.

On the one hand, results did not report significant differences between playing the game with the body or with the joystick for presence or emotions. In this sense, results do not corroborate previous studies showing that presence is enhanced by body participation. A definitive explanation cannot be presented. Nonetheless, body participation in the VE is certainly a relevant aspect that deserves attention from academics. In view of this, some speculation based on the results is offered in order to encourage further research. First, this investigation used a 360-degree stereoscopic immersive interactive visualization environment, whereas previous studies used other immersive systems, principally, a head-mounted display. Hence, future studies might consider immersion as a variable that might affect the relationship between body participation and presence. A similar reasoning could be applied to emotions. It would be of interest to analyze their relationship with body participation taking into account the immersion variable. Second, the kind of task in which body movement is involved and the connection of this task with the VE itself might also affect the relationship of body movement with presence and emotions. This investigation used a game that required the use of a joystick or the movement of the body to put a block in a hole. Different tasks and interaction situations involving body participation might report different results.

On the other hand, the investigation found presence and arousal and also presence and valence to be related. Therefore, these findings support the existence of a relationship between presence and emotions stated in previous works. In connection with this, the analysis provided better evidence of the relationship between presence and emotions when the sense of presence was determined by the count of 5, 6, and 7 scores than when it was the count of 6 and 7 scores. In this respect, it has been observed that whereas the global mean for both groups cannot be considered low ($M=3.7$ out of 7), overall SUS count of presence for 6 and 7 scores resulted in notably low punctuations (0.89 out of 6). This may explain why adding 5 scores to the presence count helped to highlight the relationship between presence and emotions better. For this reason, the addition of 5 scores in the SUS Presence Questionnaire might better serve the analysis of presence under some circumstances and should be considered in future studies.

Some limitations have also been identified in this study. First, two versions of the game were designed to be played either using the body or a joystick, with no other changes between both. A pretest was conducted in order to compare the difficulty level between both conditions with regard to achieving the objective of the game. Participants in the pretest achieved the objective in both conditions. However, in the experiment, all groups in the joystick condition achieved the objective, whereas only three groups out of seven achieved it when playing with the body. Thus achieving the objective of the game playing with the body proved to be more difficult. This aspect might have affected the results, since the difficulty level to reach the objective of the game has been found to exert an effect on emotions and presence in similar contexts (i.e., video-game playing).[26] Accordingly, difficulty level should be more strictly controlled in further experiments.

In addition, the SUS Presence Questionnaire includes an open question encouraging participants to disclose what things helped to give them a sense of really being in the virtual game, and what things caused them to pull out of the game and make them more aware of reality. In total, seven participants (five in the joystick condition and two in the body condition) mentioned that delays in the response of the movement of the block contributed to them being pulled out of the game, which comprises another limitation of this investigation. Therefore, further studies are advised to emphasize the control of technical aspects that may be likely to affect reported presence.

As a final point, more research is expected in the field of shared VEs as spaces for game playing, since this could be one of the main functions destined for these environments.

Table 3. Means and SD for Emotion Measurements

	Valence	Arousal
Condition	M (SD)	M (SD)
Joystick ($n=28$)	6.68 (1.19)	5.68 (1.78)
Body ($n=28$)	6.64 (1.79)	6.07 (1.79)

Table 4. Pearson Correlations Between Presence and Emotions

		Presence [6–7]	Presence [5–7]
Valence	r	0.215	0.294*
	p	0.111	0.028
Arousal	r	0.363**	0.402**
	p	0.006	0.002

*Correlation is significant at the 0.05 level (two-tailed).
**Correlation is significant at the 0.01 level (two-tailed).

More specifically, special attention should be paid to the role of presence and emotions in this context, given that these variables seem to hide important clues to the success of these spaces.

Acknowledgments

This study was conducted in the Advanced Visualisation and Interaction Environment (AVIE) of Centre for Interactive Cinema Research (iCinema) of University of New South Wales, Sydney, during a research stay of the author in this center. The research stay was supported by Comissionat per a Universitats i Recerca del Departament d'Innovació, Universitats i Empresa (Generalitat de Catalunya). GRISS (Image, Sound and Synthesis Research Group) is a consolidated research group recognized by Generalitat de Catalunya. The author wishes to express her most sincere gratitude to iCinema for all the facilities and support provided during the experiment.

Disclosure Statement

No competing financial interests exist.

References

1. Schuemie MJ, Van Der Straaten P, Krijn M, et al. Research on presence in virtual reality: A survey. CyberPsychology & Behavior 2001; 4:183–201.
2. Benford S, Greenhalgh C, Rodden T, et al. To what extent is cyberspace really a space? Collaborative virtual environments. Communications of the ACM 2001; 4:79–85.
3. Slater M, Usoh M, Steed A. Taking steps: The influence of a walking metaphor on presence in virtual reality. ACM Transactions on Computer–Human Interaction (TOCHI) 1995; 2:201–19.
4. Slater M, Steed A, McCarthy J, et al. The influence of body movement on subjective presence in virtual environments. Human Factors: The Journal of the Human Factors & Ergonomics Society 1998; 40:469–77.
5. Usoh M, Arthur K, Whitton M, et al. Walking. Walking-in-place. Flying in virtual environments. Computer Graphics (SIGGRAPH), Annual Conference Series 1999; 359–64.
6. Slater M, Steed A. A virtual presence counter. Presence 2000; 9: 413–34.
7. Baños RM, Botella C, Liaño V, et al. (2004) Sense of presence in emotional virtual environments. Presence 2004: The 7th Annual Workshop on Presence, Valencia, Spain.
8. Ravaja N, Saari T, Turpeinen M, et al. Spatial presence and emotions during video game playing: Does it matter with whom you play? Presence: Teleoperators & Virtual Environments 2006; 15:381–92.
9. Slater M, Steed A, Usoh M. (1993) The virtual treadmill: A naturalistic method for navigation in immersive virtual environments. In Goebel M, ed. *First Eurographics Workshop on Virtual Environments*. Polytechnical University of Catalonia, pp. 71–83.
10. Lang PJ. The emotion probe. Studies of motivation and attention. American Psychologist 1995; 50:372–85.
11. Larsen RJ, Diener E. (1992) Promises and problems with the circumplex model of emotion. In Clark M, ed. *Review of personality and social psychology* (Vol. 13). Newbury Park, CA: Sage, pp. 25–59.
12. Schneider EF, Lang A, Shin M, et al. Death with a story. How story impacts emotional, motivational, and physiological responses to first-person shooter video games. Human Communication Research 2004; 303:361–75.
13. Ravaja N, Laarni J, Saari T, et al. (2004) Spatial presence and emotional responses to success in a video game: A psychophysiological study. In Raya MA, Solaz BR, eds. *Proceedings of the Presence 2004.* Valencia, Spain: Editorial de la UPV, pp. 112–16.
14. Riva G, Mantovani F, Capideville CS, et al. Affective interactions using virtual reality: The link between presence and emotions. CyberPsychology & Behavior 2007; 10:45–56.
15. Slater M, Usoh M, Chrysanthou Y. The influence of dynamic shadows on presence in immersive virtual environments. Virtual Environments 1995; 95:8–21.
16. Baños RM, Botella C, Alcañiz M, et al. Presence and emotions in virtual environments: The influence of stereoscopy. CyberPsychology & Behavior 2008; 11:1–8.
17. Usoh M, Catena E, Arman S, et al. Using presence questionnaires in reality. Presence: Teleoperators & Virtual Environments 2000; 9:497–503.
18. Lang PJ. (1980) Behavioral treatment and bio-behavioral assessment: Computer applications. In Sidowski JB, Johnson JH, Williams TA, eds. *Technology in mental health care delivery systems.* Norwood, NJ: Ablex, pp. 119–37.
19. Lang, PJ. (1985) *The cognitive psychophysiology of emotion: Anxiety and anxiety disorders*. Hillsdale, NJ: Lawrence Erlbaum.
20. Mehrabian A, Russell J. Evidence for a three-factor theory of emotions. Journal of Research in Personality 1977; 11:273–94.
21. Morris J. SAM: The self-assessment manikin. An efficient cross-cultural measurement of emotional response. Journal of Advertising Research 1995; 35:63–8.
22. Meehan M. Physiological reaction as an objective measure of presence in virtual environments. Doctoral dissertation, University of North Carolina, 2001.
23. Meehan M, Razzaque S, Whitton MC, et al. (2003) Effect of latency on presence in stressful virtual environments. In *Proceedings of the IEEE Virtual Reality 2003*. Los Angeles, CA: IEEE Computer Society, pp. 141–8.
24. Meehan M, Insko B, Whitton M, et al. (2002) Physiological measures of presence in stressful virtual environments. In *Proceedings of SIGGRAPH 2002*. San Antonio, TX: Association for Computing Machinery, pp. 645–52.
25. Khanna P, Yu I, Mortensen J, et al. (2006) Presence in response to dynamic visual realism: a preliminary report of an experiment study. In *ACM VRST.* Limassol, Cyprus: Association for Computing Machinery, pp. 364–7.
26. Ravaja N, Saari T, Salminen M, et al. (2004) Emotional response patterns and sense of presence during video games: Potential criterion variables for game design. In Hyrskykari A, ed. *Proceedings of the NordiCHI 2004.* New York: ACM Press, pp. 339–47.

Address correspondence to:
Laura Aymerich-Franch
Dept. Comunicació Audiovisual i Publicitat I
Facultat de Ciències de la Comunicació, Edifici I
Universitat Autònoma de Barcelona
08193 Bellaterra
Barcelona
Spain

E-mail: laura.aymerich@gmail.com

This article has been cited by:

1. Elizabeth J Lyons, Deborah F Tate, Dianne S Ward. 2013. The better the story, the bigger the serving: narrative transportation increases snacking during screen time in a randomized trial. *International Journal of Behavioral Nutrition and Physical Activity* **10**:1, 60. [CrossRef]
2. Elizabeth A. Boyle, Thomas M. Connolly, Thomas Hainey, James M. Boyle. 2011. Engagement in digital entertainment games: A systematic review. *Computers in Human Behavior* . [CrossRef]