Tools, Perspectives and Avatars in Blended Reality Space

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Abstract. *Blended Reality Space* is our term for an interactive mixed reality environment where the physical and the virtual are intimately combined in the service of interaction goals and communication environments aimed at health support and rehabilitation. The present study examines the effect on rated *presence* and *self-presence* of three key factors in the way blended realities may be implemented for these purposes. Our findings emphasize the importance of tangibility for presence, but suggest that presence and self-presence are unrelated phenomena. These findings will be incorporated into design principles for our planned work to develop free movement based interactions for motor rehabilitation as well as blended reality spaces for collaboration between hospitals, care organizations and the home.

Keywords. Blended Reality Space, Tangibility, Presence, Rehabilitation

Introduction

Blended Reality Space is our term for an interactive mixed reality environment where the physical and the virtual are intimately combined in the service of interaction goals and communication environments aimed at health support and rehabilitation [1]. The present study examined three key factors in the way blended realities may be implemented for these purposes: (i) the extent to which tangible tools play a role in interaction; (ii) whether a first person or a third person perspective is provided from the user's point of view; and (iii) if a third-person perspective (of a self-representing avatar) is used, how closely the representation matches the appearance of the user. We focused on the effect of these variables on rated presence [2] and self-presence [3]. The study is novel in combining manipulations of tangibility with those of viewpoint and avatar identity and examining their effect on both perceived presence and self-presence.

1. Blended Reality Space and Our Hypotheses

Blended Reality Space is an emerging kind of interaction space where the physical and the virtual are closely combined [1]. Through this physical-virtual combination, the

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physical objects provide users with clues about the virtual environment and help them develop skills in their environment, such as picking up, positioning, altering, and arranging objects [4]. The aim of this study is to gather further insights for strategic combinations of such key factors as *Presence*, *Tangibility*, *Perspective* and *Avatars* for the development of effective Blended Reality Spaces. These factors are still under-explored as to how they effect perceptions of emerging interaction space.

Various scholars have debated the definition and value of the concept of presence. Presence is described as the perception of a virtual experience as a physical experience. Self-presence is an extension of the sense of self identity, and is seen as the extent to which a participant feels a virtual representation of self to be accurate [2][5]. Presence in a virtual environment (VE) traditionally depends on shifting attention from the physical environment to the VE, but does not usually require the total displacement of attention from the physical locale [6]. Presence is also not constrained to high technology situations, because - according to some authors at least - we may feel quite high presence when reading books or watching movies [5]. The present study used the Nintendo Wii video game and console, commonly available and widely used technology that can provide a satisfying and involving gaming experience even with relatively inexpensive technology, including computer graphics with quite low resolution. Based on earlier findings, we arrived at the following hypotheses:

Hypothesis 1: *Participants who use a physical tool will feel more* ***presence*** *than participants who use only their body as a tool, with both 1st and 3rd person perspectives.*

Many researchers have experimented with sensor-based techniques for interacting with virtual entities via the manipulation of physical objects in space. Such interaction concepts are often termed "tangible" and have been frequently discussed in the HCI (Human Computer Interaction) literature. The main idea of such a tangible interface, built on movement and position sensing techniques, is to provide physical forms which serve as both representations of and controls to digital information. The applications make the digital information directly manipulable with our hands, and perceptible through our peripheral senses by physically embodying it [7][8][9]. The effects of tangibility on presence have yet to be fully studied and explicated, but our expectation was that a physical tool would enhance the sense of presence.

Hypothesis 2: *Participants who have a 1st person perspective on the game will feel more* ***presence*** *than with 3rd person perspective both with a tool and without.*

A 1st person perspective duplicates the natural view of ones own actions by providing interaction with the blended reality space as if from the players' own physical viewpoint [10]. With a 3rd person perspective, they see their own representation as an avatar whose bodily movements reflect their physical movements in real time [10]. Because of this difference, we expected a stronger feeling of presence to be elicited with a 1st person perspective.

Hypothesis 3: *Participants who play with an avatar similar to self will feel more* ***presence*** *than participants who play with an avatar dissimilar to self.*

Hypothesis 4: *Participants who play with an avatar similar to self will feel more* ***self-presence*** *than participants who play with an avatar dissimilar to self.*

Hypothesis 5: *Participants who use a tool will feel more* ***self-presence*** *than participants who use their body as a tool for both an avatar similar and dissimilar to self.*

Avatars provide a concrete representation of the player's actions and identity [11][12][13]. We expected that there would be both higher presence and self-presence when the avatar resembled the player more accurately. We also expected that using a tool with either kind of avatar would produce higher presence than not using a tool.

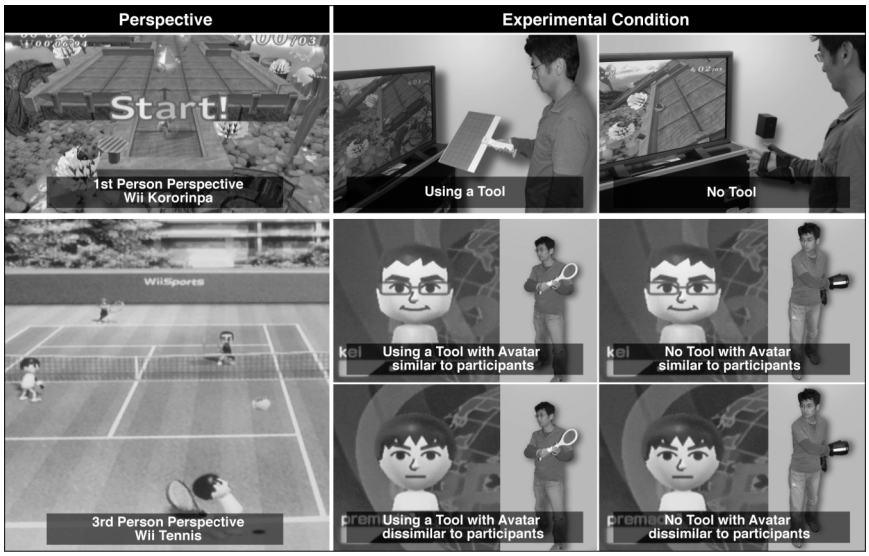

Figure 1. Experimental Conditions

2. Method

To test these hypotheses, we created several different versions of blended reality space, based on the Nintendo Wii gaming environment, its wireless movement-sensing Wiimote interaction device, and a 60" plasma display (as shown in Figure 1). For the present study, the simplest avatar-oriented game from various Wii games was chosen: Wii tennis (3rd person view) and Kororinpa (1st person view). Wii tennis requires a swinging motion of the handheld Wiimote to hit the virtual ball, while Kororinpa requires more delicate hand movements of the device to guide a marble through virtual mazes. For the tangible (with tool) conditions we embedded the Wiimote in a physical tennis racquet or maze board (Figure1). For the no tool conditions the Wiimote was worn in a glove on the back of the participant's dominant hand. In the third person view conditions, the avatar used was either the pre-supplied one (identical for all participants) or was one designed by each participant to resemble himself or herself, known as a Mii. Miis are customizable and allow the participants to capture a likeness or caricature of themselves, or others.

16 participants (20 to 65, average age 37 years) volunteered and took part in the study. After each game in the various conditions, the participants filled out a questionnaire regarding their feelings of presence and self-presence. Subjects were

asked to rate each question on a scale from poor to excellent, which were translated by the experimenter into a numerical scale from 0 to 5. T-tests were used in order to compare the means of the dependent variable scores. The questionnaire consisted of 28 questions, which in aggregates correspond to six factors thought to be correlated with presence and self-presence: Awareness, Immersion, Involvement, Naturalness, Realness, and self-presence. We partially based this on the presence questionnaire published by Witmer & Singer in 1998 [16].

3. Results

As we predicted, there was significantly higher **presence** when using a tool versus no tool for both 1st and 3rd person perspectives ($p < 0.005$, paired T-test). But there was no significant effect on **presence** of playing from a 1st person versus a 3rd person perspective for either tool or no tool. There was also no effect on **presence** of playing with an avatar similar versus dissimilar to self. There was however a highly significant increase in **self-presence** when playing with an avatar similar to self versus dissimilar to self ($p < 0.001$, paired T-test), but no effect of playing with a tool versus no tool.

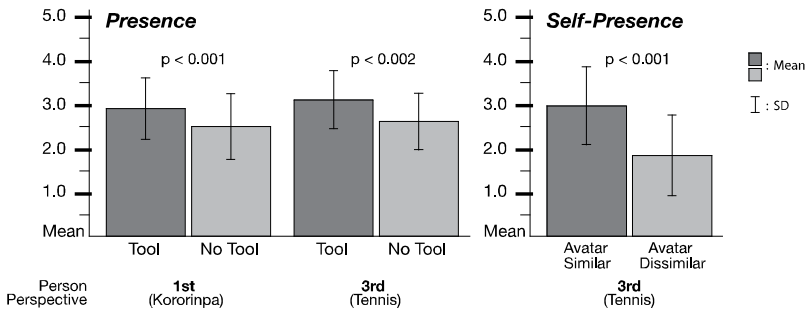

Table 1. Effect of tool, perspective and avatar on Presence and Self-presence

6. Discussion and Conclusions

Our findings confirm the importance of incorporating tangible tools in blended reality spaces aimed at eliciting a high sense of presence, but suggest that tangibility has no effect on self-presence. Although a 1st person perspective is of course more natural than a 3rd person perspective on one's own actions, it did not increase presence, which is an interesting and important finding for the future of blended reality spaces (see also [10, 14,15,16]). Accuracy of the virtual representation of self strongly affected rated self-presence, but did not affect presence (see [3, 17]). Thus, presence and self-presence appear, on the basis of our overall results, to be quite unrelated phenomena. The latter may be more important for social presence than individual presence, which suggests a tension in providing for both - but also gives hints for a nuanced approach to design.

The results will contribute to the design and implementation of strategic combinations of tools, perspectives and avatars for various application scenarios. These findings will, for example, be incorporated into design principles for our planned work

to develop free movement based interactions for motor rehabilitation as well as blended reality spaces for collaboration between hospitals, care organizations and the home.

5. Acknowledgements

The authors would like to thank the study subjects for supporting the collection of data. The authors also thank Priyantha Wijayatunga for thoughtful suggestions of the statistical data. Kei Hoshi is Ph.D. student partly supported by the Swedish Institute.

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