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Towards an Altered Body Image Through the Exposure to a Modulated Self in Virtual Reality

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ABSTRACT

Self-exposure using modulated embodied avatars in virtual reality (VR) may support a positive body image. However, further investigation is needed to address methodological challenges and to understand the concrete effects, including their quantification. We present an iteratively refined paradigm for studying the tangible effects of exposure to a modulated self in VR. Participants perform body-centered movements in front of a virtual mirror, encountering their photorealistically personalized embodied avatar with increased, decreased, or unchanged body size. Additionally, we propose different body size estimation tasks conducted in reality and VR before and after exposure to assess participants' putative-elicited perceptual adaptations.

Keywords: Avatar, virtual human, embodiment illusion, virtual body ownership, body image disturbance, eating disorders

Index Terms: Human-centered computing—HCI design and evaluation methods; Virtual Reality;

1 INTRODUCTION

In recent years, the embodiment of avatars in virtual reality (VR) has shown great promise in tackling the challenges of a negative or distorted body image [7, 9]. If left unattended, these conditions can develop into severe disorders like anorexia or bulimia nervosa [1]. To prevent such a progression and to support the treatment of existing perceptual distortions, the idea is to substitute an individual's real body with a modulated virtual body to manipulate the multisensory integration processes underlying self-perception. The sense of embodiment (SoE), the feeling of genuinely owning this virtual body, has been identified as an essential moderator for such adaptive processes [6]. It arises and amplifies through the process of being located in an avatar and observing it from an egocentric perspective while it moves in synchrony with the real body's movements [5]. Through such an embodiment of avatars, prior work has omitted noticeable perceptual adaptations concerning body image measures, leading to a recent acceleration of research on the topic [12, 7, 9].

However, despite its potential, the field faces significant challenges. In a recently released systematic review on the embodiment of avatars as a function of and method to improve body image disturbance, Portingale et al. [7] highlighted severe issues such as methodological heterogeneity, non-validated measures, and technical obstacles in existing work. As a step towards solving these challenges, our work presents a structured methodological approach for exposing users to their modulated selves in VR and for evaluating the resulting effects. To this end, our approach includes a feasible system configuration for realizing photorealistically personalized and modifiable avatars for embodiment in VR and suggests VR-based measures for investigating body image disturbances.

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Figure 1: The images show an exemplary generated personalized avatar during the exposure in front of the virtual mirror with a decreased (left), unchanged (center), or increased (right) body weight.

2 METHOD

The proposed methodological approach was submitted to the ethics review board of the Institute for Human-Computer-Media at the University of Würzburg and received approval without obligations.

2.1 Design and Procedure

We feature a 3×1 between-subject design, with the avatar's body weight being the independent variable. Participants face their photorealistically personalized avatar during self-exposure in VR either with 20 % increased, decreased, or utterly unchanged body weight. During self-exposure, participants perform different body movement tasks in front of a virtual mirror. Before and after self-exposure, we collect body weight and body size estimations in both VR and reality, as further detailed below.

2.2 Technical System

The VR experience is realized using the technical system presented by Döllinger et al. [2], developed and evaluated for use in body image interventions. It realizes the motion-synchronized embodiment of avatars from an egocentric perspective and provides an allocentric perspective on the avatar using a virtual mirror. Participants can modify the avatar's body weight using different interaction methods based on a statistical model for body weight gain/loss. To avoid intrusive tracking devices being attached to the participants' bodies, we have adopted the integration of a markerless body tracking system from Wolf et al. [11]. We further employ the pipeline for generating photorealistically avatars from smartphone videos by Wenninger et al. [10] to generate personalized avatars in a short duration.

2.3 Measures and Tasks

We measure participants' body weight and height as well as their arm, waist, and thigh circumferences and diameters to obtain the ground truth for the body size and weight estimates described below. Following Döllinger et al. [2], we further control for differences in body shape concerns and self-esteem to avoid unintended influences on our body image-related measures between groups. The concrete operationalization of the measures we used can be found in the referenced related work.

Body Movement in VR Following Döllinger et al. [2], participants perform different body movement tasks to induce and enhance the SoE through visuomotor stimulation and to focus their attention on their virtual body. SoE is measured as a potential moderator of perceptual adjustments resulting from exposure.

Body Size Estimation in Reality The test for body image distortion in children and adolescents (BID-CA) [8] assesses participants' body image before and after the VR exposure. Participants are asked to estimate their arm, waist, and thigh circumference using a simple rope without visual reference. The difference in the estimated circumference between pre- and post-measurements indicates potential changes in the body image due to the exposure, while the difference to the ground truth indicates body image distortion.

Body Weight Estimation in VR Active modification tasks (AMT) and passive estimation tasks (PET) adopted from Döllinger et al. [2] capture the participants' body image before and after the body movements. AMT involves actively modifying the avatar's body weight to match the participant's current and ideal body weight. PET requires participants to numerically estimate the avatar's body weight while it is repeatedly changed within a range of ±20 %. To avoid potential influences of embodiment on body weight estimations as described by Wolf et al. [12], the avatar remains in a fixed predefined T-pose during the assessments. A virtual mirror behind the avatar provides a comprehensive perspective on it. A deviation in estimating the body weight (except ideal) indicates potential disturbances of the body image, while a difference between pre- and post-measurements indicates exposure-related perceptual adjustments.

Affordance Estimation in VR An affordance estimation task adapted from Geuss et al. [3] further assesses participants' body image in VR. Before and after the participants execute the body movements, they are asked to change the distance between two vertically positioned pillars until they think they can exactly pass through with their real body when walking sideways. A deviation of the pillar distance from the actual waist diameter indicates possible body image disturbances, while a difference between pre- and post-measurement indicates exposure-related perceptual adjustments.

3 Discussion

We tested our proposed method in a small pilot study involving 21 participants. While the sample size limits the ability to draw reliable quantitative conclusions, we noted encouraging tendencies warranting a main study with sufficient statistical power. In this upcoming study, we aim to explore the potential effects of exposure to a modulated self and assess the reliability and validity of our VR-based body image measures compared to traditional approaches. To this end, participant and experimenter feedback during the pilot study guided the derivation of methodological improvements.

Firstly, participants in our study engaged in eight distinct body movements over approximately 6 min. While this might be enough to evoke a considerable SoE, we assume that a longer and more concise exposure to the modulated self could yield stronger effects on the body image. Hence, it suggests adapting our exposure tasks according to guidelines for traditional mirror exposure used for body image disturbances [4].

Secondly, our predefined body weight modification of ±20 % raised concerns regarding potentially exposing participants with pre-existing morbid body shapes to an even more distressing version of themselves. While pre-selection mitigated this issue in the pilot study, it seems advisable to expose participants with clinically recognized or self-determined ideals of themselves in the future.

Thirdly, we used the BID-CA as the sole traditional method to assess participants' current body image. However, to validate the results from our proposed VR-based measures, the inclusion of additional traditional body image assessment tools based on questionnaires or silhouettes becomes essential.

4 Contribution and Conclusion

In response to methodological heterogeneity in VR-based body image interventions, our work presented a methodological approach to investigate the effects of exposure to a modulated self. We proposed a technical system for the exposure and suggested diverse VR-based measures to quantify potential effects on the user's body image. The suggested methodology has been evaluated in a pilot study used to derive further methodological improvements. In summary, our work serves as a foundational framework for future assessments of body image interventions in VR and provides a basis for ongoing discussions on further improvements.

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