

# Preregistration for Quantitative Research in Psychology (PRP-QUANT) Template

## Title

### T1 Title

The title should be focused and descriptive, using relevant key terms to reflect what will be done in the study. Use title case (<https://apastyle.apa.org/style-grammar-guidelines/capitalization/title-case>).

Are Changes in Body Dissatisfaction Dependent on Gaze Patterns during Embodiment of Body-Mass Modified or Normal-Weight Self-Avatars?

### T2 Contributors, Affiliations, and Persistent IDs (recommend ORCID iD)

Provide in separate entries the full name of each contributor, each contributor's professional affiliation, and each contributor's persistent ID. See ORCID iD for an example of persistent ID (<https://orcid.org/>). Optional: include the intended contribution of each person listed (e.g. statistical analysis, data collection; see CRediT, <https://casrai.org/credit/>).

- Dr. Philipp A. Schroeder, University of Tuebingen, Department of Psychology
- Prof. Dr. Jennifer Svaldi, University of Tuebingen, Department of Psychology
  - Dr. Jan Vagedes, ARCIM Institute
- Dr. Nina Gehrer, University of Tuebingen, Department of Psychology
- M. Sc. Anesa Aljovic, University of Tuebingen, Department of Psychology
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- B. Sc. Lisa-Marie Wegfahrt, University of Tuebingen, Department of Psychology

### T3 Date of Preregistration

This is assigned by the system upon preregistration submission.

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<b>T4 Versioning information</b>
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This is assigned by the system upon submission of original and subsequent revisions. Should be a persistent identifier, if not a DOI.
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<b>T5 Identifier</b>
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This unique identifier is assigned by the system upon submission.
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<b>T6 Estimated duration of project</b>
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Include best estimate for how long the project will take from preregistration submission to project completion.
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The data collection should be completed until the 30th of September 2021 with an anticipated completion of the project in January 2022. Since the project draft and implementation of the experiment were planned from January 2021, the entire project will take 12 months.
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<b>T7 IRB Status (Institutional Review Board/Independent Ethics Committee/Ethical Review Board/Research Ethics Board)</b>
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If the study will include human or animal subjects, provide a brief overview of plans for the treatment of those subjects in accordance with established ethical guidelines. If appropriate institutional approval has been obtained for the study, provide the relevant identifier here. If the study will be exempt from ethical board review, provide reasoning here.
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Ethical approval is obtained from the local ethics committee of University of Tübingen (Approval ID: Schroeder\_2021\_0201\_215).

Embodiment in mixed reality (XR) can lead to short-term simulator sickness (vertigo, dizziness) which is minimized by design choices and synchronous visuo-motor contingencies. The embodiment in an overweight avatar can possibly lead to short-term body dissatisfaction but no long-term body dissatisfaction, according to prior research (Ferrer-Garcia et al., 2017). However, participants are offered a positive XR experience at the end of the experiment to counteract potential negative short-term effects on body satisfaction.

Participants have the option to stop the experiment at any time without justification or to request deletion of their data after the study. Finally, there is no experimental deception in this study.

### **T8 Conflict of Interest Statement**

Identify any real or perceived conflicts of interest with this study execution. For example, any interests or activities that might be seen as influencing the research (e.g., financial interests in a test or procedure, funding by pharmaceutical companies for research).

There is no conflict of interest.

### **T9 Keywords**

Include terms specific to your topic, methodology, and population. Use natural language and avoid words used in the title or overly general terms. If you need help with keywords, try a keyword search using your proposed keywords in a search engine to check results.

Body Dissatisfaction, Body-related Visual Attention, Virtual Reality, Mixed Reality, Full Body Illusion, Self-avatar, Weight Manipulation, Eye Tracking

### **T10 Data accessibility statement and planned repository**

"We plan to make the data available (yes / no)

If "yes", please specify the planned data availability level by selecting one of the options:

- Data access via download; usage of data for all purposes (public use file)
- Data access via download; usage of data restricted to scientific purposes (scientific use file)
- Data access via download; usage of data has to be agreed and defined on an individual case basis

- |                                                                                                                                                                                                                                                                |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• Data access via secure data center (no download, usage/analysis only in a secure data center)</li><li>• Data available upon email request by member of scientific community</li><li>• Other (please specify)</li></ul> |
| <p>We plan to make the data available.<br/>Yes, data access via download; usage of data restricted to scientific purposes (scientific use file)</p>                                                                                                            |

### **T11 Optional: Code availability**

We plan to make the code available (yes / no).

If "yes", please specify the planned code availability level (use same descriptors of data in T10).

No.

### **T12 Optional: Standard lab practices**

Standard lab practices refer to a (timestamped) document, software package, or similar, which specifies standard pipelines, analytical decisions, etc. which always apply to certain types of research in a lab. Specify here and refer to at the appropriate positions in the remainder of the template:

We plan to make the standard lab practices available (yes / no).

If "yes", please specify the planned standard lab practices availability level (use same descriptors of data in T10).

No.

# Abstract

## A1 Background

(See introduction I1)

Cognitive-behavioral theories suggest that body-related visual attention causally contributes to negative body image and body experience in eating disorder patients. Frequent gazes towards unattractive body regions are considered to support a biased bodily self-representation, to increase fear of gaining weight and to maintain high levels of body dissatisfaction.

## A2 Objectives and Research questions

(See introduction I2)

The study investigates the role of body-related visual attention on body-dissatisfaction during embodiment of a weight-manipulated self-avatar. By inducing a full-body illusion in mixed reality (XR), participants are embodied in a lean or overweight self-avatar and we record gaze trajectories during embodiment. We predict increases in fear of gaining weight, body dissatisfaction, and decreases in self-esteem of high body dissatisfied women associated with gaze patterns during a mirror exposure with the self-avatar.

## A3 Participants

(See methods M4)

N=25 normal-weight female participants (aged 18 – 35) with high levels of body dissatisfaction will be recruited. Participants should not be pregnant, breastfeeding, or have an eating disorder.

## A4 Study method

(See methods M10-14)

This cross-sectional study uses a repeated measures design. Order of assignment to conditions will be counterbalanced. Participants will experience a self-avatar (overweight/ normal weight) in XR. After getting used to the XR environment, gaze patterns will be measured in front of a virtual mirror. State measures of body dissatisfaction, self-esteem, and avatar embodiment are assessed before and after XR exposure.

# Introduction

(no word limit)

## I1 Theoretical background

Provide a brief overview that justifies the research hypotheses.

Patients suffering from eating disorders report high levels of body dissatisfaction, which is one burdensome aspect of the disease and contributes to disordered eating patterns but also mood dysregulation. Body dissatisfaction is associated with fear of gaining weight and may affect maladaptive behaviors, such as dangerous weight loss or bulimic attacks. Cognitive-behavioral theories hypothesize that body-related visual attention maintains these biased representations of one's body (Williamson et al., 2004). Thus, visual attention is automatically drawn more to body-relevant information, which reinforces body dissatisfaction (Williamson et al., 2004).

Studies investigating the (causal) relation between body-related attention and body dissatisfaction show for example that women with high degree of body dissatisfaction focus more often on regions of their own body which they perceive as unattractive (Jansen et al., 2005; Smeets et al., 2011). Further, Smeets et al. (2011) investigated the effect of gaze training on state body dissatisfaction of body dissatisfied women and showed a decrease in state body dissatisfaction after the redirection of attention from self-perceived ugly towards self-perceived beautiful body parts. The mentioned studies used real-life photographs, so the relevance of body-size experience could not be investigated. Virtual and Mixed Reality (XR) offers a possibility to experience body-ownership over virtual bodies through synchronous visuo-motor and visuo-tactile contingencies between one's own body and the body of the avatar (Botvinick & Cohen, 1998; Keizer et al., 2016; Rubo & Gamer, 2019; Scarpina et al., 2019). The visuo-motor contingencies are integrated multimodally allowing the virtual body to be perceived as one's own body even in the absence of similarity. The ownership, agency, and self-location experienced in this process are described as self-avatar embodiment (Gonzalez-Franco & Peck, 2018). When experiencing virtual embodiment, emotional and cognitive representations adjust according to the properties of the virtual bodies.

Ferrer-Garcia et al. (2017) investigated the effect of body-weight manipulated self-avatar embodiment on body dissatisfaction in a sample of healthy participants with increased body dissatisfaction. They showed a positive effect of full-body illusions with overweight bodies in VR on body dissatisfaction resulting in participants' increased body anxiety and concerns about gaining weight after the exposure. However, this was limited by a relatively small sample size. Moreover, gaze movements were not assessed during exposure in this study.

Results from further studies were inconclusive, but also very variable in their methodology: Preston and Ehrsson (2014) observed increases in body satisfaction after illusory ownership of a slimmer body, whereas change in body satisfaction after ownership of a larger body was related to eating disorder symptomatology (EDE-Q). Here, a static mannequin was used to induce the full-body illusion. In contrast to this, reports of anorexia nervosa patients during exposure to body-weight manipulated biometric avatars suggested increased anxiety (Mölbart et al., 2018), which was in line with the observations from healthy college students during exposure.

The present study intends to augment previous research and provide additional in-depth results regarding the effect of body-related visual attention on body dissatisfaction during body-weight manipulated self-avatar embodiment. This question should be investigated in an experimental design utilizing eye tracking within XR. Thereby, female normal-weight participants who report high levels of body dissatisfaction will experience either a normal-weight or an overweight body of a self-avatar in XR. Besides the measurement of the gaze patterns, state body dissatisfaction, avatar embodiment as well as self-esteem will be assessed.

## I2 Objectives and Research question(s)

Outline objectives and research questions that inform the methodology and analyses (below).

1. We expect an increase in state body-dissatisfaction (BISS) in the overweight condition while there should be no change regarding body dissatisfaction in the normal-weight condition
  - 1a. We expect an increase in fear of gaining weight in the overweight condition
  - 1b. We expect a decrease in state self-esteem in the overweight condition
2. We expect that body-related visual attention predicts the increase in state body dissatisfaction after the full body illusion in the overweight condition
3. We expect that avatar embodiment predicts the increase in state body dissatisfaction after the full body illusion in the overweight condition

## I3 Hypothesis (H1, H2, ...)

Provide hypothesis for predicted results. If multiple hypotheses, uniquely number them (e.g., H1, H2a, H2b,) and refer to them the same way at other points in the registration document and in the manuscript.

- H1:** Participants report significantly higher state body dissatisfaction (BISS) after the exposure to an overweight self-avatar than after the exposure to a normal-weight self-avatar
- H1a:** Participants report significantly higher fear of gaining weight after the exposure to an overweight self-avatar
- H1b:** Participants report significantly lower state self-esteem after the exposure to an overweight self-avatar
- H2:** Body-related visual attention towards weight-related areas predicts the increase in state body dissatisfaction after the full body illusion with an overweight self-avatar.
- H3:** Avatar embodiment predicts the increase in state body dissatisfaction after the full body illusion with an overweight self-avatar



#### **I4 Exploratory research questions (if applicable; E1, E2, ....)**

If planning exploratory analyses, provide rationale for them here. If multiple exploratory analyses, uniquely number them (E1, E2, ...) and refer to them in the same way in the registration document and in future publications.

E1: How does condition (normal-weight vs. overweight body of the self-avatar) affect self-esteem and can these changes be explained by gaze-patterns and avatar embodiment?

E2: What are the differences regarding gaze-patterns between participants with above-average vs. under-average body satisfaction/self-esteem?

(E.g.: Is body-related visual attention of participants with above-average body satisfaction/self-esteem more holistic and not focused too much on specific areas of the body? (Lang et al., 2014))

E3: Do participants with high trait body dissatisfaction show significantly higher presence values than participants with low trait body dissatisfaction (because they pay more attention on specific body parts)?

E4:: Do participants with low self-esteem show significantly higher trait body dissatisfaction?

E5: Do participants in the overweight avatar condition show significantly lower values in self-esteem after the exposure in comparison to participants in the normal weight avatar condition?

# Method

## M1 Time point of registration

Select one of the options:

- Registration prior to creation of data
- Registration prior to any human observation of the data
- Registration prior to accessing the data
- Registration prior to analysis of the data
- Other (please specify; might include if T1 longitudinal data has been analyzed, but T2 has not yet been analyzed)

Registration prior to creation of data.

## M2 Proposal: Use of pre-existing data (re-analysis or secondary data analysis)

Will pre-existing data be used in the planned study? If yes, indicate if the data were previously published and specify the source of the data (e.g., DOI or APA style reference of original publication). Specify your level of knowledge of the data (e.g., descriptive statistics from previous publications), whether or not this is relevant for the hypotheses of the present study, and how it is assured that you are unaware of results or statistical patterns in the data of relevance to the present hypotheses.

*No use of pre-existing data.*

## Sampling Procedure and Data Collection

### M3 Sample size, power and precision

(1) Relevant sample sizes: e.g., single groups, multiple groups, and sample sizes (or sample ranges) found at each level of multilevel data. (2) Provide power analysis (e.g. power curves) for fixed-N designs. For sequential designs, indicate your 'stopping rule' such as the points at which you intend to be viewing your data and in any way analyzing them (e.g., t-tests and correlations, but even descriptively such as with histograms).

Sample size estimation is based on a power analysis of the effect of the manipulation (overweight self-avatar vs. normal-weight self-avatar) on subjective experience, as this effect is a prerequisite for analysis of gaze data. To achieve a statistical power of  $1-\beta = 0.8$  ( $\alpha = 0.05$ ) in a repeated measures t-test, a total of  $N = 25$  participants are needed. The

underlying effect size ( $d = 0.59$ ) is based on the effect of self-avatar embodiment in a body-dissatisfied group of students on self-reported fear of gaining weight (Ferrer-Garcia et al., 2017).

#### **M4 Participant recruitment, selection, and compensation**

Indicate (a) methods of recruitment (e.g., subject pool advertisement, community events, crowdsourcing platforms, snowball sampling); (b) selection and inclusion/exclusion criteria (e.g., age, visual acuity, language facility); (c) details of any stratification sampling used; (d) planned participant characteristics (gender, race/ethnicity, sexual orientation and gender identity, SES, education level, age, disability or health status, geographic location); (e) compensation amount and method (e.g., same payment to all, pay based on performance, lottery).

- (a) Participants will be recruited through university circular email, through social media and through announcements on boards in university.
- (b) Inclusion criteria will be an age between 18 and 35 years, female gender, a BMI between 18.5 and 24.9 kg/m<sup>2</sup>, no severe neurological disorder (e.g., epilepsy). Exclusion criteria will be male sex, pregnancy or current lactation (because of changed body image in that time). People who wear glasses need to wear contact lenses or sport glasses for the experiment.
- (c) -
- (d) only healthy female participants with high body-dissatisfaction, age between 18 and 35
- (e) Payment includes 10 € or credit compensation for students (psychology or cognitive science students)

#### **M5 How will participant drop-out be handled?**

Indicate any special treatment for participants who drop out (e.g., there is follow-up in a manner different from the main sample, last value carried forward) or whether participants are replaced.

Before the study a screening will be conducted to obtain information about the eating style, general and eating-related psychopathology as well as the trait body dissatisfaction of interested participants. We only include participants with a combined score on weight and shape concern of the EDE-Q  $> 3.36$  (Voges et al., 2019; Hilbert et al., 2007). Participants who drop out will be excluded and replaced by new recruited participants to obtain the required sample size from the power analysis

#### **M6 Masking of participants and researchers**

Indicate all forms of masking and/or allocation concealment (e.g., administrators, data collectors, raters, confederates are unaware of the condition to which participants were assigned).

Researchers will be aware of the participants' condition, as they will monitor the experiment to support participants in the virtual environment. However, ratings obtained during and following the embodiment experience are pseudo-randomized and/or directly recorded without experimenter involvement. Moreover, since the head-mounted display and headphones occlude the participants' experience of the laboratory, experimenter bias is minimal. Researchers will also be aware of participants' groups during data analysis.

### **M7 Data cleaning and screening**

Indicate all steps related to data quality control, e.g., outlier treatment, identification of missing data, checks for normality, etc.

If no or remarkably few changes regarding gaze patterns/eye movements are recognized, participants should be excluded due to possible technical problems regarding eye tracking. Non-parametric tests are performed in case of violated normality.

### **M8 How will missing data be handled?**

Indicate any procedures that will be applied during the analysis to deal with missing data, such as (a) case deletions; (b) averaging across scale items (to handle missing items for some); (c) test of missingness (MAR, MCAR, MNAR assumptions; (d) imputation procedures (FIML vs. MI); (e) Intention to treat analysis and per protocol analysis (as appropriate).

In case of missing data in the screening (before the experimental testing), cases will be deleted/participants will be excluded from the study.

In case of missing data regarding eye tracking, technical problems can be assumed and thus the participant should be excluded from the analysis of gaze patterns.

### **M9 Other information (optional)**

For example, training of raters/participants or anything else not yet specified.

With the PHQ-9, the severity of symptoms of a Major Depression and other affective disorders (according to DSM or ICD) will be measured. If the cut-off values are higher than 9, participants will be informed and receive a brief counseling about their result. If the value of item 9 (suicidal thoughts or wishes) is higher than 1, the PI will investigate and counsel participants as well. In severe cases, a psychological psychotherapist will be informed to clear up the suicidal symptoms and further to take steps against that. The same procedure will be initiated, if participants show a total score > 2.30 in the EDE questionnaire (Mond et al., 2004) and are followed-up with a psychological interview.

## Conditions and design

### M10 Type of study and study design

Indicate the type of study (e.g., experimental, observational, crosssectional vs. longitudinal, single case, clinical trial) and planned study design (e.g., between vs. within subjects, factorial, repeated measures, etc.), number of factors and factor levels, etc..

The experimental study is designed as a within-subject procedure with a repeated measure. There are two factors, which are the condition (normal-weight vs. overweight body of the self-avatar) and the measurement time regarding state body dissatisfaction and state self-esteem (before vs. after the XR-exposure).

In the lab, all participants complete the BISS before and after XR-exposure. The entire procedure is repeated after a brief filler video, to neutralize mood; accordingly, participants experience the XR-exposure once with overweight and once with normal-weight self-avatar. Order of the sequence is counterbalanced across participants.

### M11 Randomization of participants and/or experimental materials

If applicable, describe how participants are assigned to conditions or treatments, how stimuli are assigned to conditions, and how presentation of tests, trials, etc. is randomized. Indicate the randomization technique and whether constraints were applied (pseudo-randomization). Indicate any type of balancing across participants (e.g., assignments of responses to hands, etc.).

Participants see their self-avatar as normal weight or overweight. The condition mapping is randomized. The XR exposure and process of the experiment is equivalent for every participant and condition.

### M12 Measured variables, manipulated variables, covariates

This section shall be used to unambiguously clarify which variables are used to operationalize the hypotheses specified above (item I3). Please (a) list all measured variables, and (b) explicitly state the functional role of each variable (i.e., independent variable, dependent variable, covariate, mediator, moderator). It is important to (c) specify for each hypothesis how it is operationalized, i.e., which variables will be used to test the respective hypothesis and how the hypothesis will be operationally defined in terms of these variables. The description here shall be consistent with the statistical analysis plans specified under AP6 (below).

- Body Mass Index (BMI): continuum from 18.5 to 24.9, control variable (for analysis covariate); measured by weighing and measuring the height of the participants in a determined room, then calculating the BMI
- Trait Body Dissatisfaction: screening variable, measured by Eating Disorder Examination Questionnaire (SWC scale; see Hilbert et al., 2007)
- State Body Dissatisfaction: dependent variable; measured with Body Image State Scale;

repeated: before and after XR

- Gaze Patterns: dependent variable; measured by SMI Eye Tracker (integrated into the VR headset, fixation duration towards the respective AOIs, number of saccades and saccade latency will be measured, providing respective descriptive statistical data for regions of interest); repeated: during XR
- Body Ownership: dependent variable; measured by self-report (standardized Embodiment Questionnaire, Visual Analogue Scales); repeated: before and after XR
- Figure Rating: Out of 11 body regions, participants select and rank their most and least favorite body regions; grouping variable, after XR

## M13 Study Materials

Please describe any relevant study materials. This could include, for example, stimulus materials used for experiments, questionnaires used for rating studies, training protocols for intervention studies, etc.

Study information and eligibility

- Eating Disorder Examination Questionnaire (EDE-Q)
- Patient Health Questionnaire 9 (PHQ-9)
- Body Shape Questionnaire (BSQ8-c)
- Body Image State Scale (BISS)
- State Self-Esteem Scale (SSES)
- Visual Analogue Scales (VAS: Body Dissatisfaction, Fear of Weight Gain)
- Embodiment: Audio items during XR and Embodiment Questionnaire (EQ)
- Figure Rating (FR)
- Virtual Reality:
  - Rocketbox library (selected self-avatar) and customized script to deform the body of the avatar while manipulating body weight and shape
  - realization through Unity3D
  - HTC-Vive headset, HTC-Vive trackers (head, hand, feet)
  - Valve Knuckles controller
  - real and virtual pillow for embodiment enhancement
  - mounted Lighthouse stations for optical tracking in the experiment room
- SMI Eye Tracker, integrated into the VR headset
  - eye tracking data will be streamed through the API of Unity3D and recorded at framerate

During the screening participants general and eating-related psychopathology is investigated by Eating Disorder Examination Questionnaire (Hilbert et al., 2007) and Patient Health Questionnaire (Löwe et al., 2004), trait body dissatisfaction is also assessed by the Body Shape Questionnaire 8c (Mutale et al., 2016). The screening variable is the SWC scale from the EDEQ (Hilbert et al., 2007)

Pre- and post XR, state body dissatisfaction and state self-esteem are measured by Body Image State Scale (Cash et al., 2002), State Self-Esteem Scale (Rudolph et al., 2018) and Visual Analogue Scales. Avatar Embodiment is measured by SUD items presented auditorily during XR (after both interaction phases and after the mirror phase), as well as through the individualized embodiment questionnaire (Peck & Gonzalez-Franco, 2021).

Further, Simulator Sickness Questionnaire (Kennedy et al., 1993) is used to assess possible simulator sickness problems and the Igroup Presence Questionnaire (Schubert et al., 2001) is used to assess the experience of presence.

Body Mass Index: For the Measurement of the BMI weighing and height scales and the according formula ( $BMI = kg/m^2$ ) are used.

Full Body Illusion in XR: From the Rocketbox library (Gonzalez-Franco et al., 2020) a self-avatar was chosen and adjusted for the present experiment. The head of the self-avatar is covered by a head-mounted display and a mouth mask, to maximize identification with the avatar. For the experimentally manipulation of the body weight and shape, the character's bones and mesh vertices were dynamically adjusted by a script adapted from Rubo and Gamer (2019). Inverse kinematics and physics simulation are realised through VRIK and PuppetMaster plugins in Unity3D. Participants wear a custom HTC-Vive headset with integrated SMI eyetracking and are equipped with a 6-point motion tracking solution (realized through HTC-Vive trackers and Valve Knuckles at hands, feet and hip).

To obtain a full body illusion a synchronous visuo-motor and visuo-tactile stimulation procedures is used (Maselli & Slater, 2013; see also Ferrer-Garcia et al., 2017; Gonzales-Franco & Peck, 2018; Kim et al., 2020; Porras-Garcia et al., 2020; Rubo & Gamer, 2019). Participants experience the first-person perspective of the self-avatar.

Through inverse kinematics of head, hand and feet tracker, the animation of the self-avatar is enabled. Thus, the position and animation of the self-avatar is synchronous regarding the actual movements of the participants. During a first experience phase with a duration of 2-3 minutes, participants are asked to perform various tasks in XR (move hands in front of them, walk to a position in the room, look down on their body and move the right/left arm; instructed and overseen by a trained experimenter).

For the second embodiment phase, participants are asked to turn around and place their hands on a passive haptic device (a pillow present in both simulation and laboratory). For 2 minutes, falling beach balls are presented above the hands and are accompanied with controller vibrations and sound on collision. Finally, participants are asked to turn around and view themselves (i.e., their self-avatars) for a while in a mirror while standing still. The mirror was not active during the interaction phases. In parallel, background sounds of a swimming pool are played. Gaze patterns are recorded during the mirror confrontation with the self-avatar. The entire simulation is situated in a non-populated public indoor swimming pool. After each of the phases were completed, SUD items regarding embodiment are played to the participants. Questionnaires are answered subsequently outside of the XR. Participants are equipped with feet and hip tracker throughout the entire procedure.

To separate the two conditions, a filler video of tranquilizing jellyfish is played along. Participants have to answer three attention check items before the second trial.

## M14 Study Procedures

Please describe here any relevant information about how the study will be conducted, e.g., the number and timing of measurement time points for longitudinal research, the number of blocks or runs per session of an experiment, laboratory setting, the group size in group testing, the number of training sessions in interventional studies, questionnaire administration for online assessments, etc.

Participants will be tested at one appointment, one at a time, after undergoing the eligibility screening via phone or E-Mail.

At the start of the session, participants will be asked to indicate their current state body dissatisfaction, state self-esteem, and fear of gaining weight. In the next phase, participants will be asked to conduct multiple tasks in XR, e.g. "walk forward two steps" or "raise your left arm" to enhance embodiment of the virtual self avatar. (see above) The order of the tasks and instructions used will be standardized. We will track the gaze-patterns of participants via the XR headset during a mirror phase of the experiment.

Afterwards, participants exit the XR environment and are asked to fill out the second phase of questionnaires (relating to pre-/ post measured variables). Finally, participants' weight and height will be measured. As we expect a decrease in the mood of some participants, given that our experimental design could heighten body dissatisfaction, participants will be given the opportunity to play the XR game "The Blu" after filling out the questionnaires.

### **M15 Other information (optional)**



# Analysis plan

(NOTE: If this varies by hypothesis, repeat analysis plan for each)

## AP1 Criteria for post-data collection exclusion of participants, if any

Describe all criteria that will lead to the exclusion of a participant's data (e.g. performance criteria, non-responding in physiological measures, incomplete data). Be as specific as possible.

Participants will be excluded if the data is incomplete, e.g. because of simulator sickness or because of any other reason why participants stop the experiment early.

## AP2 Criteria for post-data collection exclusions on trial level (if applicable)

Describe all criteria that will lead to the exclusion of a trial or item (e.g. statistical outliers, response time criteria). Be as specific as possible.

Not applicable

## AP3 Data preprocessing

Describe all data manipulations that are performed in preparation of the main analyses, e.g. calculation of variables or scales, recoding, any data transformations, preprocessing steps for imaging or physiological data (or refer to publicly accessible standard lab procedure, cf. T12).

The gaze pattern data will be streamed and pre-processed through SMI's API for Unity3D. Thereby, the raw data will be pre-processed into required metrics such as fixation duration towards the respective AOIs, number of saccades and saccade latency. According to Keizer et al. (2016) the AOIs are the abdomen, hips, waist and additionally the thighs. Moreover, in line with Smeets et al. (2001), gaze patterns according to the most and least attractive body regions are investigated.

## AP4 Reliability analysis (if applicable)

Specify the type of scale reliability that will be estimated, whether it is internal consistency (e.g. Cronbach's alpha, omega), test-retest reliability, or some other form (e.g., a confirmatory factor analysis incorporating multiple factors as sources of variance). In a study involving measure development, researchers should specify criteria for removing items from measures a priori (e.g., largest factor loading magnitude, smallest drop in alpha-if-item removed).

The internal consistencies of the questionnaires used will be checked and reported (Cronbach's alpha). No further reliability analysis is needed.

### **AP5 Descriptive statistics**

Specify which descriptive statistics will be calculated for which variables. If appropriate, specify which indices of effect size will be used. If descriptive statistics are linked to specific hypotheses, explicitly link the information given here to the respective hypothesis.

For the total scores of the questionnaires (state body dissatisfaction, state self-esteem, embodiment consisting of avatar embodiment and presence, simulator sickness) means and standard deviations will be calculated.

For the demographic data such as gender, age and BMI descriptive statistics such as frequencies and means are calculated.

Regarding the eye tracking, appropriate metrics such as fixation duration, number of saccades and saccade latency are described by the system for each region of interest.

### **AP6 Statistical models (provide for each hypothesis if varies)**

Specify the statistical model (e.g. t test, ANOVA, LMM) that will be used to test each of your hypotheses. Give all necessary information about model specification (e.g., variables, interactions, planned contrasts) and follow-up analyses. Include model selection criteria (e.g., fit indices), corrections for multiple testing, and tests for statistical violations, if applicable. Wherever unclear, describe how effect sizes will be calculated (e.g., for d-values, use the control SD or the pooled SD).

H1: ANOVA with factors time and avatar weight (normal weight versus overweight) and dependent variable state body dissatisfaction.

H1a: ANOVA with factors time and avatar weight (normal weight versus overweight) and dependent variable fear of gaining weight.

H1b: ANOVA with factors time and avatar weight (normal weight versus overweight) and dependent variable state self-esteem.

H2: ANCOVA with factors time and avatar weight, covariate gaze pattern (relative gaze durations and frequencies) and dependent variable state body dissatisfaction

H3: ANOVA with factors time and avatar weight, covariate avatar embodiment, and dependent variable state body dissatisfaction

### **AP7 Inference criteria**

Specify the criteria used for inferences (e.g., p values, Bayes factors, effect size measures) and the thresholds for accepting or rejecting your hypotheses. If possible, define a smallest effect size of interest. If inference criteria differ between hypotheses, specify separately for each hypothesis and respective statistical model by explicitly referring to the numbers of the hypotheses. Describe which effect size measures will be reported and how they are calculated.

We use an alpha level of  $\alpha=.05$  to consider effects statistically significant.

### **AP8 Exploratory analysis (optional)**

Describe any exploratory analyses to be conducted with your data. Include here any planned analyses that are not confirmatory in the sense of being a direct test of one of the specified hypotheses.

E1: AP6 is conducted again replacing the outcome variable state body dissatisfaction through state self-esteem.

E2: The regions of interest regarding gaze patterns are extended to other body regions such as arms, shoulder etc. in order to represent the whole body. For every body region differences between under vs. above-average body satisfaction regarding fixation duration should be investigated via t-tests.

E3: ANOVA with factors avatar weight (normal weight versus overweight) and trait body dissatisfaction, effect on dependent variable state body dissatisfaction.

### **AP9 Other information (optional)**

# Other information optional

(NOTE: If needed, multiple lines with other information can be included)

## O1 Other information (optional)

If there is any additional information that you feel needs to be included in your preregistration, please enter it here. Literature cited, disclosures of any related work such as replications or work that uses the same data, or other context that will be helpful for future readers would be appropriate here.

# References

## R1 References

Enter your references below. Use a consistent format (e.g.,  
<https://apastyle.apa.org/style-grammar-guidelines/references/examples>)

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