Varying Avatar Weight to Increase Player Motivation: Challenges of a Gaming Setup

Anna Barenbrock
BIBA – Bremer Institut für Produktion und Logistik GmbH
28359 Bremen, Germany
bar@biba.uni-bremen.de

Jan David Smeddinck
ICSI, UC Berkeley
1947 Center St.
Berkeley, CA 94704, USA
jandavid@icsi.berkeley.edu

Marc Herrlich
University of Kaiserslautern
Serious Games Engineering
Kaiserslautern, Germany
herrlich@eit.uni-kl.de

Rainer Malaka
University of Bremen
Digital Media Lab, TZI
Bremen, Germany
malaka@tzi.de

Kathrin Maria Gerling
KU Leuven
Andreas Vesaliusstraat 13
3000 Leuven, Belgium
kathrin.gerling@kuleuven.be

The definitive version was published as:
Barenbrock, A., Herrlich, M., Gerling, K. M., Smeddinck, J. D., & Malaka, R. (2018). Varying Avatar Weight to Increase Player Motivation: Challenges of a Gaming Setup. Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems, LBW066:1-LBW066:6. https://doi.org/10.1145/3170427.3188634

Abstract
One fundamental way how players relate to games is through the avatar they are represented by. In this work, we explore the impact of real-time adjustment of avatar appearance (visual body weight) on player motivation in exergames. Our results draw a mixed picture: while qualitative findings show that players were aware of adaptations, quantitative results do not demonstrate significant differences in player motivation. Instead, observations suggest that players leveraged the mechanic to develop their own meta-game, an effect that needs to be considered when designing mechanics that aim to improve player motivation in exergaming settings.

Author Keywords
avatar appearance; player motivation; game design; exergames; body weight; physical exercises

ACM Classification Keywords
K.8.0 [Personal Computing]: General – Games; H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction
One fundamental way of how players relate to games is through the choice of avatar they are represented by in the virtual world. The effects of avatar personalization

Reference Study

This study builds on the work of Fox & Bailenson [4], who investigated the effect of varying body shape of avatars on motivation to do more exercise. They rely on Social Cognitive Theory [2,3].

In their study, participants were immersed in the virtual world via a *head-mounted display* (HMD), seeing a front-facing avatar representing themselves. The 3D model had a generic body shape, but using photos, the head had been modelled to look like the participant's head to ensure identification with the avatar.

Seeing their own avatar constantly losing visual weight when doing simple sports exercises and gaining visual weight when standing still led to a significantly increased number of voluntary exercise repetition of participants in contrast to participants of a control group, which did not see changes in the avatars' appearance.

on player experience have been studied from various perspectives, including the comparison of *actual-self* and *ideal-self* representations on player motivation in exergames [5]. Likewise, exergaming research has explored how virtual representations can be leveraged to communicate player progress, thereby fostering desirable behaviour [1]. In this study, we draw from these lines of research to explore the impact that real-time adjustment of avatar appearance (visual body weight) depending on the physical activity of the users has on player motivation in exergames. To this end, we adapt a previous study by Fox and Bailenson [4] (see infobox on the left) that demonstrated positive effects of avatar adjustment on exercise engagement in a gamification setting through the design of a window-cleaning exergame. We employ more common motion-based game technology without an HMD. Our results draw a mixed picture: while qualitative findings suggest that players were aware of adaptations, quantitative results did not show significant differences in player motivation. Instead, observations suggest that players leveraged the mechanic to develop their own meta-game, suggesting that consequences of the *lusory attitude* need to be considered when designing mechanics that aim to improve player motivation in exergaming settings.

Background

Basic research [9] has clearly established that manipulations of self-perception, for example to the clothing worn [15], or association with characters that we relate to, can trigger notable cognitive and behavioural biases. Combined with approaches to directed behavior change, for example through employing role models [2, 3] these insights motivate explorations on the impact of avatar representations in the context of games with a serious purpose (e.g. [4]). In the context of exergames, more ideal self-representations appear to trigger increased motion, although these affects did not appear to be bound to actual participant BMI [10]. Other work could not show impacts on performance but showed impacts on self-perception due to stronger or weaker looking avatars [6]. Together with work from the angle of personalization through customizable avatars [16], these works provide compelling evidence that avatar manipulations play an influential role in (exer-)games. Due to increased immersion and dense multimodal interaction, avatar (self-)identification questions arguably become even more pressing with the current AR/VR boom [14, 12]. However, the question whether adjustments to avatar representations can be used to achieve increased motivation or performance in exergames in a directed and controlled manner remains underexplored, motivating our research to explore whether prior results extrapolate.

Game Concept and Interaction Design

This work explores whether weight changes of the avatar (communicated through changing physical appearance) have measurable effects on player motivation in an exergaming setup. We developed a movement-based research game that is played using the Kinect camera sensor and follows the main parameters of the reference study. The game was implemented in the Unity game engine. Gameplay features a playful window cleaning task. Players need to move the arms widely to clean virtual windows (see Figure 1). Avatars are presented front-facing and imitate player movement as detected by the Kinect camera. Whenever a window is clean, a new one appears, until the time limit is hit. A scoring system keeps track of the player's achievements.

Figure 1: In-game screenshot.

Figure 2: Photo and avatar of one participant.

Integration of weight change

The avatar loses and gains visual weight in line with player movement. Arrows and colour-contrasting highlights that are visualized on the avatar's waist indicate the upcoming change to raise the awareness of the participant. To further communicate this feature, the game consists of three rounds: the first two are introductory to show how the in-game behaviour affects the avatar's visual appearance. In the first round (lasting one minute) the player is asked to get to know the game and clean the appearing windows. During this time, the avatar gets thinner two times. In the second round the player is asked to stand still and observe the monitor. Within one minute the avatar (restarting at the normal weight) gains visual weight twice. Round 3 is semi-mandatory. Players should play at least 30 seconds of the game freely, and after that time they can stop playing any time. The game ends automatically after three minutes and within that time span the avatar can change its' visual weight 4 times in each direction, depending on the player's behaviour.

Avatars & Personalization

The game includes a female and male avatar, each featuring nine different models (while keeping skins constant) to represent different weight stages. To ensure a high amount of identification with the avatar, the face is personalized to each player by taking a biometric photo of the participant that is then mapped onto the face of the avatar (see Figure 2). Additionally, the examiner can choose from a range of hairstyles and colours to match the participant's appearance. Clothes are kept as neutral as possible across avatars (see Figure 1). The avatars in our study were not designed to gain and lose visual weight continuously, as used in the reference study, because this lead to unproportional body shapes. We opted for changing appearance in well-designed realistically looking steps to maintain a realistic player experience.

User Study

In this study we evaluate the effects of changing body weight of the avatar on player motivation (dependent variable) in exergames. It follows a between-subjects design with two groups (*treatment*: changing avatar body shape; *control*: static avatar body shape).

Participants and Procedure

We recruited 37 participants to contribute to the study. All participants were German speaking, aged between 21 and 55 years (M=33.45, SD=8.37). There was no financial incentive for people to participate in the study but free sweets and beverages were offered. In the beginning, each participant provided informed consent while the photo was prepared for personalization. Afterwards participants played three rounds of the game while the examiner made observations. Each round began with an instruction what to do and to pay attention to the avatar while playing. In the treatment group, the avatar was reset to the initial body shape in the beginning of each round. After playing the game, participants were asked to fill out a post-questionnaire, followed by a semi-structured interview. In total, a session took about 30-40 minutes per participant.

Measures

The collected measures can be seen in the info box on the left-hand side on the next page ("*" indicates questions, which were assessed both, before and after playing the game). We included established questionnaires asking for felt exertion and its potential impact on exer-

Collected Measures

- Demographics
- General Self-Efficacy Scale (**GSE-6**) [13]*****
- Assessment of Athletic Behaviour
  - Rapid Assessment of Physical Activity (**RAPA**) [17]
  - Locus of Causality for Exercise Scale (self-determination subscale; **LOC**) [7]*****
  - 5 custom questions about exercise behavior*****
  - Modified Borg Scale (**MBS**) [19]*****
- Intrinsic Motivation Inventory (**IMI**) [8]; preferred over gaming-specific measures for better match with study context
- Avatar Identification [18]
- Control question about notice of avatar adjustment
- Interview
- Game logs
  - Cleaned windows
  - Avatar adjustment
  - Play time
- Observations

cise motivation as well as different dimensions of intrinsic motivation and background information about the players. We further included an avatar identification questionnaire and custom questions regarding face similarity and avatar adjustment. The game logged the number of windows cleaned, avatar adjustments, and play times.

Results

31 datasets (n female = 8) were included in analysis after removal of outliers. Two participants were excluded because they did not follow the protocol, one had to leave early, and another three did not notice the adjustments. Participants were randomly assigned to the treatment group (*"avatar change"*-AC) (n=15) or the control group (*"no change"*-NC) (n=16).

Exertion and motivation. The GSE-6 did not show any significant changes between the groups according to a Welch's t test ($t(28.56)=-0.02$, $p=0.99$). In both groups the mean increased evenly by a small amount after playing. The RAPA questionnaire showed that the participants were evenly allocated in the conditions regarding their general physical activity (AC: M=5.36, SD=1.55, NC: M=5.5, SD=1.21), which was rated in the second highest category on average. The *Locus of Causality* (LOC), increased significantly after playing the game in contrast to before playing the game for both conditions (AC: $t(14)=-5.18$, $p < 0.001$, Cohen's $d=0.27$, NC: $t(15 =-2.66$, $p=0.018$, Cohen's $d=0.5$). The MBS showed that participants of both groups were evenly more exerted after game play than before. The ratings of the IMI are moderately high for each scale (between 4.59 and 5.16) except for pressure/tension (M=2.10, SD=0.97). Two scales (pressure/tension & perceived choice) show absolute differences in the participant's ratings between the groups (pressure/tension: AC: M=2.25, SD=1.0, NC: M=1.97, SD=0.96 / perceived choice: AC: M=5.93, SD=1.65, NC: M=6.5, SD=0.98), although they are not statistically significant. *Avatar identification*: Ratings for overall identification with the avatar were below average (M=2.42, SD=0.86); results for identification with the personalized face were slightly higher (M=3.35, SD=1.12) with no significant between-group differences ($t(83.45)=-0.77$, $p=0.44$). Interview results suggest that participants found it difficult to identify with certain body shapes in both conditions. *Playing time:* On average, the AC group played 17 seconds longer than the NC group did in the semi-mandatory round. This value is statistically not significant. Also, both groups performed almost similarly regarding the number of cleaned windows. *Player behaviour:* Interviews and observations show that the avatar had an impact on player behaviour. For instance, players stated that they were curious about how thin the avatar could get, and one stopped playing because it became too thin. Others were interested in the game play (about half of AC); testing if the game will end, or beating their own record of the first round.

Discussion

Generally, our results do not confirm pre-experimental assumptions or those of the reference setup. Our findings do not demonstrate higher levels of player motivation through avatar identification and virtual weight adjustment, and did not lead to increased engagement in exercise in an exergaming setting. However, we observed a number of unexpected effects of avatar personalization that warrant further discussion.

Acknowledgements

This work was funded by the German Federal Ministry of Education and Research (BMBF) through the project *Adaptify*. This work was partially funded through the DAAD FITweltweit program.

Effects of Adaptive Avatar Weight on Players
Our results show that despite being noticed by participants, weight changes of the avatar had no impact on player motivation. However, it did influence player behaviour as participants made the weight changing a part of "their game" by deliberately adjusting the way they interacted with the game to make the avatar thinner or bigger. This tendency to "meta-game" also pervaded other aspects of our study: while the reference study allowed participants to purely focus on the avatar, our exergame included further elements such as a scoring system, leading to some players setting their own goals within the game: For instance, they were trying to beat their own record, or wanted to see if the game would eventually end. This highlights one of the challenges of introducing adaptive avatars in a gaming setting: while they can be leveraged to provide feedback to players and to create a responsive game world, it also opens up ways for participants to create their own meta-game, a common observation in traditional gaming settings which may be undesirable in serious gaming or research settings.

Translating the Reference Study into an Exergame
Another point that warrants further discussion in the light of the null results is the way the reference study was translated into our game. There are two aspects particularly worth studying in the future: (1) We translated the reference study into an exergame that mirrors a real-world chore. Choosing a household-related setting rather than an exercise-related one might be a confounding variable that should be further explored. (2) In contrast to the reference study, our study showed no continuous change in the avatar's body shape and we did not use an HMD. This lack of immediate feedback to the in-game behaviour and differing level of immersion might have had the effect that some players were not as focused on the avatar, which could explain some of the previously discussed tendencies to "meta-game".

Conclusion & Future Work

In this paper, we present a study investigating the influence of simulating weight changes in an avatar on player motivation in exergames. Our results do not support the findings of the reference study (increased exercise motivation), and instead reveal several challenges when personalizing and adapting avatars in an exergaming setting. Future work will provide an in-depth exploration of limitations of our study: further fine-tuning the exergaming experience to investigate whether changes in avatar weight can be leveraged to influence player motivation, e.g., by testing different granularities of avatar fidelity, introducing a more subtle way of adjusting avatar weight, and by transferring the game into different genres, including a tightly controlled fitness setting that more closely resembles the context of the reference study.

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