Self-Avatars in Virtual Reality: A Study Protocol for Investigating the Impact of the Deliberateness of Choice and the Context-Match

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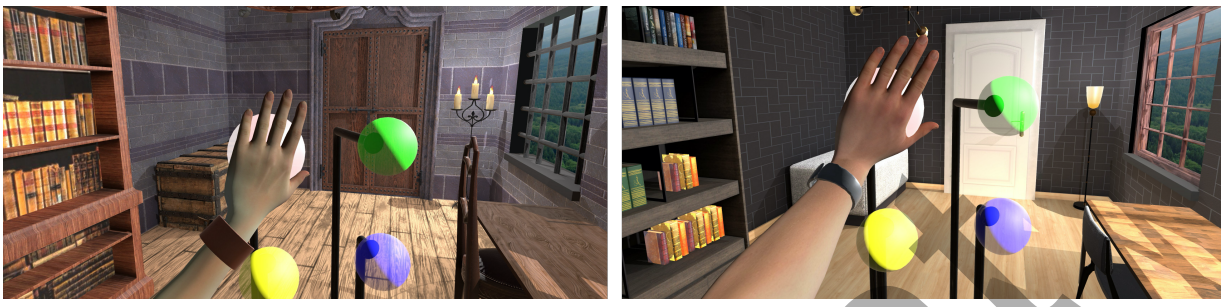

Figure 1: Participants playing the Simon game in the medieval (l.) and contemporary (r.) room, with context-matching accessories.

Abstract

The illusion of virtual body ownership (VBO) plays a critical role in virtual reality (VR). VR applications provide a broad design space which includes contextual aspects of the virtual surroundings as well as user-driven deliberate choices of their appearance in VR potentially influencing VBO and other well-known effects of VR. We propose a protocol for an experiment to investigate the influence of deliberateness and context-match on VBO and presence. In a first study, we found significant interactions with the environment. Based on our results we derive recommendations for future experiments.

Index Terms: Human-centered computing—Visualization—Visualization design and evaluation methods

1 Introduction

The illusion of virtual body ownership (VBO) can be described as the acceptance of ones avatar as the digital alter ego in the virtual world [2]. It plays a critical role in virtual reality (VR) in terms of quality of immersive experience, usability, and task performance [10]. Several simulation qualities have been identified to influence VBO. First, general VR qualities, i.e., the degree of immersion [11], promote VBO similarly to their effect on promoting presence [7], which suggests the assumption of a close interrelation of presence and VBO. In addition, visuotactile, visuomotor, visuoproprioceptive, and semantic stimuli such as anatomical structure and size plausibility also influence VBO [3, 4, 8, 9, 13]. Others, like the degree of realism or human-likeliness are still discussed [5, 6]. Waltemate et al. further investigated the impact of realism in conjunction with personalization [11]. They found that visually close-to-real-appearance avatars significantly increased the sense of VBO and presence in comparison to a generic avatar of the same degree of realism. This may be caused by the matched mental connection between the memorized information of one's own body and the observed avatar body [4].

However, VR provides a much broader design space. Contextual aspects of a virtual surrounding as well as user-driven deliberate choices of their appearance in VR seem to be highly important for several use cases like entertainment and specifically social VR. The two aspects deliberateness and context-match have received less attention from the research community in the context of VBO thus far. In our research we want to investigate the influence of these aspects on VBO and presence. We operationalize this overall goal with two research questions: Does the *deliberateness* of choice of avatar appearance modulated by choice of accessory have an impact on VBO and presence? If so, does the *context-matched deliberateness* of the feature have an impact on VBO and presence?

Contribution: We present a study protocol to investigate the influence of both deliberateness and context-match on VBO and presence. Based on the results of a first study we derive recommendations for future experiments.

2 Study

We created a personalized avatar for each participant using our photogrammetry rig and closely following the template-fitting method of Achenbach et al. [1]. We omitted the separate face scan and instead improved the quality of the avatars' hands by using additional hand scans. The created avatars were animated using a six-point tracking and inverse kinematics approach oriented towards the system architecture introduced by Wolf et al. [12].

We then conducted the VR experiment following a 2x2x2 mixed factorial design. In this experiment, participants wore virtual bracelets while playing a game in a virtual environment (see Fig. 1). The *context-match* between accessory and virtual environment was a between-factor: match vs. mismatch (IV_{mat}). The style of the environment was the other between-factor: contemporary vs. medieval (IV_{env}). The *deliberateness* of the presented virtual accessory was the within-factor: selected vs. replaced, i.e., not selected by the participant but by the experimenter (IV_{del}).

First, the participants were assigned either to the match or the no-match condition (IV_{mat}) and selected one out of three accessories. The provided accessories were either in contemporary or medieval style. Depending on their style and match-condition, participants played the game either in a medieval or in a contemporary environment (IV_{env}). For example, a person that had to choose a contemporary style bracelet and was assigned to the no-match condition would enter the medieval environment. They executed the task in the virtual environment twice. Once with the *selected* bracelet, once with a *replaced* one (IV_{del}) in counterbalanced order.

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Each task consisted of three parts: First, a one minute embodiment phase including simple movements in front of a virtual mirror. Second, a game round with low difficulty, and third, a game round with medium difficulty. The participants played an adaptation of the classic Simon game in HMD-VR while being fully embodied with their personalized avatar. The game required players to firstly, memorize a sequence of colored spheres and secondly to repeat the sequence by touching the spheres with their virtual hand. As a consequence, participants had to move their dominant, accessory-wearing hand in their field of view. Each game round started with a one signal sequence with increasing sequence length up until seven.

We measured VBO and Presence via questionnaires outside of the virtual environment after each task. Additionally, we asked participants to evaluate the accessories and the environment atmosphere.

3 Results

$N = 25$ participants (60% female) with a mean age of $M(SD) = 22.32(4)$ participated in the study ($n = 12$ contemporary, $n = 13$ medieval; $n = 13$ match, $n = 12$ mismatch). We calculated mixed ANOVAs and found two significant interactions between the deliberateness and the environment. One occurred on the VBO subscale *Change*: The *replaced* accessory led to a higher perceived change of the own body in the contemporary world than in the medieval one. The second interaction was only marginal significant ($p = .05$) and occurred on the Presence subscale *Spatial Presence*. In the *selected* condition participants felt more spatially present being in the medieval environment. Manipulation checks showed that participants rated the contemporary bracelets as more modern than the medieval ones and vice-versa. However, on average, the participants did not assign the accessories strongly enough to their respective category. The environments were perceived as similarly cozy and detached but the contemporary one was perceived as less tense and less lively. The contemporary environment was rated as more modern and less medieval than the medieval one.

4 Discussion and Limitations

So far we did not find any main effects on VBO and presence coming from deliberateness or context-match alone. We found two interactions between the environment and the deliberateness even though we expected that the environment would not have an impact. (1) Since participants controlled a personalized avatar, we expected low scores on the change of the own body schema subscale in all of the groups. Deliberateness made a difference in the contemporary world regarding the perception of the change of their own body. Wearing the replaced accessory in the contemporary environment led to a greater perception of change. (2) In the medieval environment, participants wearing the accessory they had selected felt more spatially present. However, this interaction was only marginally significant. Therefore, we can not answer our research questions sufficiently. Despite our efforts to keep the environments as comparable as possible, participants perceived the medieval environment as significantly more lively and tense. This may have partly caused the interaction effects. Another explanation of the environments' impact might come from the unfamiliarity with the setting. Even though we thought of contemporary and medieval environments as bipolar metrics, the contemporary environment might feel more familiar than the medieval environment, and it also might create fewer expectations or questions about it. Our manipulation checks further revealed that the provided accessories did not result in an obvious match or mismatch with the environment. Hence we suggest to manipulate more than just a small bracelet in order to transport the context-match, e.g., avatars in medieval clothes. Due to the ongoing COVID-19 pandemic we conducted the study under unusual conditions, i.a., strict hygenic measures and contact restrictions. This led to a low number of participants which must be taken into account when interpreting our results.

5 Conclusion and Future Work

We investigate the influence of deliberateness and context-match of the appearance of one's personalized avatar on VBO and presence. Unexpectedly, we found significant interactions with the virtual environment. Based on our results, we derive two recommendations for future work: (1) The choice of environment needs careful reconsideration. The environments have to be distinct enough to produce a clear match or mismatch. Yet, the environments should not invoke different atmospheres, emotions or expectations in order to control possible confounds. (2) A single item, e.g., a small bracelet, may not be a big enough stimulus to produce a clear context-match or mismatch. More holistic changes to the avatar's appearance, e.g., fully context-matched clothing, need to be investigated. While this poster represents an informative start on investigating the influence of deliberateness and context-match on VBO and presence, future work that considers our recommendations is needed.

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