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Real and Illusory Interaction Enhance Presence in Virtual Environments

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Summary

In two experiments, two forms of interactivity were investigated concerning their effect on presence: (1) the possibility of viewpoint changes, and the (2) interaction with other characters in the virtual environment. A multi-component presence measure was used as dependent variable. The results show that viewpoint changes enhance spatial presence and experienced realism. The presence of other acting characters in the VE may only enhance presence when interactions with them are considered as possible. This was manipulated without changes in the technology by merely giving different instructions to the participants. That presence can be manipulated in this manner supports the idea that the cognitive conceptualisation of a VE determines presence.

Extended Abstract

Interactivity of virtual environments (VEs) has been regarded a central feature of virtual reality for many years. The possibility to interact with the virtual world distinguishes VEs from a range of other media. Together with vividness, "the ability of a technology to produce a sensorially rich mediated environment", interactivity, "the degree to which users ... can influence the form or content of the mediated environment", defines virtual reality (Steuer, 1992, p. 80).

Models of *presence*, the sense of actually being in the virtual environment, also stress the importance of interactivity in VEs. Different forms of interactivity are related to presence: Witmer and Singer (1998), building upon Sheridan (1992), refer to the ability to actively search the VE: "An environment should enhance presence when it permits observers to control the relation of their sensors to the environment (p. 230). Modifying the own viewpoint, Witmer and Singer argue, should enhance presence.

But the mere possibility to interact is not sufficient to enhance presence. If users can modify the viewpoint, but do not understand how, this should rather decrease presence. The same goes for the two other basic categories of interaction: the manipulation of (inanimate) objects in the virtual world and the interaction with animate characters and real human beings. Users need to have a sense of control over or at least an understanding of the results of their actions. Consequences should be predictable. Witmer and Singer (1998), following Held and Durlach (1992), call this the ability to anticipate: "Individuals probably will experience a greater sense of presence in an environment if they are able to anticipate or predict what will happen next...." (p. 229).

Why should interaction enhance presence? The Embodied Presence Model (Schubert, Friedmann & Regenbrecht, 1999a, b) proposes that presence develops from the cognitive representation of possible actions that can be performed in the virtual world. The model builds upon embodied cognition approaches (Glenberg, 1997; Lakoff & Johnson, 1999), and argues that a virtual environment is conceptualised in terms of possible actions. What is important about interactivity is that actions which are represented mentally are bodily actions within the space depicted. These actions can be functionally related to navigation, manipulation of objects, or interaction with other agents. Embodied presence develops from the mental representation of navigation (movement) of the own body (or body parts) as a possible actions in the virtual world (Schubert et al., 1999a).

This proposal ties together the basic possibility to interact at all (e.g., viewpoint modification), and the ability to anticipate what results the interactions will have. Bodily actions should only be *meshed* (Glenberg, 1997) with the virtual world when the consequences seem to be predictable. No meshing at all should occur when no interaction is possible. (Except when the user identifies with an observed actor and empathetically acts with him or her, as in feature films (Tan, 1996)).

Although the importance of interactivity for presence is widely acknowledged, direct empirical evidence is rare. Welch, Blackmon, Liu, Mellers and Stark (1996) showed in a within-subjects design, that driving a virtual car creates higher presence than merely being a passenger in it. A recent study by Schubert et al. (1999a, b), applying factor and path analyses, identified among others two facets of interactivity which formed different factors. The *exploration* factor is constituted by close and complete exploration of objects and the environment from multiple viewpoints. It is also important that these explorations seem natural to the user. A second *predictability & interaction* factor matches what Witmer and Singer call anticipation. Together, exploration and predictability describe the successful *meshing* of actions: It is important that actions can be performed in the first place (basic interactivity), that the actions have an impact on the VE and that this impact is the one desired and predicted. The two factors are closely interrelated. Path analysis show that both facets have a high impact on spatial presence (Schubert et al., 1999a). However, these results were correlational in nature and cannot be interpreted causally.

The goal of the present work is to show in an experimental between-subjects design that providing interactivity leads to an enhanced sense of presence. To this purpose, two studies were conducted. Study 1 manipulated in a two by two design the possibility to change the own viewpoint and the presence of other active agents in the VE. Study 2 tested more directly whether the mental representation of possible action itself has an effect on presence.

Study 1

Study 1 hypothesised, following the argumentation above, that providing the possibility to change the own viewpoint (self-movement) in a predictable manner should lead to an enhanced sense of presence. Furthermore, we hypothesised that introducing other agents which moved around in the same space as the user (animation) should lead to enhanced presence since more possibilities to interact are provided. Both factors were manipulated independently in a 2x2 between-subjects design. We expected two main effects. The participants were randomly assigned to the conditions, experienced a virtual environment, and subsequently filled out a questionnaire assessing presence.

Method

Fifty six students and university staff members (fourteen in each cell of the design) took part in the study.

Participants were first given a brief verbal description of the VR technology, especially the Head-Mounted Display (HMD), and the VE they were going to experience. They then put on the HMD. The presented VE consisted of a hallway resembling an administration building. The participants stood on an intersection, looking into four corridors with numerous doors. Across the walls, a number of plates were visible. In order to give the participants a minimal task and to avoid boredom, participants were instructed to count the number of the plates which would be asked for after the immersion.

One half of the participants was able the change the viewpoint in the VE themselves by turning their head and walking around in a circle of approximately 4 m diameter in the real and the virtual environment (self-movement). The other half saw a film-like presentation of the VE *on the HMD*, which was recorded earlier. The presentation showed the VE from the viewpoint of a person slowly wandering and looking around (normal eye-height).

The manipulation of the second factor involved the presence of other active agents in the VE. To this purpose, for one half of the participants the doors of the hallways opened and closed from time to time, and two comic-strip-like shoes came out of the doors, walked across the hall and entered other rooms (animation). This introduced the impression that other agents walked around the same space. In the no-animation condition, doors remained closed all the time, and no characters appeared.

After about 10 minutes, the immersion was stopped and participants were given questionnaires. The questionnaire consisted of a version of a three-component presence questionnaire, measuring *spatial presence (SP)*, *involvement (INV)* of the user, and experienced *realness (REAL)* of the VE (Schubert et al., 1999a, b).

Results and Discussion

The three scales had acceptable reliabilities, as estimated by Cronbach's Alphas of .82, .87 and .69 for SP (10 items), INV (7 items) and REAL (2 items), respectively. Separate 2x2 ANOVAS for the three depended variables showed a main effect of self-movement on both SP, $F(1,52)=6.95$, $p=.011$, and REAL, $F(1,52)=4.52$, $p=.038$. animation had only a weak effect on REAL, $F(1,52)=3.797$, $p=.057$. No interaction approached significance, F's < 1.

The means show that self-movement increases both SP and REAL, and that REAL is also enhanced by animation. The attention component INV is virtually unaffected by the experimental manipulations.

The results show that while self-movement had the expected effects, the presented animations did not. A possible explanation is that the users did not see the possibility of interacting with the comic-strip characters, since they did not cross their way and did not react to the movements of the user.

Study 2

To investigate this question further, we conducted a second experiment in which all participants experienced the same VE, with both self-movement and animated characters. When our model is correct, animations should only enhance presence when interactions with the characters are considered possible. Therefore, one half of the participants was told that they would see other characters in the VE and that these characters would react to the participant's actions (it was not said in which way). The other half was told that other characters would appear, but that no interactions with them were possible. In fact, the characters did never react to the participants' actions.

Method

Thirty two students took part in the study. Six persons were excluded from the analysis because the post-questionnaire revealed that they did not experience control over their self-movement or that they did not see moving objects in the VE. Of the remaining 26 participants, 10 received the instruction that they would be able to interact with the characters.

The procedure was the same as in Study 1, with the additional explicit instruction before the immersion that interaction with the characters would be possible or not. However, immersion times were somewhat shorter than in Study 1, due to a lower motivation of the participants.

Results and Discussion

Reliabilities of the scales were comparable to those from Study 1. Comparison of means in a one-way ANOVA showed a small effect of the manipulation on SP, $F(1,24)=3.44$, $p=.076$. A balanced design, with 6 randomly chosen participants in the no-interaction condition excluded from the analysis, yields an $F(1, 18)=4.025$, p=.060. Spatial presence is higher, when the possibility to interact with the animated characters is expected. The mean changes for INV and REAL are in the right direction, but these effects do not reach statistical significance (p's < .29). The rather weak effects may be due to the fact that we did not actually provide possibilities to interact, but merely told that we would.

General Discussion

Our results support a hypothesis long postulated in the presence literature: The possibility to change the own viewpoint increases presence. When the mode of presentation is kept constant by presenting a VE via HMD, users who can walk and look around develop a stronger sense of being in the VE, and experience the VE as more real.

Moreover, our results concerning the effects of animated characters in the VE tell something about the cognitive process underlying the effect of interaction on presence. Animations in the VE do *not* increase presence unless the participants perceive some possibility to be part of the action, to interact with the characters. This is supported by the special form of manipulation in Study 2. To our knowledge for the first time it is shown that presence can be manipulated by merely changing the way the users perceive the VE, without any change in hard- and software.

On a more general level, this supports our Embodied Presence Model, which postulates that a VE is conceptualised in terms of possible actions. It makes the prediction that the more possible bodily interactions with the VE are mentally represented, the higher the sense of presence. For the participants in study 2, walking around the space was the only possibility of interaction with the other characters. Bodily movement was additionally meshed with the VE via its characters, increasing the spatial presence. Conceptualisation of the VE in reference to the own body determines presence.

In these studies, for the first time we used a multi-component measure of presence in experimental research, distinguishing different facets of this construct. The results demonstrate the usefulness of this approach: While spatial presence was affected by the manipulations, the attention component *involvement* was not. We hope to show with the present research that hypotheses on the cognitive processes leading to presence gain from this approach.

References

Held, R., & Durlach, N. (1992). Telepresence. *Presence: Teleoperators and Virtual Environments, 1*, 109-112.

Glenberg, A.M. (1997). What memory is for. *Behavioral and Brain Sciences*, 20, 1-55.

Lakoff, G., & Johnson, M. (1999). *Philosophy in the Flesh*. New York: Basic Books.

Schubert, T., Friedmann, F., & Regenbrecht, H. (1999a). *Decomposing the Sense of Presence: Factor Analytic Insights.* Paper presented at the 2nd International Workshop on Presence, University of Essex, 6th and 7th April, 1999.

Schubert, T., Friedmann, F., & Regenbrecht, H. (1999b). Embodied Presence in Virtual Environments. In Ray Paton & Irene Neilson (Eds.), *Visual Representations and Interpretations.* (pp. 269-278). London: Springer-Verlag.

Sheridan, T.B. (1992). Musings on Telepresence and Virtual Presence. *Presence: Teleoperators and Virtual Environments, 1*(1), 120-125.

Steuer, J.S. (1992). Defining virtual reality: Dimensions determining telepresence. *Journal of Communication, 42*(4), 73-93.

Tan, E.S. (1996). *Emotion and the structure of narrative film*. Mahwah, N. J.: Lawrence Erlbaum.

Welch, R. B., Blackmon, T. T., Liu, A., Mellers, B. A., Stark, L. W. (1996). The Effects of Pictorial Realism, Delay of Visual Feedback, and Observer Interactivity on the Subjective Sense of Presence. *Presence: Teleoperators and Virtual Environments, 5*(3), 263-273.

Witmer, B.G., & Singer, M.J. (1998). Measuring Presence in Virtual Environments: A Presence Questionnaire. *Presence: Teleoperators and Virtual Environments, 7*(3), 225-240.