The effect of avatar body size on healthy eating behavior

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Snr. 2044609 – Anr. 681002

Master's Thesis

MSc Communication and Information Sciences

Specialization New Media Design

Tilburg School of Humanities and Digital Sciences (TSHD)

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July, 2021

Abstract

In virtual reality (VR), people can feel virtual body ownership (VBO) over a body dissimilar to one's own. The present study aimed to investigate whether embodying and feeling body ownership over an overweight avatar can increase healthy eating intentions and behavior. Furthermore, people may overestimate their own body size after embodying an overweight avatar since people represent the virtual body as their own through VBO illusions. An overestimation of one's own body size can cause people to think differently about their eating behavior. Therefore, changes in body size estimations could mediate the effect between embodying an overweight avatar and healthy eating intentions. At last, previous literature suggests the importance of synchronous visuotactile stimulation (VTS) to create VBO illusions when embodying an avatar dissimilar to one's own (e.g., Banakou, 2018). Hence, synchronous visuotactile stimulation (VTS) was induced and compared with an asynchronous VTS control condition. Participants (N = 60) were randomly assigned to a 2 (avatar body size: overweight vs. normal weight) by 2 (VTS: synchronous vs. asynchronous) between-subjects experimental design. Results showed that embodying an overweight avatar did not increase participants' intentions to eat healthily. Moreover, participants did not estimate their body size differently after embodying an overweight avatar. Nevertheless, asynchronous VTS affected participants' healthy eating intentions after embodying a normal weight avatar, suggesting that asynchronous VTS is not a neutral condition. This effect was not observed by participants embodying an overweight avatar. At last, results showed a positive relationship between participants' healthy eating intentions and healthy eating behavior, even though embodying an overweight avatar did not increase participants' healthy eating intentions.

Keywords: Avatar body size, virtual body ownership, healthy eating intentions, healthy eating behavior, body size estimation, visuotactile stimulation

The effect of avatar body size on healthy eating behavior

Body ownership describes the paradigm of how people perceive their body as something that belongs to them and they accept as their body. Virtual reality (VR) expanded this paradigm since body ownership can be induced in immersive environments (Petkova, Ehrsson, & Harris, 2008). In immersive environments, people can embody a virtual body representing their own body (i.e., avatars) and experience this virtual body from a first-person perspective. As a result, people can feel body ownership over their virtual body, referred to as Virtual Body Ownership (VBO), and represent the avatar's virtual body as their own body (Kilteni, et al., 2012; Slater et al., 2009). VR has unique features allowing to change the appearance of one's avatar body. Embodying an avatar whose appearance has been adjusted can result in VBO over a body dissimilar to one's own (Banakou et al., 2013; Banakou et al., 2020; Normand et al., 2011; Peck et al., 2013; Slater et al., 2010; Weber, et al., 2020; van der Hoort et al., 2011)

Feeling VBO over an overweight avatar can be used to stimulate people to eat more healthily. Stimulating healthy eating behavior is essential to maintain a healthy weight, which is crucial since overweight and obesity are considered a growing global crisis (Mata & Hertwig, 2018). Previous studies have already shown that people's health behavior can be stimulated by confronting them with potential physical changes in their bodies due to unhealthy behavior (Ahn, 2015; Şenel & Slater, 2020). More specifically, these studies let people observe their potential 'future self' from a third-person perspective in an immersive environment. This contributed to their risk perception and stimulated them to engage in healthy behavior. However, embodying an overweight avatar to experience potential physical future consequences from a first-person perspective to influence people's healthy eating behavior has not been examined before. Hence, there is no established view on the positive impact of embodying overweight avatars to stimulate people to eat more healthily. According

to Banakou and Slater (2014), VBO is more likely to occur when embodying an avatar and observing this avatar from a first-person view instead of observing an avatar from a third-person perspective. Furthermore, Banakou et al. (2020) have shown that VBO illusions are necessary when impacting people's behavior after embodying an avatar dissimilar to one's own. The present study expects that people can feel VBO when embodying an overweight avatar and that this illusion of having an overweight body is essential to have a realistic experience of potential physical future consequences of unhealthy behavior. Therefore, the first aim of this study is to examine whether embodying an overweight avatar is effective for stimulating healthy eating behavior.

Furthermore, people's intention to engage in healthy behavior is important for actual behavior change. People's intentions are indications of one's motivation to change current behavior (Azjen, 1991; Fishbein & Ajzen, 1975; Web & Sheeran, 2006). Previous studies also mentioned the importance of healthy eating intentions to engage in healthy eating behavior (Conner et al., 2002; Psouni et al., 2016). Therefore, this study examines whether participants' intentions to eat healthily after embodying an overweight avatar predict their healthy eating behavior. Previous studies measuring the relationship between healthy eating intentions and healthy eating used self-report measurements to examine this relationship (Conner et al., 2002; Psouni, et al., 2016). Thus, actual eating behavior was not objectively measured. The present study will contribute to the existing knowledge about the healthy eating intentions and healthy eating behavior relationship by measuring people's actual food intake with a taste test. Hence, the second aim of the present study is to examine whether participants' intentions to eat healthily predict their actual healthy eating behavior by performing a taste test.

To continue, people may estimate their own body size differently after embodying an overweight avatar which could mediate the effect between embodying an overweight avatar

and healthy eating intentions. Inaccurate body size estimations are associated with weight loss or weight gain behaviors. For example, people with eating disorders, such as anorexia nervosa, typically overestimate their body size, which results in weight loss behaviors (Robinson, 2017). On the other hand, underestimation is typically related to people who are overweighted. People who are overweighted are less likely to lose weight when they cannot estimate their body size accurately (Bodde et al., 2014; Robinson, 2017). Thus, accurately estimating one's body size seems to be important in maintaining a healthy weight. Previous literature has shown that people with a healthy weight can estimate their own body size accurately since they have a good representation of their own body (Longo, 2015). Nevertheless, Normand et al. (2011) have shown that participants in the study overestimated their own belly size after feeling VBO over an avatar with a larger belly size. It has not been examined yet if people's intention to eat healthily can be influenced when people estimate their own body size differently after embodying an overweight avatar. Therefore, the third aim of this study is to examine whether people estimate their own body size differently after embodying an overweight avatar and whether this change mediates the effect between embodying an overweight avatar and healthy eating intentions.

At last, inducing synchronous visuotactile stimulation (VTS) is a common procedure to create VBO illusions over an avatar dissimilar to one's own (Banakou, 2018; Normand et al., 2011; Piryankova et al., 2014). When inducing synchronous VTS in VR, people feel a touch on a part of their own body and simultaneously see the same touch on their virtual body (Pan & Hamilton, 2018). The brain integrates these two signals as one event, making it possible for the brain to represent the virtual body as its own (Slater, 2018). Even though synchronous VTS is an important procedure to create VBO over an avatar dissimilar to one's own, less is known about whether it is important to induce synchronous VTS when trying to impact people's behavior after the embodiment. For example, Banakou et al. (2020) found

changes in white participants' implicit racial bias after embodying a virtual black body. The researchers found that participants felt VBO over their avatar without inducing synchronous VTS. No research has been done before examining the effectiveness of synchronous VTS on health behavioral change after embodying an avatar dissimilar to one's own. Therefore, the present study contributes to the existing knowledge by examining whether synchronous VTS will strengthen the effect between embodying an overweight avatar and participants' intentions to eat healthily.

Moreover, previous research described the importance of inducing synchronous VTS to let people overestimate their own belly size after embodying an avatar with a larger belly size (Normand et al., 2011). However, it is still unclear whether people estimate their total body size differently after embodying an avatar with a dissimilar body size as a result of synchronous VTS since several studies also mentioned that changes in body size estimation were not a result of synchronous VTS (Keizer et al., 2016; Piryankova et al., 2014). Hence, the present study contributes to the existing knowledge by examining whether people will estimate their own body size differently after embodying an overweight avatar due to synchronous VTS. To conclude, the fourth aim of the present study is to investigate whether synchronous VTS will strengthen the effect of embodying an overweight avatar on body size estimation and on healthy eating intentions.

This paper aims to answer the gaps in current literature by the following research question: 'What is the effect of embodying an overweight avatar and body size estimation on healthy eating intentions and behavior? And will this effect be strengthened by synchronous visuotactile stimulation?'

Theoretical framework

Responding to stimuli in VR

People typically have a subjective psychological response when being transported into

a virtual environment (Slater, 2003), which can be described as presence: “the feeling of being *inside* the virtual world” (Riva & Mantovani, 2012, p. 3). When feeling presence, people’s perceptual system reacts much faster than people’s cognitive system. Specifically, a human brain ‘knows’ that the virtual environment is not real, however, the human body responds to the information provided by the virtual environment as if it is real (Slater, 2018).

Besides the virtual environment, people can also react to their virtual body as if it is their own body. This illusion can be described by Virtual Body Ownership (VBO) and refers to whether embodying an avatar results in an illusory perception of owning that virtual body. VBO and presence are closely related to each other. Slater (2018) explained that “responding to a virtual body as if it were your own body is perhaps the most powerful demonstration of presence in virtual reality” (p. 214). Since people can feel body ownership over a virtual body, it is possible to feel VBO over a body dissimilar to one’s own by changing the appearance of the visual representation of a user (the avatar). Previous researchers have examined this phenomenon and found that it is possible to feel body ownership over an avatar with a different gender (Slater et al., 2010), belly size (Normand et al., 2011), age (Banakou et al., 2013), race (Banakou et al., 2020; Peck et al., 2013), and body size in length (Weber et al., 2020; van der Hoort et al., 2011).

Avatar body size manipulations to stimulate health behavior

As mentioned before, embodying overweight avatars might have the potential to stimulate people to eat more healthily. Enabling individuals to embody their future self (e.g., embodying an overweight avatar) can be used to show potential physical future consequences of unhealthy eating behavior (Fox, 2011). People are likely to visualize their future positively because the physical consequences of unhealthy behavior do not occur directly. In other words, people find it challenging to make decisions that would improve their future health. Instead, people are more likely to benefit from immediate rewards, for example, enjoying a

bar of chocolate (Fox, 2011). This distance between people's current behavior and potential future consequences can be explained by temporal and social distance, which are essential components of the Construal Level Theory by Trope and Liberman (2010). Temporal distance refers to the distance in time (between the present and the future), and social distance refers to the distance between oneself and another (e.g., "that won't happen to me"). Changing the appearance of one's avatar can reduce the temporal and social distance between people's current unhealthy behavior and potential future physical consequences, which is important for people's risk perception (Rutchick et al., 2018; Wienrich et al., 2020). Ahn (2015) tested whether reducing temporal and social distance with overweight avatars on health behavior was effective. The study compared a health message via a traditional pamphlet alone to a health message via a traditional pamphlet coupled with a VR experience. All conditions promoted a lower intake of soft drinks. In the additional VR experience, participants saw their avatar observed from a third-person view consuming soft drinks and simultaneously gained weight as a result. Participants were only able to observe their avatar, meaning that the participants had no control over the actions of the avatar (e.g., the movements of the participants were not synchronized with the avatar). Ahn (2015) found that reducing the social distance by using avatars representing the participant and reducing the temporal distance by confronting participants with future physical consequences of soft drink consumption (gaining weight) effectively reduced participants' soft drink intake. However, in the study by Ahn (2015), it was obvious to the participant that the VR experience was a health message aimed at themselves. For example, participants saw what behavior caused the physical changes in the body. Furthermore, a clock was presented with the time and date during the VR experience, so participants could indicate how long it took for the body to see physical changes resulting from unhealthy behavior. Ahn's study (2015) indicates possible effects on health behavior when using overweight avatars, although the present study did not use such

external cues to make the health message so clear to the participant. The question is whether participants will consider eating more healthily immediately after embodying an overweight avatar. No research has been done before to examine this effect. This study will examine whether a change in healthy eating intentions and healthy eating behavior can occur after embodying an overweight avatar without explicitly telling participants that their body size changed due to unhealthy behavior. Hence, participants will only embody an overweight avatar without being told that the avatar is their future self.

Likewise, Şenel and Slater (2020) examined whether participants' attitude towards the effects of smoking can be influenced by having a conversation with their future self in VR (their future self that quit smoking vs. their future self that did not quit smoking) while being embodied in an avatar representing their present self. The researchers found that the conversation with both future-self conditions decreased temporal and social distance, which led to better risk perception of smoking. Again, the health message about the future effects of smoking was obvious for the participants. Similar to Ahn (2015), this study by Şenel and Slater (2020) also indicates that health behavior can be stimulated by using avatars that represent a participant's future self. Although, there are still many questions about the possibility to stimulate healthy eating behavior when embodying an overweight avatar.

It might be important to mention that there is also a contrasting view suggesting how manipulating avatar body sizes could impact someone's health behavior, known as the Proteus Effect (Yee & Bailenson, 2007). More specifically, the Proteus Effect indicates that health behavior intentions can be enhanced by using avatars that are physically active and fit (Rheu, Jang, and Peng, 2020). In this case, the user knows that other people expect specific behavior from his or her avatar's appearance. Therefore, the user will engage in those expected behaviors. However, the present study does not expect this Proteus Effect to happen. Examining how body size manipulation influences people's health behavior according to the

Proteus Effect has been studied in (exer)games (e.g., Peña, Khan, and Alexopoulos, 2016), where participants did not embody the avatar in VR. This study expects that embodying an overweight avatar will result in a more realistic experience of having an overweight body since people can feel VBO. More specifically, embodying an overweight avatar may lead to a better risk perception of unhealthy behavior, which can cause people to improve their health behavior instead of adopting the behavior of the overweight avatar.

To conclude, people find it challenging to make decisions that would improve health behavior in the future. Changing the appearance of one's avatar can reduce the temporal and social distance between people's current unhealthy behavior and potential future physical consequences, which is important to contribute to people's risk perception. Avatar embodiment and VBO may maximize this impact since these can create a realistic experience of undergoing physical changes in one's body. This study will elaborate on this new field of embodying avatars dissimilar to one's own to impact future health behavior. Therefore, this study hypothesizes that participants embodying an overweight avatar will have more intentions to eat healthily than participants embodying a normal weight avatar. Thus, the following hypothesis is proposed:

H_1: Participants' healthy eating intentions are stronger when embodying an overweight avatar than when embodying a normal weight avatar**.**

The importance of intentions for behavioral change

As mentioned before, increasing people's intention to perform a specific behavior is important for actual behavioral change (Faries, 2016; Hagger, 2010; Sheeran, 2002). A common theory describing the importance of intention on behavior is the Theory of Planned Behavior (TPB) by Ajzen (1991). This theory shows that several factors drive people's intentions, for example, people's attitude towards the behavior. Subsequently, people's intention is fundamental to perform the behavior. Several studies tested whether people's

intentions to eat more healthily predict people's healthy eating behavior. Conner et al. (2002) have shown that respondents' healthy eating intentions were strongly related to their (self-reported) healthy eating behavior. Moreover, Psouni et al. (2016) have shown in a survey study that participants with a healthy weight have more intentions to eat healthily than overweight participants and therefore engage in more healthy eating behavior than overweight participants.

Furthermore, Ahn (2015) has shown that participants' intention to reduce soft drink intake after observing their potential future self from a third-person perspective in an immersive environment predicted their actual soft drink consumption. However, in Ahn's study (2015), participants tracked their soft drink consumption themselves and reported this by filling out a questionnaire. To the best of knowledge of the present study, examining the relationship between healthy eating intentions and healthy eating behavior by the amount of food consumed by participants in a laboratory setting has not been done before.

Accordingly, this study will test whether people will translate their intentions into action during a taste test after the virtual embodiment. Since behavioral intentions seem to be an important predictor of actual health behavior, this study hypothesizes that participants' healthy eating intentions will predict their kcal intake during the taste test. Therefore, the following hypothesis is proposed:

H_2: Participants' healthy eating intentions will predict their kcal intake during the taste test.

Mediating role of body size estimation

Body size estimation plays an important role in someone's body image. Body image can be described as how people feel about their bodies regarding body shape or weight and is typically divided into a perceptual component and a subjective component (Carey, & Preston, 2019). The subjective component captures people's attitudes and emotions towards their bodies, resulting in body satisfaction or dissatisfaction (Steinsbekk et al., 2017). The

perceptual component captures people's accuracy in estimating their body size, whereby an inaccurate body size estimation affects people's attitude towards their own body (Carey, & Preston, 2019). Since the present study focuses on the mediating role of body size estimation between embodying an overweight avatar and healthy eating intentions, the perceptual component (body size estimation) will be explained in more depth. The influence of body satisfaction is beyond the scope of the present study.

When maintaining a healthy weight, it is important to accurately perceive one's own body size (Bodde et al., 2014). As already mentioned before, people with eating disorders typically overestimate their body size and are therefore more likely to lose weight. Contrarily, people with overweight typically underestimate their body and are therefore less likely to lose weight (Bodde et al., 2014; Farrell et al., 2005; Robinson, 2017). Although people with a healthy weight commonly perceive their own body size correctly (Longo, 2015), it has been shown that even people with a healthy weight could estimate their body size inaccurately, influencing their eating behavior. For example, a survey study by Rahman and Berenson (2011) showed that females with a healthy weight who overestimated their own body size were more likely to lose weight compared to females with a healthy weight who estimated their own weight correctly. Therefore, the present study supposes that body size estimation could explain the effect between embodying an overweight avatar and healthy eating intentions.

Previous studies have shown that people with a healthy weight estimated their own body size differently after embodying an avatar with a dissimilar body size. In a study by Preston and Ehrsson (2014), participants estimated their own body size as slimmer after the embodiment with a slimmer avatar. Contrarily, participants did not estimate their own body size differently after embodying an overweight avatar. Furthermore, in a study by Piryankova et al. (2014), participants' attitudes towards their own body size changed after embodying an

underweight or overweight avatar. However, their accuracy in estimating their body size did not change. Nevertheless, Normand et al. (2011) examined belly size estimations by participants with a healthy weight and found that participants overestimated their belly size after embodying an avatar with a larger belly size. Piryankova et al. (2014) suggested that their results differed from Normand et al. (2011) because they only included women in the experiment and Normand et al. (2011) both men and women. Piryankova et al. (2014) argued that women in the study perhaps felt slimmer or thicker even before embodying an underweight or overweight avatar. However, Preston and Ehrsson (2014) did not find differences in body size estimation after embodying a slimmer avatar between men and women. Since Normand et al. (2011) and Preston and Ehresson (2014) did not find differences in body size estimation between men and women after embodying an avatar with a dissimilar body size, the present study expects that one's gender will not influence differences in body size estimation after embodying an overweight avatar.

To summarize, inaccurate body size estimation influences people's eating behavior. Although people with a healthy weight are usually more likely to estimate their own body size accurately (Longo, 2015), Normand et al. (2011) have shown that participants overestimated their own belly size after embodying an avatar with a larger belly size. This study, therefore, predicts that participants will overestimate their body size after embodying an overweight avatar and that this overestimation subsequently influences participants' intentions to eat more healthily. Therefore, the following hypotheses are proposed:

H_3: The overestimation of one's body size is larger when embodying an overweight avatar than when embodying a normal weight avatar.

H_4: Higher overestimation of one's body size will lead to higher intentions to eat healthily.

Moderating role of visuotactile stimulation

Body ownership became an upcoming topic in cognitive neuroscience as the result of the rubber hand illusion (RHI) which was a breakthrough study by Botvinick and Cohen in 1998. Botvinick and Cohen (1998) have shown that it is possible to feel body ownership over a rubber hand. In this study, participants watched a rubber hand in front of them on a table. Their own hand was in the same position as the rubber hand on the table but covered. In other words, participants were only able to see the rubber hand. The experimenter stroked the rubber hand and the participant's own hand with a paintbrush synchronously (synchronous VTS). The participants' bodies integrated these two separate signals (seeing touch on the rubber hand and feeling the same touch on their own hand) as one event, resulting in an illusion of ownership over the rubber hand. More specifically, participants thought the rubber hand was their own hand. According to Botvinick and Cohen (1998), this synchronous VTS was, among other things, fundamental to this illusion of body ownership over fake body parts.

This RHI paradigm has been investigated extensively with VR to examine whether VTS contributes to the illusion of owning a virtual body (VBO). Previous research has shown that the RHI can be reproduced by 2D projections of the rubber hand including synchronous VTS compared to asynchronous VTS as a control condition (which has been found to break the VBO illusion) (IJsselsteijn et al., 2006). In addition, it has been shown that it is possible to create out-of-the-body experiences with synchronous VTS compared to asynchronous VTS (Ehrsson, 2007; Lenggenhager et al., 2007). Thereafter, Petkova and Ehrsson (2008) examined the possibility of owning another persons' entire body in VR. Participants embodied another persons' body and synchronous VTS was induced and compared against a condition with asynchronous VTS. Again, the researchers found that inducing synchronous VTS successfully created the illusion of owning another person's full body. Although more studies found that synchronous VTS is effective to create VBO illusions (e.g., Normand et al.,

2011; Perez-Marcos et al., 2017; González-Franco et al., 2010), there are also studies suggesting that that synchronous VTS compared to asynchronous VTS was not necessary to increase VBO (Carey et al., 2019; Rubo & Gamer, 2019; Weber et al., 2020). For example, Rubo and Gamer (2019) have shown that VBO illusions can also occur by only seeing a virtual body from a first-person perspective and having control over the avatar's actions. Besides, Weber et al. (2020) concluded that a participants' perspective in the immersive environment is important to create VBO illusions.

Thus, synchronous VTS can contribute to VBO illusions. Although, in the current study, it is essential to examine whether inducing synchronous VTS is necessary when trying to achieve behavioral effects after embodying an avatar dissimilar to one's own. As mentioned before, Banakou et al. (2020) found changes in white participants' implicit racial bias after embodying a black-skinned avatar. The researchers also found that participants felt VBO over the embodied avatar and argued that this VBO was important to reduce white participants' implicit racial bias. However, VBO was not elicited by synchronous VTS. In their study, participants were not only able to look at their own bodies to see the skin color of their embodied avatar, but other avatars were also passing by and acting negatively towards the participant (discriminatory behaviors). This social setting may contribute to participants' VBO illusions since they thought the crowd behaved negatively because of their skin color. Therefore, participants reacted to the virtual body as if it was their own. In the present study, participants will embody an overweight avatar alone and not in a social context. Participants themselves must experience that their body size is increased and believe the overweight body is their own. Therefore, this study expected that synchronous VTS could be important to elicit VBO since no further context is given to the participant. Accordingly, the present study hypothesizes that the effect of avatar body size on participants' intentions to eat more healthily is moderated by VTS and is the following hypothesis proposed:

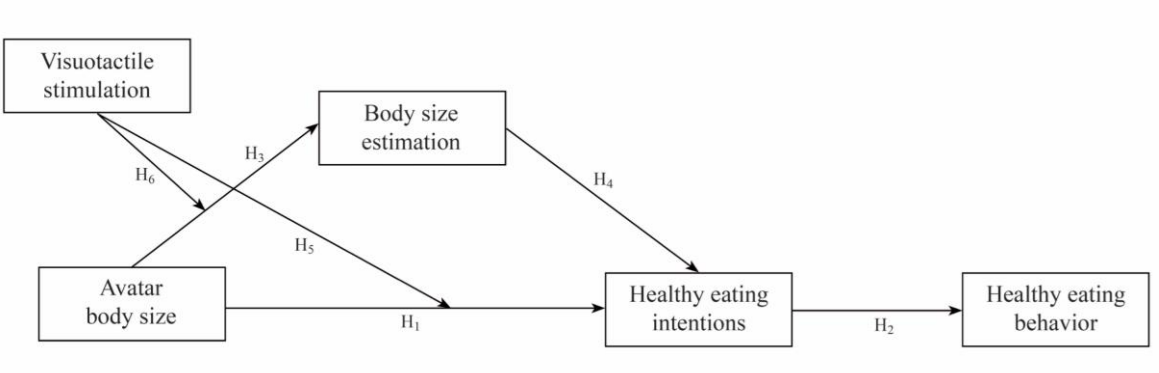
H_5: Participants will have stronger healthy eating intentions after embodying an overweight avatar, especially when synchronous VTS was induced compared to asynchronous VTS.

To continue, Normand et al. (2011) have shown that participants overestimated their own belly size after embodying an avatar with a larger belly size coupled with synchronous VTS. The researchers did not find changes in body size estimation after the virtual embodiment coupled with asynchronous VTS. Some studies also mentioned that synchronous VTS did not cause participants to estimate their body size differently (Keizer et al., 2016; Piryankova et al., 2014), but only included female participants in their sample. This study expects that a more diverse sample will yield different results, as with Normand et al. (2011). Therefore, this study hypothesizes that participants will overestimate their body size more after embodying an overweight avatar when synchronous VTS is induced compared to asynchronous VTS. Therefore, the following hypothesis is proposed:

H_6: Participants in the synchronous VTS condition will overestimate their body size after the embodiment with an overweight avatar more than participants in the asynchronous VTS condition.

Figure 1

Conceptual model



Note. This conceptual model provides an overview of the described theoretical constructs including all six hypotheses.

Method

Design

This study entailed an experimental approach which was approved by the Research Ethics and Data Management Committee of the Tilburg School of Humanities and Digital Science. A 2-by-2 between-subjects design was conducted with avatar body size (overweight vs. normal weight) as independent variable, and VTS (synchronous vs. asynchronous) as moderator variable. Furthermore, body size estimation was included as mediator variable and healthy eating behavior as dependent variable. At last, healthy eating intentions was included as mediator variable and dependent variable.

Participants

For this study, a total of 62 individuals were recruited. Two participants were excluded because an error occurred during the experimental procedure. The final sample consisted of 60 individuals with an average Body Mass Index (BMI) score of 22.25 (*SD* = 1.93). Participants were aged between 18 and 62 years old (*M* = 23.77, *SD* = 7.43) and 52% were male and 48% female. The majority of the sample was highly-educated (*n* = 50). Participants were recruited through the researcher's network and Tilburg University's participation pool website and rewarded with course credit or 10 euros.

The present study only included participants with a healthy weight. Therefore, people with underweight (BMI score less than 18.5) and overweight (BMI more than 25) were excluded (Dutch Nutrition Centre, 2021). Since the experiment contained manipulations in body weight, people with a history of eating disorders were excluded as well because embodying an overweight avatar might be too confrontational.

Stimuli and manipulations

Virtual environment

A virtual living room including a full-length mirror on the wall was created with Unity

3D software. González-Franco et al. (2010) showed that it is possible to create body ownership illusions when participants looked at themselves in a virtual mirror. Participants were transported to this living room while wearing the HTC Vive head-mounted display (HMD), two controllers, and two foot-trackers. The controllers and foot trackers ensured that participants' movements were synchronized in the virtual environment. Participants were able to look at their avatar from a first-person perspective and in the full-length mirror. To make sure participants felt similarity with their avatar, the HMD covered a big part of the virtual face. Furthermore, participants always embodied their own gender.

Avatar body weight

For the experimental manipulation of avatar body size**,** avatar bodies were created with Reallusion Character Creator Software. This software enabled to change the heaviness of the avatar's body to create a normal weight avatar body and an overweight avatar body. A pre-test was conducted among 53 individuals who did not participate in the experiment to determine the heaviness of the normal weight avatar and the overweigh avatar. The individuals were presented with 12 different avatar body sizes. Six avatar body sizes were overweight and six avatar body sizes had a normal weight. Subsequently, the respondents had to indicate whether they thought the avatar had a normal weight or whether the avatar had overweight. As a result, two avatar body sizes (overweight vs. normal weight) were created, as shown in Figure 2. The normal weight avatar had a heaviness value of 15 within Reallusion Character Creator Software, and the overweight avatar had a heaviness value of 45 within Reallusion Character Creator Software.

Figure 2

Avatar bodies

Note. Avatar bodies from left to right: (1) female normal weight, (2) female overweight, (3) male normal weight, (4) male overweight.

Visuotactile stimulation

For the experimental manipulation of VTS, participants were stroked with a controller to their physical arms (i.e., tactile stimulation). Simultaneously, participants saw their virtual arms being stroked with the same controller (i.e., visual stimulation). In the synchronous VTS condition, participants felt the tactile stimulation on their left arm and saw the visual stimulation on their virtual left arm (and vice versa). In the asynchronous VTS condition, participants felt the tactile stimulation on their left arm and saw the visual stimulation on their virtual right arm (and vice versa). This procedure was similar to previous studies (e.g., Piryankova et al., 2014). In the present study, either synchronous or asynchronous VTS was induced for 45 seconds by the participant's right arm and 45 seconds by the participant's left arm.

Measurements

Body size estimation

To determine participants' accuracy in estimating their body size after embodying an overweight or normal weight avatar, the percentual difference between a participant's actual weight status and the participant's self-perceived weight status was calculated. Participants' actual weight status was measured by asking the participant's weight and length to calculate

their BMI score. Participants' self-perceived weight status was measured by one question in which participants were presented with a silhouette scale, developed and validated as a subjective measurement for body size estimation by Gardner and Brown (2010). This scale consists of figural drawings resembling silhouettes of body sizes from 60% towards 140%. In this scale, 100% resembled a silhouette of an average normal weight body size. The participants were not presented with the percentages but only with the figural drawings. The participants had to indicate which silhouette matched most closely with the silhouette of their own bodies. To calculate a difference score in percentages for body size estimation, participants' BMI score had to be translated into percentages as well. To do this, the mean BMI score (22.25) of all participants was taken as the average normal weight body size (100%) in the silhouette scale by Gardner and Brown (2010). Since a BMI score of 22.25 was determined as 100%, all participants' BMI scores could be translated into percentages. For example, a BMI score of 22.55 was translated into a percentage score of 101.33%. When this participant indicated its body size in the silhouette scale as 91%, there was an underestimation of -10.33%. The mean score of the percentual difference in body size estimation of all participants was

-11.50% (*SD* = 10.20).

Healthy eating intentions

Participants' healthy eating intentions were initially measured by four questions related to healthy eating intentions (e.g., "I expect to start eating healthy for the next two weeks") on a 7-point Likert scale (1= strongly disagree to 7 = strongly agree). However, the scale's reliability analysis showed no good internal consistency ($\alpha = .64$). This could be due to a poor interrelatedness between items. Therefore, questions three and four were deleted from the scale. These contained questions about reducing energy-rich food consumption whose meaning may have been misinterpreted by participants. As a result, participants' healthy

eating intentions were measured by the first two items of the scale (Appendix C, p. 57). The analysis of the scale's reliability showed good internal consistency (α = .73). The mean score of the two items was finally used to determine participants' healthy eating intentions (*M* = 4.98, *SD* = 1.25).

Healthy eating behavior

Healthy eating behavior was measured by the Bogus Taste Test. This test is a validated laboratory measurement of food intake (Robinson, 2017). This taste test measured the amount of food consumed by participants in a laboratory setting while they were led to believe the purpose of this method was to examine the relationship between taste perceptions and assessment of A-brands and house brands. This study followed the procedure of the Bogus Taste Test performed by Benjamins et al. (2020). In line with their study, participants had to evaluate a bowl of chocolate, a bowl of crisps, a bowl of grapes, and a bowl of tomatoes by answering questions (e.g., "How would you rate the quality of the chocolate?") with a 7-point visual analog scale (e.g., 1 = very bad to 7 = very good). Participants' actual food consumption was measured by weighting the bowls with food before and after the taste test. The post-test weight was subtracted from the pre-test weight to calculate the weight difference in grams. Thereafter, the difference in gram per product was translated into kilocalories (kcal). The amount of kcal per gram for chocolate was 5.40 kcal, for crisps 5.49 kcal, for grapes 0.76 kcal, and for tomatoes 0.31 kcal. At last, participant's total consumption in kcal was calculated and used as measurement for participants' healthy eating behavior (*M* = 134.52, *SD* = 65.06). More specifically, the fewer participants' kcal intake during the bogus Taste Test, the more participants showed healthy eating behavior.

Manipulation checks

To examine whether the experimental manipulation of avatar body size (overweight vs. normal weight) was successful, four questions related to the participant's experience of the

avatar body size were asked (e.g., “the virtual avatar had a higher body weight than myself”) on a 7-point Likert scale (1= strongly disagree to 7 = strongly agree). The analysis of the scale’s reliability showed good internal consistency ($\alpha = .73$) and was averaged as one score ($M = 5.25$, $SD = 1.30$). Moreover, to examine whether the experimental manipulation of VTS (synchronous vs. asynchronous) was successful, one question related to the participants’ experience of the touches was asked (“It seemed as if the object I saw moving in the virtual environment caused the touch on my arm”) on a 7-point Likert scale (1= strongly disagree to 7 = strongly agree).

Procedure

After participants completed the inclusion questionnaire (Appendix A), they were invited into the lab and received an information letter containing information about the procedure of the study and an informed consent form (Appendix B). To avoid that participants would be aware of the purpose of the study, it was told as a cover story that they were taking part in three separate studies. The first study was framed to examine motor activities in VR and the effect of owning different body types. The second study was framed to examine personality traits and satisfaction with yourself. At last, the third study was framed to examine the relationship between taste perception and assessment of A-brands and house brands.

Starting the first part of the experiment, participants were instructed about the movements they had to perform to make sure participants believed the cover story. The experimenter first showed these movements. Thereafter, participants were provided with all equipment necessary for the VR experiment (HMD, controllers, and foot-trackers) and were asked to stand in the start position, which the experimenter also showed during the instructions. Participants were transported to the virtual environment where they faced their virtual avatar (normal weight or overweight) in the full-length mirror and were asked to adjust

to the virtual environment. Thereafter, the experimenter indicated that the participants could start with the instructed movements. During this procedure, the experimenter orally instructed which movements they had to perform. After the movements, the experimenter instructed the participants to look at their left or right arm and VTS was induced depending on the condition (for this procedure, go to p. 19). After the VTS procedure, participants were asked to pay one more time attention to themselves while looking at the virtual mirror.

After returning all equipment, participants were directed to a computer and instructed to fill out the first part of the survey containing questions about the VR experience. This first part of the survey contained questions of other experimenters measuring other variables. The present study did not include these variables since it did not contribute to the aim of this study. In addition, misleading questions were asked related to the cover story. After this first part of the survey, participants were informed they finished the first study and they could wait outside the lab.

While participants were waiting, another experimenter pretended to be preparing the second study for the credibility of the cover story. Thereafter, participants were directed to the same computer and instructed to fill out the second part of the survey in which body size estimation and healthy eating intentions were measured. Again, this part of the survey contained other experimenter questions measuring other variables that were not included in the present study. Finally, the survey contained questions about participants' demographic information. Besides, questions about the similarity between the avatar's body size and one's own and questions about the VTS experience were asked as manipulation checks. All survey questions are presented in Appendix C.

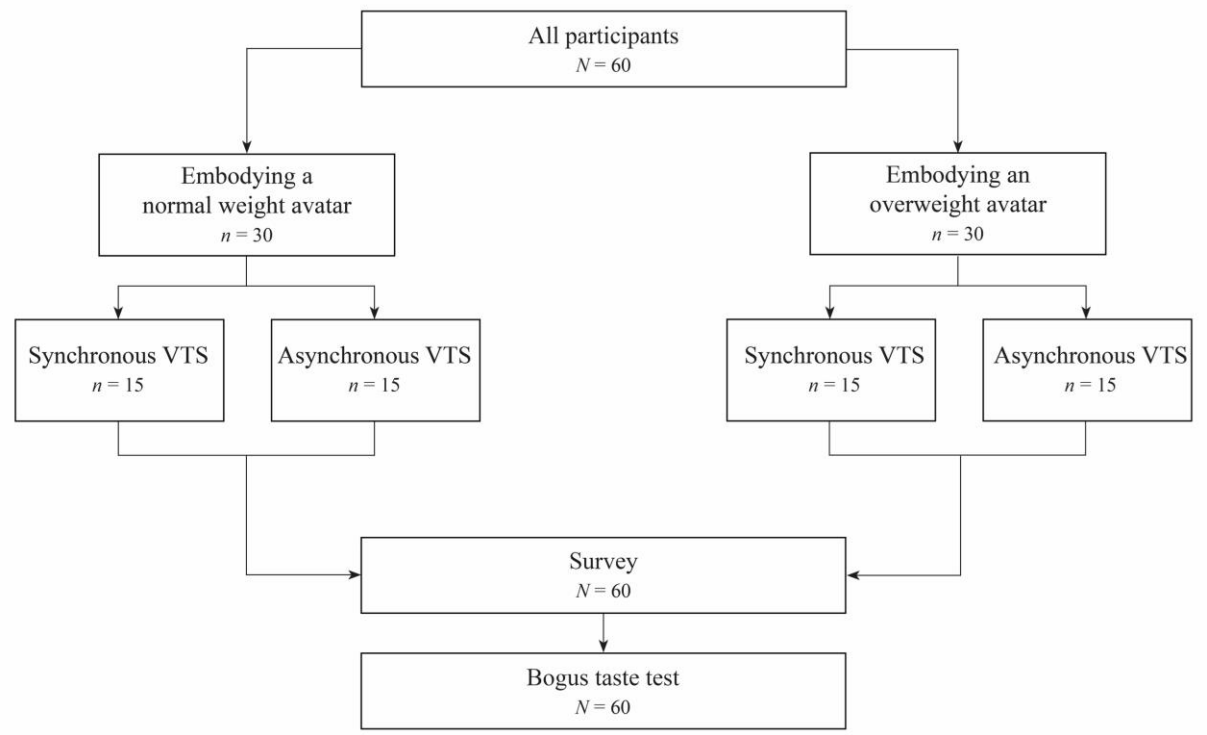
In the last study, participants performed the Bogus Taste Test. The bowls with unhealthy foods (chocolate and crisps) and healthy foods (grapes and tomatoes) were presented on a table together with the taste evaluation forms (Appendix D). The participants

were all presented with a different order of the food bowls to ensure the order did not influence the results. Participants were informed that they were allowed to eat as much as they wanted to answer the questions properly and as a reminder that the food would be thrown away after the test. After participants completed the taste evaluation questions, they were informed that they finished the third study.

A debrief was given in which the participants were thanked for their participation and asked not to share the experiment procedure with other people until they received an information letter via email containing information about the purpose of the study (Appendix E). Finally, participants were allowed to leave the lab. Figure 3 illustrates an overview of the whole procedure of this experiment.

Figure 3

Overview procedure



Data analysis

IBM SPSS Statistics version 25 was used for the statistical analysis. To examine whether the manipulation of the independent variable body size (overweight vs. normal

weight) and the moderated variable VTS (synchronous vs. asynchronous) was successful, independent samples *t*-tests were performed. Thereafter, PROCESS macro models 6 and 8 by Hayes (2017) were performed since no other model can test the conceptual model of the present study. To test the main effect of avatar body size on healthy eating intentions, the mediating effect of body size estimation, and the relationship between healthy eating intentions and healthy eating behavior, PROCESS macro model 6 (Figure 4) was performed (H_1 to H_4). In addition, to test whether VTS moderated the effect of avatar body size on body size estimation and on healthy eating intentions, PROCESS macro model 8 (Figure 5) was performed (H_5 and H_6).

Figure 4

Sequential mediation

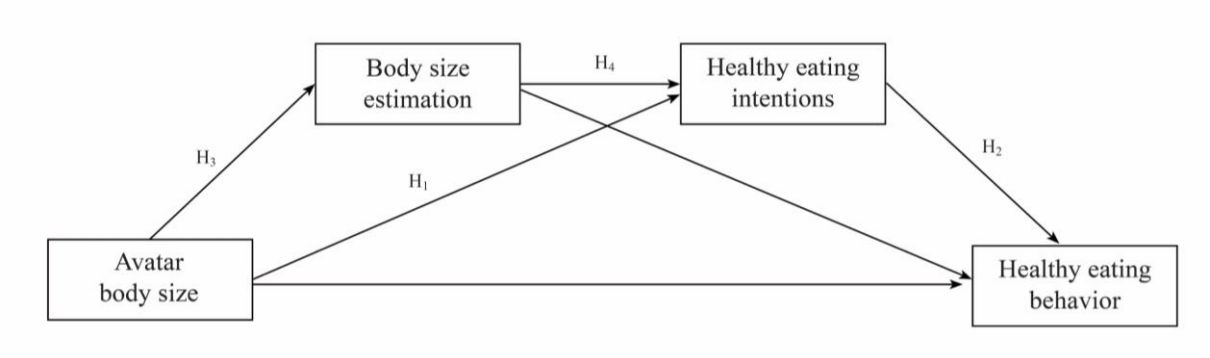
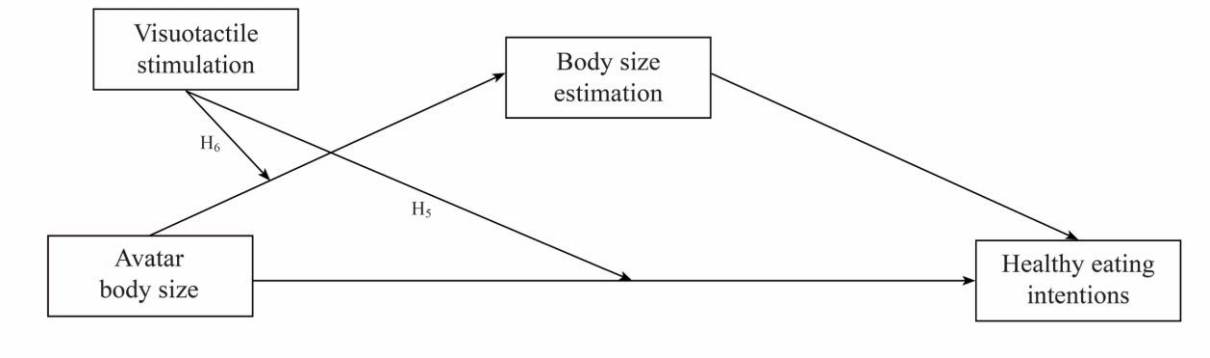


Figure 5

Moderated mediation



Results

Manipulation check

An independent T-test was performed to indicate whether the manipulation of the independent variable body size (overweight vs. normal weight) and the moderator variable VTS (synchronous vs. asynchronous) was successful. On average, participants in the overweight condition were more aware that their avatar was overweight or had a different body size than themselves (M = 6.15, SD = 0.70) than participants in the normal weight condition (M = 4.34, SD = 1.12). This difference, -1.81, 95% CI [-2.29, -1.33], was significant $t(58) = -7.52$, $p \leq .000$. The difference represents a large effect size, d = 1.94. In addition, on average, participants in the synchronous VTS condition had more the impression that the touches on their arms were caused by the object they saw in the VR (M = 5.10, SD = 1.86), than participants in the asynchronous VTS condition (M = 3.27, SD = 2.13). This difference 1.83, 95% CI [0.80, 2.87], was significant $t(58) = 3.55$, $p = .001$. The difference represents a large effect size, d = 0.92. According to these results, it can be concluded that the manipulation of the independent variable avatar body size (overweight vs. normal weight) and the moderator variable VTS (synchronous vs. asynchronous) was successful.

Sequential mediation analysis

Assumptions

An analysis of standard residuals was carried out, which showed that the data of the dependent variable ‘healthy eating behavior’ did not contain outliers (Std. Residual Min = -1.57, Std. Residual Max = 2.10). Thereafter, tests to see if the data met the assumption of collinearity indicated that multicollinearity was not a concern (Avatar body size, Tolerance = 0.99, VIF = 1.02; Body size estimation, Tolerance = 0.99, VIF = 1.01; Healthy eating intentions, Tolerance = 0.99, VIF = 1.01). In addition, the data met the assumption of independent errors (Durbin-Watson value = 2.00). Overall, the histogram and the normal P-P

plot of standardized residuals indicated that the data contained normally distributed errors. In addition, the scatter plot of standardized predicted values showed that the data met the assumptions of homogeneity of variance and linearity.

Hypothesis testing

In the analysis, avatar body size (overweight vs. normal weight) was included as independent variable, body size estimation as first mediator variable, healthy eating intentions as second mediator variable, and healthy eating behavior as dependent variable. First, it was hypothesized that healthy eating intentions are stronger when embodying an overweight avatar than when embodying a normal weight avatar (H_1). The analysis showed no significant effect (b = -0.21, t = -0.66, p = .515) of avatar body size on healthy eating intentions. This indicated that participants embodying an overweight avatar did not have higher intentions for healthy eating behavior (M = 4.83, SD = 1.15) than participants embodying a normal weight avatar (M = 5.13, SD = 1.34). Therefore, H_1 cannot be supported.

Second, it was hypothesized that participants' healthy eating intentions after the virtual embodiment would predict their kcal intake during the taste test (i.e., participants' healthy eating behavior) (H_2). The analysis showed a significant effect between healthy eating intentions and kcal intake, b = -14.36, t = -2.03, p = .047, 95% CI [-28.51, -0.21]. The negative b shows that as healthy eating intentions increases, the amount of kcal intake declines (and vice versa). More specifically, participants' healthy eating intentions (M = 4.98, SD = 1.25) did predict their kcal intake during the taste test (M = 134.51, SD = 65.05). Therefore, H_2 can be supported. Table 1 provides an overview of the results of the different predictors of healthy eating behavior.

Table 1

Predictors of healthy eating behavior

Variable	*b*	*se*	*t*	*p*
Constant	225.28 [132.46, 318.11]	46.32	4.86	<.000
Avatar body size	-15.54 [-49.22, 18.14]	16.81	-0.92	.359
Body size estimation	-0.42 [-2.07, 1.24]	0.83	-0.50	.617
Healthy eating intentions	-14.36 [-28.51, -0.21]	7.06	-2.03	.047

Third, it was hypothesized that the overestimation of one's body size is larger when embodying an overweight avatar than when embodying a normal weight avatar (H_3). The analysis showed no significant effect between avatar body size and body size estimation, b = -1.79, t = -0.67, p = .506. This indicates that there was no significant difference in body size estimation between the embodiment of a normal weight avatar (M = -10.46, SD = 9.09) and the embodiment of an overweight avatar (M = -12.53, SD = 11.26). Therefore, H_3 cannot be supported.

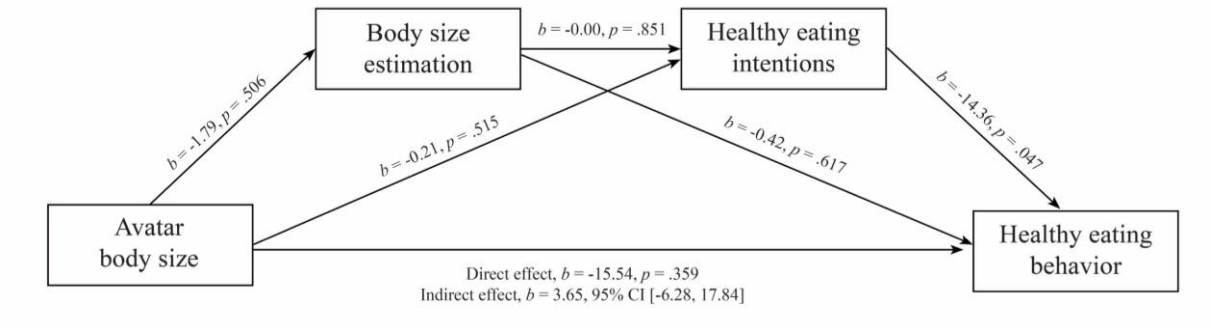
Fourth, it was hypothesized that an overestimation of one's body size would lead to higher intentions to eat healthily (H_4). The analysis showed no significant effect of body size estimation on healthy eating intentions, b = 0.00, t = -0.19, p = .851. This indicated that changes in body size estimation did not predict participants' healthy eating behavior. Therefore, H_4 cannot be supported.

The total sequential mediation effect showed no indirect effect of avatar body size on healthy eating behavior via body size estimation, b = 0.74, 95% CI [-2.84, 10.26]. In addition, there was no indirect effect of avatar body size on healthy eating behavior via healthy eating intentions, b = 2.98, 95% CI [-6.46, 14.43]. At last, there was no indirect effect of avatar body

size on healthy eating behavior via body size estimation and healthy eating intentions, *b* = -0.08, 95% CI [-2.08, 1.66]. These results indicate that either body size estimation and healthy eating intentions did not mediate the relationship between avatar body size and healthy eating behavior. The total sequential mediation model is presented in Figure 5.

Figure 5

Sequential mediation model



Moderated mediation analysis

Assumptions

An analysis of standard residuals was carried out, which showed that the data of the dependent variable 'healthy eating intentions' contained no outliers (Std. Residual Min = -2.48, Std. Residual Max = 1.79). Thereafter, tests to see if the data met the assumption of collinearity indicated that multicollinearity was not a concern (Avatar body size, Tolerance = 0.99, VIF = 1.01; VTS, Tolerance = -0.93, VIF = 1.08; Body size estimation, Tolerance = 0.92, VIF = 1.09). In addition, the data met the assumption of independent errors (Durbin-Watson value = 1.64). Overall, the histogram and the normal P-P plot of standardized residuals indicated that the data contained normally distributed errors. In addition, the scatter plot of standardized predicted values showed that the data met the assumptions of homogeneity of variance and linearity.

Hypothesis testing

In the analysis, avatar body size (overweight vs. normal weight) was included as

independent variable, VTS (synchronous vs. asynchronous) as moderator variable, body size estimation as mediator variable, and healthy eating intentions as dependent variable. It was hypothesized that participants will have higher healthy eating intentions immediately after the embodiment of an overweight avatar, especially when synchronous VTS was induced compared to asynchronous VTS (H_5). The analysis a significant main effect of VTS on healthy eating intentions, b = 2.79, t = 2.84, p = .006. However, there was no significant main effect of avatar body size on healthy eating intentions, b = 1.88, t = 1.93, p = .059. At last, the analysis showed a significant interaction effect between avatar body size and VTS on healthy eating intentions, b = -1.44, t = -2.34, p = .023. Table 2 shows an overview of the main effects and the interaction effect.

Table 2

Predictors of healthy eating intentions

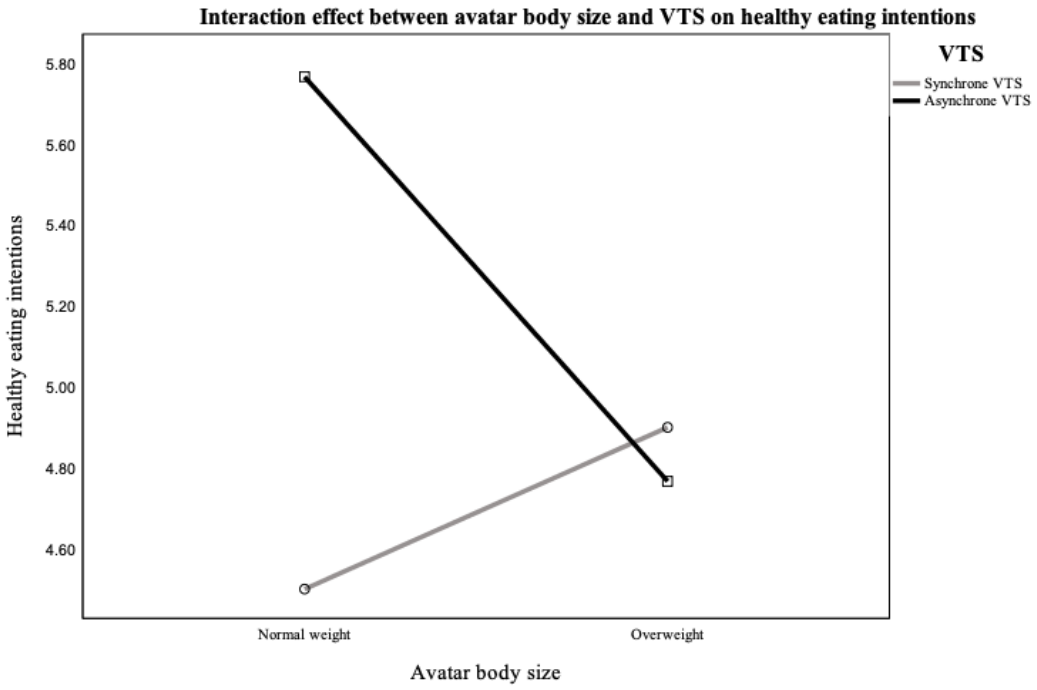
Variable	*b*	*se*	*t*	*p*
Constant	1.35 [-1.73, 4.43]	1.54	0.88	.383
Avatar body size	1.88 [0.07, 3.84]	0.98	1.93	.059
Body size estimation	0.01 [-0.02, 0.04]	0.02	0.77	.446
Visuotactile stimulation	2.79 [0.82, 4.76]	0.98	2.84	.006
Avatar body size x visuotactile stimulation	-1.44 [-2.67, -0.20]	0.62	-2.34	.023

A simple effect analysis revealed that participants' healthy eating intentions were similar in the synchronous VTS condition for participants embodying a normal weight avatar M = 4.50, SD = 1.22) and participants embodying an overweight avatar (M = 4.90, SD = 1.00), p = .359. In the asynchronous condition, participants' healthy eating intentions were

higher for participants embodying a normal weight avatar (M = 5.77, SD = 1.16) than participants embodying an overweight avatar (M = 4.77, SD = 1.32). This effect was significant, $F(1, 56) = 5.35$, $p = .024$. This interaction effect is illustrated in Figure 2. However, it was hypothesized that participants would have higher intentions for healthy eating behavior after the embodiment of an overweight avatar compared to participants embodying a normal weight avatar, especially when synchronous VTS was induced compared to asynchronous VTS. Since the analysis did not show a significant difference between synchronous VTS and asynchronous VTS in the overweight condition on healthy eating intentions, H_5 cannot be supported.

Figure 2

Interaction effect avatar body size and VTS on healthy eating intentions



At last, it was hypothesized that participants in the synchronous VTS condition would overestimate their body size after the embodiment with an overweight avatar more than participants in the asynchronous VTS condition (H_6). The analysis showed no significant interaction effect between avatar body size and VTS on body size estimation, b = 3.08, t =

0.60, p = .553. These results indicate that VTS did not moderate the effect of avatar body size on body size estimation. Therefore, H_6 cannot be supported. An overview of the results of the main effects and the interaction effect is presented in Table 3.

Table 3

Predictors of body size estimation

Variable	*b*	*se*	*t*	*p*
Constant	6.58 [-19.30, 32.46]	12.92	0.51	.612
Avatar body size	-6.70 [-23.06, 9.67]	8.17	-0.82	.416
Visuotactile stimulation	-9.98 [-26.38, 6.39]	8.17	-1.22	.227
Avatar body size x visuotactile stimulation	3.08 [-7.27, 13.43]	5.17	0.60	.553

Looking at the total moderated mediation effect, the index of moderated mediation test showed no moderated mediation effect, since the confidence interval crosses zero, 95% CI [-0.19, 0.31]. This indicated that the effect of avatar body size on healthy eating intentions via body size estimation did not depend on VTS.

Discussion

This study aimed to investigate whether embodying an overweight avatar could influence participants' healthy eating intentions and healthy eating behavior and to what extent this effect was mediated by body size estimation. Furthermore, this study aimed to investigate whether synchronous VTS could strengthen the effect of embodying an overweight avatar on body size estimation and on healthy eating intentions. The study tested in total six hypotheses, which will be discussed in this section.

The first aim of the study was to examine whether the embodiment of an overweight

avatar would stimulate people's intentions to eat healthily. Improving people's intention to eat healthily is important since overweight and obesity are considered a growing global crisis (Mata & Hertwig, 2018). Theories about risk perception described the importance of reducing the temporal and social distance between current unhealthy behavior and potential future physical consequences to improve people's health behavior (Rutchick et al., 2018; Trope & Liberman, 2010; Wienrich et al., 2020). Moreover, previous studies have shown how avatars representing one's own in virtual environments can contribute to this by confronting people with how their bodies will look like in the future when continuing with unhealthy behavior (Ahn, 2015; Şenel & Slater, 2020). The present study expected that avatar embodiment could maximize this impact since people can feel VBO over their overweight avatar. This illusion can give a realistic experience of having an overweight body and contribute to people's risk perception about unhealthy eating behavior. It was hypothesized that participants' healthy eating intentions are stronger when embodying an overweight avatar than when embodying a normal weight avatar (H_1). However, H_1 was not supported by the results. Thus, the embodiment of an overweight avatar had no significant effect on participants' intention to eat healthily. Embodying an overweight avatar alone might not be effective in stimulating participants' intentions to eat healthily. Participants may not have realized that the overweight body was a result of unhealthy eating behavior. Wang and Coups (2010) examined beliefs about obesity and found that most respondents believed that obesity is associated with bad eating habits and insufficient physical activity. Future research could extend the present study by examining whether embodying an overweight avatar influences other factors contributing to obesity (e.g., physical activity).

The second aim of the present study was to examine whether participants' intentions to eat more healthily predicted their healthy eating behavior during a taste test. Theories about intention and behavior described the importance of people's intention to perform a certain

behavior (Ajzen, 1991; Fishbein, & Ajzen, 1975; Webb & Sheeran, 2006). It was hypothesized that participants' healthy eating intentions would predict their kcal intake during the taste test (H_2). Although the present study did not find differences in healthy eating intentions between the two avatar body size conditions (normal weight vs. overweight), a relationship between participants' healthy eating intentions and healthy eating behavior was observed. Therefore, H_2 was supported by the results, indicating that participants' healthy eating intentions predicted their healthy eating behavior. More specifically, participants having stronger intentions to eat healthily were more likely to reduce their kcal intake during the taste test. This result extends the results by Conner et al. (2002) and Psouni et al. (2016), who found in a survey study that people's healthy eating intentions were a strong predictor of healthy eating behavior. The present study contributed to the existing knowledge about the relationship between healthy eating intentions and actual healthy eating behavior by examining participants' healthy eating behavior objectively with a taste test.

The third aim of the present study was to investigate participants' accuracy to estimate their own body size after embodying an overweight avatar, and whether this body size estimation mediates the effect of embodying an overweight avatar and healthy eating intentions. According to the literature, inaccurate body size estimation influences people's attitude towards their own body and is therefore associated with weight loss or weight gain behaviors (Bodde et al., 2014; Carey and Preston, 2019; Farrell et al., 2005; Kim & Lee, 2010; Lowry et al., 2002; Robinson, 2017;). Even though people with a healthy weight are good at estimating their own body size (Longo, 2015), previous research has shown that people with a healthy weight overestimated their own belly size after embodying an avatar with a larger belly size (Normand et al., 2011). It was predicted that the overestimation of one's own body was larger when embodying an overweight avatar than when embodying a normal weight avatar (H_3). In addition, it was predicted that participants' overestimation

would lead to more intentions to eat healthily (H_4). The results showed that participants embodying an overweight avatar did not estimate their body size differently than participants embodying a normal weight avatar. Furthermore, there were no differences in healthy eating intentions as a result of overestimation. Thus, the effect of avatar body size on healthy eating intentions was not mediated by body size estimation.

The results indicating that participants did not estimate their body size differently after embodying an overweight avatar than when embodying a normal weight avatar, were in line with Preston and Ehrsson (2014) and Piryankova et al. (2014). Both studies did not found changes in participants' body size estimation after embodying an overweight avatar. Perhaps, people with a healthy weight are good at estimating their own body size, even after embodying an overweight avatar. Longo (2015) suggested that healthy populations generally have a good representation of their own body. In a study by Keizer et al. (2016), participants with a healthy weight were better at estimating their body size after embodying an avatar with a healthy weight than participants diagnosed with anorexia nervosa. This suggests that it is difficult to let people with a healthy weight estimate their own body size differently after embodying an avatar with a dissimilar body size.

Furthermore, possibly there were no differences in participants' healthy eating intentions because participants did not significantly estimate their own body size differently after embodying an overweight avatar or normal weight avatar. Therefore, the present study cannot conclude whether overestimation or underestimation changed participants' intentions to eat healthily. A survey study by Bodde et al. (2014) examined health behaviors among overweight participants who underestimate their own body size. Their results indicated that the more overweight the participant, the less likely they were to accurately perceive their body size, the less likely they were to try to lose weight. Therefore, future research could expand this knowledge by replicating the present study and including participants with

overweight to examine the mediating role of body size estimation between avatar body size and healthy eating intentions.

At last, the fourth aim of the study was to examine whether synchronous VTS could strengthen the effect of embodying an overweight avatar on body size estimation and on healthy eating intentions. Previous literature has shown the importance of VBO for behavioral change (Banakou et al., 2020) and how synchronous VTS can increase that illusion (González-Franco et al., 2010; Keizer et al., 2016; Normand et al., 2011; Perez-Marcos et al., 2017). Therefore, the present study hypothesized that participants would have higher intentions to eat healthily after the embodiment of an overweight avatar, especially when synchronous VTS was induced compared to asynchronous VTS (H_5). The results did not support this hypothesis. However, participants embodying a normal weight avatar showed higher intentions to eat healthily than participants embodying an overweight avatar, but only when asynchronous VTS was induced. This difference in healthy eating intentions between the two avatar body size conditions (normal weight vs. overweight) was not found in the synchronous VTS condition. Like previous studies (e.g., Keizer et al., 2016), asynchronous VTS was induced as a control condition, because it has been shown that asynchronous VTS break the VBO illusion. Earlier, Perez-Marcos et al. (2017) have shown that asynchronous VTS can influence participants' body image, while synchronous VTS increased VBO illusions. The researchers argued that asynchronous VTS may cause changes in participants' body representation, because one's body representation is updated by sensory input constantly. The present study agrees with Perez-Marcos et al. (2017) who suggested that asynchronous VTS is not a neutral condition. Future research could explore potential effects of asynchronous VTS on how people perceive their virtual body, instead of inducing asynchronous VTS as a control condition.

In addition, Normand et al. (2011) found that participants overestimated their own belly size after embodying an avatar with a larger belly size as a result of synchronous VTS. Therefore, this study hypothesized that participants would overestimate their body size after the embodiment of an overweight avatar, especially when synchronous VTS was induced compared to asynchronous VTS (H_6). As mentioned before, the results of the present study showed that participants did not estimate their body size differently after embodying an overweight avatar. Moreover, participants also did not estimate their body size differently even though synchronous VTS was induced compared to asynchronous VTS. Thus, the effect of avatar body size on body size estimation was not moderated by VTS. This result was in line with Preston, and Ehrsson (2014) and Piryankova et al. (2014), who also did not find differences in body size estimation after the embodiment of an overweight avatar, even though VTS was induced (synchronous vs. asynchronous). However, this result was not in line with Normand et al. (2011), who argued that synchronous VTS was fundamental for changes in body size estimation after the virtual embodiment of an avatar with a dissimilar body size. In the present study, VTS was only induced on participants' both arms (synchronous vs. asynchronous). However, the heaviness of the size of the abdomen and legs were most characteristic for the overweight avatar. Perhaps the procedure carried out by Normand et al. (2011) and Keizer et al. (2016) can lead to higher illusions of owning an overweight body. In the study by Normand et al. (2011), participants touched their own belly and saw the same touch on their virtual body simultaneously (synchronous) or delayed (asynchronous) on their virtual body seen from a first-person perspective. In the study by Keizer et al. (2016), the experimenter induced VTS to the participants' abdomen. Again, the participants saw the same touch on their virtual body simultaneously (synchronous) or delayed (asynchronous). Therefore, future research could consider inducing VTS

(synchronous vs. asynchronous) on body parts to which it is clearly observable that the body size had been adjusted.

Limitations

There are several limitations to the present study. First, the sample size (N = 60) was limited. Due to COVID-19, it was difficult to recruit participants. Furthermore, while the embodiment of the avatars was perceived as sufficient, the present study did not match each avatar identically to each participant. Participants may not have realized that the avatar was a representation of themselves. Yoo et al. (2015) suggested that the similarity between a participant and its avatar is really important to influence people's perceptions and behavior. Future research could use of a 3D scanning technique to increase the similarity between the avatar and the participant.

Moreover, it may be that there were no differences between the avatar body size conditions (overweight vs. normal weight) because participants' intentions to eat healthily were already strong, even when embodying a normal weight avatar. According to research conducted by Zilveren Kruis (Dutch health insurance) in October 2020, young adults in the Netherlands (18 till 24 years old) paid more attention to physical exercise and a better diet as due to the COVID-19 pandemic. The majority of the sample were students with an average age of 23.77 years (SD = 7.43). Therefore, it could be that participants were already trying to eat healthier. In addition, research has shown that, in general, people with a healthy weight have more intentions to eat healthily than people with overweight (Psouni et al., 2016). Therefore, future research could include participants with overweight to examine whether intentions to eat healthily are influenced after embodying an avatar with a dissimilar body size.

At last, the present study used participants' BMI as a measurement to indicate the percentual difference between a participant's actual body size heaviness and the participants'

self-perceived body size heaviness. BMI indicates whether someone has a healthy weight (BMI between 18.5 and 25), but it ignores someone's muscle mass, fat percentage, or waist circumference. Therefore, it is difficult to say anything about someone's body shape only with BMI as a measurement. Perhaps comparing a participant's self-perceived body size heaviness with their BMI status was not sufficient to determine differences in someone's accuracy to estimate their body size. Verhulst et al. (2018) mentioned that the Body Adiposity Index (BAI) could be a better alternative. The BAI uses the size of someone's hips compared to the person's height.

Conclusion

The purpose of this study was to gain a better understanding of the effect of embodying an overweight avatar and body size estimation on healthy eating intentions and behavior and whether synchronous VTS can strengthen this effect. Looking at the results, the present study indicates that the embodiment of an overweight avatar alone might not be enough to increase healthy eating intentions. Body size estimation as underlying mechanisms also did not influence this possible relationship. This suggests that people with a healthy weight can estimate their own body size accurately, even when embodying an overweight avatar. However, asynchronous VTS had more effect on intentions to eat healthily after embodying a normal weight avatar than after embodying an overweight avatar. This effect was not observed when synchronous VTS was induced. This indicated that asynchronous VTS is not a neutral condition. This result has raised new questions of the potential effects of asynchronous VTS on how people perceive their virtual body instead of using asynchronous VTS as a control condition. Although the present study cannot show significant improvements in participants' healthy eating behavior after the embodiment of an overweight avatar, the present study can be seen as a step towards using of avatar body size dissimilar to one's to stimulate people's health behavior. The present study contributes to the emerging

body of work in the field of VBO illusions over an avatar body dissimilar to one's own to improve health behavior by providing insights on how embodying overweight avatars might affect people's intentions to eat more healthily. Hopefully, the present study stimulates further investigation of the use of overweight avatars to stimulate healthy eating behavior.

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Appendix A

This appendix presents the inclusion questionnaire that was sent to participants in advance to determine whether participants met the criteria. The inclusion questionnaire was presented in Dutch.

Beste deelnemer,

Leuk dat je geïnteresseerd bent in deelname aan dit labonderzoek aan Tilburg University. We combineren hier de datacollectie van drie onderzoeken: 'Lichaamsverhoudingen en motoriek in Virtual Reality', 'Persoonlijkheidskenmerken en tevredenheid met jezelf' en 'smaakpercepties en evaluaties van A- en huismerken voedingsproducten'. Als je je aanmeldt, geef je je op voor alle drie de onderzoeken.

We zullen je nu een aantal vragen stellen om te kijken of je geschikt bent voor deelname. Het zou dus kunnen dat je na het invullen van deze korte vragenlijst toch niet mee kunt doen. Het is belangrijk om te weten dat wij deze gegevens niet gebruiken voor de data-analyse. Het beantwoorden van deze vragen zal ongeveer 2 minuten duren.

De totale duur van het onderzoek in het lab is ongeveer 3 kwartier tot 1 uur, waarvan:

- 15-20 minuten voor de studie 'Lichaamsverhoudingen en motoriek in Virtual Reality'
- 15-20 minuten voor de studie 'Persoonlijkheidskenmerken en tevredenheid met jezelf'
- 15-20 minuten voor de studie 'smaakpercepties en evaluaties van A- en huismerken voedingsproducten'

Als je geschikt blijkt voor het onderzoek, ontvang je een e-mail met de verdere procedure. We hopen op je deelname, succes met het invullen!

Nummer	Item naam	Vraag	Antwoordtype
1	Cover1	Game je wel eens in een virtuele 3D-omgeving? Zo ja, geef aan hoeveel uur per week je dit doet.	Meerkeuze (open invoerveld): · Ja, ___uur per week · Nee
2	Incl_length	Wat is je lengte in centimeters?	Open invoerveld
3	Incl_weight	Wat is je gewicht in kilo's?	Open invoerveld
4	Cover1	Bespeel je een instrument? Zo ja, geef aan hoeveel uur per week je dit doet.	Meerkeuze (open invoerveld): · Ja, ___uur per week · Nee
5	Cover2	Beoefen je een balsport? Zo ja, geef aan hoeveel uur per week je dit doet.	Meerkeuze (open invoerveld): · Ja, ___uur per week · Nee

6	Incl_ED	Heb je op dit moment een eetstoornis, of heb je een eetstoornis gehad in de afgelopen vijf jaar?	Meerkeuze: · Ja · Nee
7	Email	Wat is je e-mailadres? Wij zullen je per e-mail een bericht sturen om aan te geven of je mee kunt doen aan de studie. Let op: deze zou kunnen belanden in jouw ongewenste e-mail.	Open invoerveld

Appendix B

This appendix presents the information letter, which was presented in Dutch.

Informatiebrief

Deze brief is van alle informatie voorzien die nodig is voordat je kunt starten met je onderzoek deelname, lees deze dus goed door. In dit onderzoek combineren we de datacollectie van drie verschillende studies. Je zult dus aan drie verschillende onderzoeken deelnemen. Bij vragen kun je altijd terecht bij de proefleider of één van de hoofdonderzoekers. De onderzoeksresultaten zullen gebruikt worden voor diverse wetenschappelijke artikelen en master scripties. De vergoeding voor deelname van 10 euro of 1 proefpersoon punt krijg je na het voltooien van de drie onderzoeken. De totale duur van de onderzoeken zijn is 3 kwartier tot 1 uur. De Ethische Commissie van de TSHD heeft toestemming gegeven voor het uitvoeren van de drie onderzoeken.

Deelname

De deelname aan dit onderzoek is geheel vrijwillig. Je kan jouw deelname te allen tijde terugtrekken, om welke reden dan ook en zonder dat dit nadelige gevolgen heeft. Na je deelname heb je ook altijd de mogelijkheid om de gegevens te laten verwijderen: hiervoor heb je wel jouw participant nummer nodig.

De totale duur van dit onderzoek is drie kwartier tot één uur, en je ontvangt 1 proefpersoon punt of 10 euro als compensatie voor jouw deelname.

Vertrouwelijkheid

Alle gegevens die wij verzamelen zal vertrouwelijk worden behandeld, en gaat conform de AVG (Algemene Verordening Gegevensbescherming). Wij vragen naar een aantal directe persoonsgegevens (namelijk e-mailadres en bankrekeningnummer). Deze gegevens zullen worden verwijderd na het afronden van de dataverzameling. De indirecte persoonsgegevens zullen wij bewaren, omdat wij deze nodig hebben om de steekproef te kunnen beschrijven. Hieronder vallen de vragen over opleidingsniveau, geslacht, lengte, gewicht, leeftijd.

Dataopslag

De gegevens zullen tien jaar bewaard blijven op de servers van Tilburg University. Hier vallen de directe persoonsgegevens niet onder, en de indirecte persoonsgegevens wel (zoals hierboven beschreven). De gegevens kunnen, op verzoek, gedeeld worden met andere onderzoekers.

Informatie over de studie

Onderzoek 1: Lichaamsverhoudingen en motoriek in Virtual Reality

Het doel van de eerste studie is om te onderzoeken in hoeverre verschillende soorten lichaam formaten en -verhoudingen in Virtual Reality invloed hebben op je motoriek. Daarbij zul je een lichaam ervaren dat afwijkt van jouw eigen lichaam, bijvoorbeeld groter of kleiner, met bredere of smallere lichaamsomvang, of met ledematen langer of korter ten opzichte van jouw eigen lichaam. In dit lichaam zul je beweging taken uitvoeren. De proefleider doet eenvoudige bewegingen eerst voor, waarna je dezelfde bewegingen zult uitvoeren terwijl je je in de virtuele omgeving begeeft. De totale duur van dit onderzoek is ongeveer 15-20 minuten.

Onderzoek 2: Persoonlijkheidskenmerken en tevredenheid met jezelf

In deze vragenlijststudie kijken wij naar in hoeverre persoonlijkheidskenmerken samenhangen met tevredenheid over jezelf, en in hoeverre persoonlijkheidskenmerken van invloed zijn op jouw intenties om gezond te leven. Het is belangrijk dat je de vragen zorgvuldig leest en eerlijk antwoord geeft. Het beantwoorden van de vragen duurt ongeveer 15-20 minuten.

Onderzoek 3: Smaakpercepties en evaluaties van A- en huismerken voedselproducten

Het doel van deze studie is om te achterhalen in hoeverre smaakperceptie van invloed is op evaluatie van voedselproducten van A-merken en huismerken. Je zult in de proeftaak vier soorten voedselproducten beoordelen op de smaak. Daarnaast zijn we geïnteresseerd in jouw inschatting van of dit een A-merk of een huismerk product is. De taak duurt in totaal ongeveer 15-20 minuten.

Na afronding van alle onderzoeken ontvang je 10 euro of 1 proefpersoon punt. Let op: om de kwaliteit van de onderzoeksgegevens te waarborgen, vindt er misleiding plaats gedurende de onderzoeken. Je zult van deze procedure en de onderzoeksdoeleinden op de hoogte worden gebracht per e-mail, nadat alle datagegevens zijn verzameld. Deze e-mail kun je in de zomer van 2021 verwachten.

Als je deelname accepteert geef je aan:

- Dat je 18 jaar of ouder bent;
- Dat je ermee instemt dat verzamelde persoonsgegevens tien jaar opgeslagen zullen worden;
- Dat je ermee instemt dat verzamelde persoonsgegevens gebruikt kunnen worden voor verder onderzoek of wetenschappelijke publicaties;
- Dat je ermee instemt dat verzamelde persoonsgegevens gedeeld kunnen worden met andere onderzoekers;
- Dat je weet dat je te allen tijde, zonder consequenties en zonder het opgeven van een reden terug mag trekken.

Als je contact wilt opnemen naar aanleiding van een van deze onderzoeken, kun je de onderzoekers bereiken via n.e.vdwaal@uvt.nl (Nadine van der Waal; studie 1 en studie 2) of l.n.vdlaan@uvt.nl (Nynke van der Laan; studie 3). Voor eventuele opmerkingen of klachten over (een van) de studies kun je ook contact opnemen met de “Research Ethics and Data Management Committee” van Tilburg School of Humanities and Digital Sciences via tshd.redc@tilburguniversity.edu.

Alvast bedankt voor je tijd en deelname!

Met vriendelijke groet,

Het onderzoeksteam

Appendix C

This appendix presents the survey questions. This survey included questions from other studies as well, which were not relevant for this study. For this study, questions numbered 1 till 4, 48 till 55, 64, 91 till 95, and 102 till 105 were included in this study and marked in bold letters. All questions were presented in Dutch.

"Study 1"

< Informed consent tekenen (op laptop), mondelinge instructie VR. Proefleider doet de bewegingen voor die de participant in de VR omgeving moet maken. Daarna begint te VTS procedure. >

Nummer	Item naam	Vraag	Antwoordtype
1	**PPno**	**(In te vullen door proefleider)** **Wat is het participant nummer?**	**Open invoerveld (numeric values only)**
2	**Geslacht**	**(In te vullen door proefleider)** **Welk geslacht gebruikt in VE?**	**Meerkeuze:** · **Man** · **Vrouw**
3	**Condition_ VTS**	**(In te vullen door proefleider)** **Welke VTS conditie?**	**Meerkeuze:** · **Wel VTS** · **Geen VTS**
4	**Condition_ ABS**	**(In te vullen door proefleider)** **Welke ABS conditie?**	**Meerkeuze:** · **Normal** · **Overweight**

Virtual Embodiment Questionnaire - VEQ

Lees alsjeblieft elk van de volgende stellingen, en geef op een schaal van 1 t/m 7 aan in hoeverre iedere stelling op jou van toepassing was tijdens de VR beleving. Er zijn geen foute antwoorden mogelijk. Reageer alsjeblieft spontaan en intuïtief.

Nummer	Item naam	Vraag	Antwoordtype
5	OW1_VE	Het voelde alsof het virtuele lichaam mijn eigen lichaam was.	7-point Likert Scale (1 = helemaal mee oneens 7 = helemaal mee eens)
6	OW2_VE	Het voelde alsof de virtuele lichaamsdelen mijn eigen lichaamsdelen waren.	
7	OW3_VE	Het virtuele lichaam voelde als een menselijk lichaam.	
8	OW4_VE	Het voelde alsof het virtuele lichaam aan mij toebehoorde.	

9	AG1_VE	De bewegingen van het virtuele lichaam voelden aan als mijn eigen bewegingen.	
10	AG2_VE	Ik voelde me in controle over de bewegingen van het virtuele lichaam.	
11	AG3_VE	Het voelde alsof ik de bewegingen van het virtuele lichaam veroorzaakte.	
12	AG4_VE	De bewegingen van het virtuele lichaam waren synchroon met mijn eigen bewegingen.	
13	CH1_VE	Het voelde alsof de vorm of het uiterlijk van mijn eigen lichaam was veranderd.	
14	CH2_VE	Het voelde alsof het gewicht van mijn eigen lichaam was veranderd.	
15	CH3_VE	Het voelde alsof de lengte van mijn eigen lichaam was veranderd.	
16	CH4_VE	Het voelde alsof de omvang van mijn eigen lichaam was veranderd.	
17	VEopen	Kun je in je eigen woorden omschrijven wat je van de virtuele beleving vond?	Open vraag

Controle variabele Presence

Lees alsjeblieft elk van de volgende stellingen, en geef op een schaal van 1 t/m 7 aan in hoeverre elke stelling op jou van toepassing was tijdens de VR beleving. Er zijn geen foute antwoorden mogelijk. Reageer alsjeblieft spontaan en intuïtief.

Nummer	IPQ item naam	Vraag	Antwoordtype
18	G1	Ik had het gevoel aanwezig te zijn in de computerwereld	7-point Likert Scale: Helemaal niet--Heel erg
19	SP1_P	Ik had het gevoel omgeven te zijn door de virtuele wereld	7-point Likert Scale: Helemaal mee oneens -- Helemaal mee eens
20	SP2_P	Ik had het gevoel slechts plaatjes te aanschouwen	7-point Likert Scale: Helemaal mee oneens--Helemaal mee eens
21	SP3_P	Ik had niet het gevoel in de virtuele ruimte aanwezig te zijn	7-point Likert Scale: Helemaal mee oneens-- Helemaal mee eens
22	SP4_P	Ik had meer het gevoel bezig te zijn in de virtuele ruimte, dan dat ik het gevoel had iets van buitenaf te bedienen	7-point Likert Scale: Helemaal mee oneens--Helemaal mee eens
23	SP5_P	Ik voelde me aanwezig in de virtuele ruimte	7-point Likert Scale: Helemaal mee oneens--Helemaal mee eens

24	INV1_P	Hoe bewust was je je van de echte omgeving (bv. geluiden van buiten, kamertemperatuur), terwijl je je bevond in de virtuele ruimte?	7-point Likert Scale: Zeer bewust--Helemaal niet bewust
25	INV2_P	Ik was me niet bewust van mijn echte omgeving	7-point Likert Scale: Helemaal mee oneens--Helemaal mee eens
26	INV3_P	Ik lette nog op de echte omgeving	7-point Likert Scale: Helemaal mee oneens--Helemaal mee eens
27	INV4_P	Ik ging volledig op in de virtuele wereld	7-point Likert Scale: Helemaal mee oneens--Helemaal mee eens
28	REAL1_P	Hoe echt kwam de virtuele omgeving op u over	7-point Likert Scale: Heel echt--Helemaal niet echt
29	REAL2_P	In hoeverre kwam jouw ervaring in de virtuele omgeving overeen met je ervaringen in de echte wereld?	7-point Likert Scale: Geen overeenstemming--Volledige overeenstemming
30	REAL3_P	Hoe werkelijk kwam de virtuele wereld op je over?	7-point Likert Scale: Zoals een denkbeeldige wereld--Niet te onderscheiden v. d. echte wereld
31	REAL4_P	De virtuele wereld kwam echter op mij over dan de werkelijke wereld	7-point Likert Scale: Helemaal mee oneens--Helemaal mee eens

Positive/Negative affect scale

Denk terug aan hoe je je voelde in het virtuele tijdens de virtuele ervaring. Geef aan in welke mate je de volgende emoties ervaarde tegenover of in het lichaam.

Nummer	Item naam	Vraag	Antwoordtype
32	NA_1	Beschaamd	7-point Likert Scale (1 = Helemaal niet 7 = Extreem)
33	NA_2	Schuldig	
34	NA_3	Angstig	
35	NA_4	Walging	
36	NA_5	Onbehagelijk	
37	NA_6	Gespannen	
38	NA_7	Gefrustreerd	
39	NA_8	Verontrust	
40	NA_9	Teleurgesteld	

41	NA_10	Geschrokken	
42	PA_1	Trots	
43	PA_2	Tevreden	
44	PA_3	Actief	
45	PA_4	Alert	
46	PA_5	Zelfverzekerd	
47	PA_6	Ontspannen	

Geloofwaardigheid coverstory

Lees elk van de volgende stellingen, en geef op een schaal van 1 t/m 7 aan in hoeverre iedere stelling op jou van toepassing is.

Hoe moeilijk of makkelijk is het voor jou om:

Nummer	Item naam	Vraag	Antwoordtype
48	**Cover4**	**Een bal te vangen?**	**7-point Likert Scale (1 = helemaal niet moeilijk 7 = heel erg moeilijk)**
49	**Cover5**	**Een bal te raken met een (tennis)racket?**	
50	**Cover6**	**In balans te blijven terwijl je op één been staat?**	
51	**Cover7**	**Papier op een dunne lijn te knippen?**	

Bedankt voor het meedoen aan de Virtual Reality ervaring! Je kunt nu de proefleider halen, zij zal je begeleiden naar het volgende onderzoek.

“Study 2”

Dan gaan we nu verder met het tweede onderzoek. In deze studie willen we onderzoeken wat het effect is van persoonlijkheidskenmerken op hoe je over jezelf denkt en in hoeverre dit jouw intenties om gezond te leven beïnvloedt. Lees de stellingen zorgvuldig en geef eerlijk antwoord op de vragen.

Afhankelijke variabele Intentions

Lees elk van de volgende stellingen, en geef antwoord op een schaal van 1 (zeker niet) t/m 7 (zeker wel).

Nummer	Item naam	Vraag	Antwoordtype:
52	**Int_diet1.1**	**Ik ben van plan om de komende twee weken gezond te eten.**	**7-point Likert Scale: (1 = zeker niet van plan**
53	**Int_diet1.2**	**Ik verwacht dat ik de komende twee weken gezond en gevarieerd ga eten**	**7 = zeker wel van plan)**
54	Int_diet2.1	Ik ben van plan om de komende twee weken minder calorierijke voedingsmiddelen te eten	
55	Int_diet2.2	Ik verwacht dat ik de komende twee weken minder calorierijke voedingsmiddelen ga eten	

Lees elk van de volgende stellingen, en geef antwoord op een schaal van 1 (zeker niet) t/m 7 (zeker wel).

Nummer	Item naam	Vraag	Antwoordtype:
56	Int_sport1	Ik ben van plan de komende twee weken vaker intensief te bewegen.	7-point Likert Scale: (1 = zeker niet van plan 7 = zeker wel van plan)
57	Int_sport2	Ik verwacht dat ik de komende twee weken vaker intensief ga bewegen.	

Mediatievariabelen perceived susceptibility / perceived severity

Lees elk van de volgende stellingen, en geef op een schaal van 1 tot 7 aan in hoeverre je het eens of oneens bent met de onderstaande stellingen.

Nummer	Item naam	Vraag	Antwoordtype
58	PSus_1	Ik loop risico op overgewicht.	7-point Likert Scale: (1 = helemaal mee oneens 7 = helemaal mee eens)
59	PSus_2	Het is mogelijk dat ik overgewicht krijg.	
60	PSus_3	Ik ben vatbaar voor overgewicht.	

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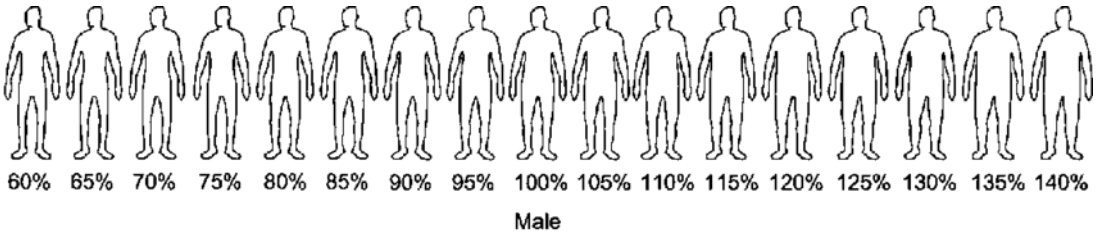
Nummer	Item naam	Vraag	Antwoordtype
61	PSev_1	Overgewicht is een serieuze bedreiging.	7-point Likert Scale:

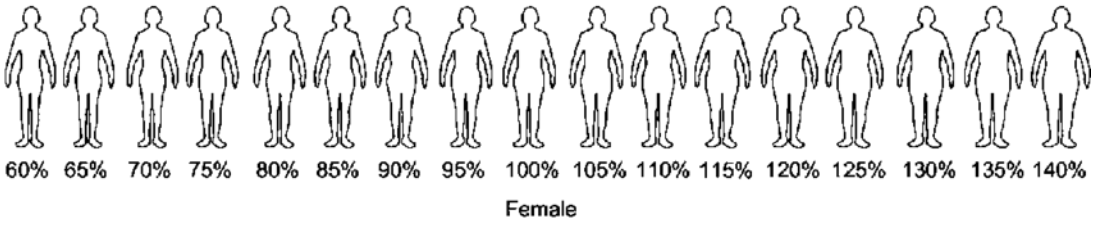
62	PSev_2	Overgewicht is schadelijk.	(1 = helemaal mee oneens 7 = helemaal mee eens)
63	PSev_3	Overgewicht is een ernstige bedreiging.	

Mediatievariabele Body Size Perception

Op de volgende pagina zie je een aantal silhouetten met daaronder balkjes en een schuiver. Door de schuiver van links naar rechts te verplaatsen, kun je de vragen beantwoorden.

Nummer	Item naam	Vraag	Antwoordtype
64	**BSP_ideal**	**Welk silhouet komt het meest overeen met het silhouet van jouw eigen lichaam?**	**Slider van 60 tot 140 (afbeeldingen staan erboven, participanten zien geen cijfers)**
65	BSP_now	Welk silhouet komt het meest overeen met jouw ideale lichaamsbeeld?	Slider van 60 tot 140 (afbeeldingen staan erboven, participanten zien geen cijfers)
66	BSP_ought	Wel silhouet komt het meest overeen met het lichaam dat je vindt dat je zou moeten hebben?	Slider van 60 tot 140 (afbeeldingen staan erboven, participanten zien geen cijfers)





Mediatievariabele Body Satisfaction

Lees elk van de volgende stellingen, en geef op een schaal van 1 t/m 7 aan in hoeverre de stelling op jou van toepassing is.

Nummer	Item naam	Vraag	Antwoordtype
67	BS1	Op dit moment ben ik____ met mijn uiterlijk	7-point Likert Scale: Heel erg ontevreden t/m heel erg tevreden
68	BS2	Op dit moment ben ik ___ met mijn lichaamsomvang en mijn lichaamsvorm	7-point Likert Scale: Heel erg tevreden t/m heel erg ontevreden

69	BS3	Op dit moment ben ik ___ met mijn gewicht	7-point Likert Scale: Heel erg tevreden t/m heel erg ontevreden
70	BS4	Op dit moment voel ik me ___	7-point Likert Scale: Heel erg aantrekkelijk t/m heel erg onaantrekkelijk
71	BS5	Op dit moment voel ik me ___	7-point Likert Scale: Veel slechter over mijn uiterlijk dan gewoonlijk t/m veel beter over mijn uiterlijk dan gewoonlijk
72	BS6	Op dit moment heb ik het gevoel dat ik er ___	7-point Likert Scale: Veel beter uitziet dan de gemiddelde persoon t/m veel slechter uitziet dan de gemiddelde persoon

Mediatievariabele Body Appreciation

Nummer	Item naam	Vraag	Antwoordtype
73	BAS1	Ik respecteer mijn lichaam	5-point Likert scale (1 = nooit, 5 = altijd)
74	BAS2	Ik voel mij goed over mijn lichaam.	
75	BAS3	Ik vind dat mijn lichaam op zijn minst wat goede kwaliteiten bezit	
76	BAS4	Ik heb een positieve houding richting mijn lichaam	
77	BAS5	Ik let op wat mijn lichaam nodig heeft	
78	BAS6	Ik voel liefde richting mijn lichaam	
	BAS7	Ik waardeer de unieke en verschillende kenmerken die mijn lichaam bezit	
79	BAS8	Mijn gedrag straalt de positieve houding uit die ik heb richting mijn lichaam; bijvoorbeeld, ik loop met mijn rug recht en glimlach	
80	BAS9	Ik voel mij goed in mijn eigen vel	
81	BAS10	Ik vind mezelf mooi ondanks dat ik er anders uit zie als de foto’s die gepresenteerd worden in de media / op sociale media (bijvoorbeeld van modellen en acteurs/actrices).	

Body Shape Importance

Geef voor iedere vraag aan welk antwoord het beste op jou van toepassing is. Er zijn geen goede of foute antwoorden, dus probeer zo eerlijk mogelijk te zijn in je antwoorden.

Nummer	Item naam	Vraag	Antwoordtype
82	DFT-1	Ik eet zoetigheden en koolhydraten zonder mij zenuwachtig te voelen.	6-point Likert Scale: 1 = nooit 2 = zelden 3 = soms 4 = vaak 5 = meestal 6 = altijd
83	DFT-2	Ik denk erover om te gaan lijnen.	
84	DFT-3	Ik voel me ontzettend schuldig als ik teveel gegeten hebben.	
85	DFT-4	Ik ben erg bang om in gewicht aan te komen.	
86	DFT-5	Ik hecht zeer veel belang aan mijn gewicht.	
87	DFT-6	De wens dunner te worden houdt mij erg bezig.	
88	DFT-7	Als ik een halve kilo aankom maak ik me zorgen dat ik zal blijven aankomen.	

Beliefs About Obese Persons

Geef aan in hoeverre je het eens of oneens bent met de onderstaande stellingen. Gebruik de cijfers op de onderstaande schaal (-6 t/m +6) om je antwoorden te geven. Hierbij staat -3 voor helemaal mee oneens en +3 voor helemaal mee eens.

Nummer	Item naam	Vraag	Antwoordtype
89	BAOP2	Overgewicht ontstaat meestal door te veel eten	6-point Likert Scale: (1 = helemaal mee oneens 6 = helemaal mee eens)
90	BAOP4	De meeste mensen krijgen overgewicht door onvoldoende beweging	

Manipulation checks

Denk nog even terug aan de virtuele ervaring van eerder. Beantwoord vervolgens de onderstaande vragen:

Manipulatiecheck: Body Size Similarity – BSS. In hoeverre ben je het eens of oneens met onderstaande stellingen?

Nummer	Item naam	Vraag	Antwoordtype
91	**MBSS1**	**Het voelde alsof ik in de virtuele omgeving een andere lichaamsomvang had dan mijn eigen lichaamsomvang.**	**7-point Likert Scale (1 = helemaal mee oneens 7 = helemaal mee eens)**

92	**MBSS2**	**Het voelde alsof mijn virtuele representatie dezelfde lichaamsomvang had als mijn eigen lichaamsomvang.**	
93	**MBSS3**	**De avatar in de virtuele omgeving had overgewicht.**	

Manipulatiecheck: Visuotactile Stimulation – VTS. *In hoeverre ben je het eens of oneens met onderstaande stellingen?*

Nummer	Item naam	Vraag	Antwoordmogelijkheden 7-punts-schaal
94	**MVTS1**	**Het leek alsof de aanraking die ik voelde op mijn rechterarm werd veroorzaakt door het voorwerp dat ik zag bewegen op mijn virtuele rechterarm.**	**7-point Likert Scale (1 = helemaal mee oneens 7 = helemaal mee eens)**
95	**MVTS2**	**Het leek alsof de aanraking die ik voelde op mijn linkerarm werd veroorzaakt door het voorwerp dat ik zag bewegen op mijn virtuele linkerarm.**	

Simulation sickness

In hoeverre ben je het eens of oneens met onderstaande stellingen?

Nummer	Item naam	Vraag	Antwoordmogelijkheden 7-punts-schaal
96	Sick1	Ik voelde mij onprettig tijdens de virtuele ervaring (bijv. duizelig, misselijk)	7-point Likert Scale (1 = helemaal mee oneens 7 = helemaal mee eens)
97	Sick2	Ik vond het moeilijk mij te focussen door duizeligheid of misselijkheid veroorzaakt door de virtuele omgeving	

Demographics / controls

Nummer	Item naam	Vraag	Antwoordtype
98	Allergy	Heb je voedselallergieën?	Open invoerveld
99	Diet	Zit je op een medisch dieet?	Ja / nee
100	Vegan	Ben je veganistisch?	Ja / nee
101	Hunger	Op een schaal van 0 (helemaal geen) tot 100 (heel erg veel), hoeveel honger heb je nu?	Slider 0 t/m 100
102	**Length**	**Wat is je lengte in centimeters?**	**Open invoerveld**
103	**Weight**	**Wat is je gewicht in kilo's?**	**Open invoerveld**
104	**Edu**	**Wat is je hoogst genoten opleiding?**	**Meerkeuze**
105	**Age**	**Wat is je leeftijd in jaren?**	**Open invoerveld**

Appendix D

This appendix presents the taste evaluation forms.

CHIPS
Beoordeel de smaak van de voedingsmiddelen in de bakjes. Je kunt jouw antwoord op een schaal van 1 tot 7 omcirkelen.

Hoe beoordeel je de hartigheid van de chips?

1 Helemaal niet hartig	2	3	4 Neutraal	5	6	7 Heel erg hartig

Hoe beoordeel je de zoetheid van de chips?

1 Helemaal niet zoet	2	3	4 Neutraal	5	6	7 Heel erg zoet

Hoe aangenaam vind je de smaak van de chips?

1 Helemaal niet aangenaam	2	3	4 Neutraal	5	6	7 Heel erg aangenaam

Hoe beoordeel je de kwaliteit van de chips?

1 Heel erg slecht	2	3	4 Neutraal	5	6	7 Heel erg goed

CHOCOLADE
Beoordeel de smaak van de voedingsmiddelen in de bakjes. Je kunt jouw antwoord op een schaal van 1 tot 7 omcirkelen.

Hoe beoordeel je de hartigheid van de chocolade?

1 Helemaal niet hartig	2	3	4 Neutraal	5	6	7 Heel erg hartig

Hoe beoordeel je de zoetheid van de chocolade?

1 Helemaal niet zoet	2	3	4 Neutraal	5	6	7 Heel erg zoet

Hoe aangenaam vind je de smaak van de chocolade?

1 Helemaal niet aangenaam	2	3	4 Neutraal	5	6	7 Heel erg aangenaam

Hoe beoordeel je de kwaliteit van de chocolade?

1 Heel erg slecht	2	3	4 Neutraal	5	6	7 Heel erg goed

DRUIVEN
Beoordeel de smaak van de voedingsmiddelen in de bakjes. Je kunt jouw antwoord op een schaal van 1 tot 7 omcirkelen.

Hoe beoordeel je de hartigheid van de druiven?

1 Helemaal niet hartig	2	3	4 Neutraal	5	6	7 Heel erg hartig

Hoe beoordeel je de zoetheid van de druiven?

1 Helemaal niet zoet	2	3	4 Neutraal	5	6	7 Heel erg zoet

Hoe aangenaam vind je de smaak van de druiven?

1 Helemaal niet aangenaam	2	3	4 Neutraal	5	6	7 Heel erg aangenaam

Hoe beoordeel je de kwaliteit van de druiven?

1 Heel erg slecht	2	3	4 Neutraal	5	6	7 Heel erg goed

TOMAATJES
Beoordeel de smaak van de voedingsmiddelen in de bakjes. Je kunt jouw antwoord op een schaal van 1 tot 7 omcirkelen.

Hoe beoordeel je de hartigheid van de tomaatjes?

1 Helemaal niet hartig	2	3	4 Neutraal	5	6	7 Heel erg hartig

Hoe beoordeel je de zoetheid van de tomaatjes?

1 Helemaal niet zoet	2	3	4 Neutraal	5	6	7 Heel erg zoet

Hoe aangenaam vind je de smaak van de tomaatjes?

1 Helemaal niet aangenaam	2	3	4 Neutraal	5	6	7 Heel erg aangenaam

Hoe beoordeel je de kwaliteit van de tomaatjes?

1 Heel erg slecht	2	3	4 Neutraal	5	6	7 Heel erg goed

Appendix E

This appendix presents the information letter containing information about the purpose of the study which participants received after the experiment.

Beste deelnemer,

Bedankt voor je deelname aan deze onderzoeken! Via deze brief willen we je op de hoogte stellen van het ware doel van deze studie. Om de kwaliteit van de onderzoeksgegevens te waarborgen waren de onderzoeksdoelen zoals beschreven in de informatiebrief bedoeld ter misleiding en onjuist. De drie experimenten waar je aan deel hebt genomen maakten namelijk deel uit van hetzelfde onderzoek. Dit is gedaan om ervoor te zorgen dat jij als deelnemer niet bewust zou zijn van het doel van de studie, omdat dit de antwoorden op de vragen zou kunnen beïnvloeden.

Dit onderzoek bestudeert in hoeverre het hebben van een bepaalde lichaamsgrootte in Virtual Reality (overgewicht vs. gezond gewicht) invloed heeft op eetgedrag na de Virtual Reality ervaring. Je hebt ofwel een avatar ervaren met gezond gewicht, ofwel met overgewicht. Daarnaast onderzoeken we in hoeverre het aanraken van de echte arm kan bijdragen aan het gevoel dat het virtuele lichaam van jou is. De combinatie van de aanraking op jouw echte arm en het zien van de aanraking op jouw virtuele arm, leidt volgens voorgaand onderzoek tot een sterkere illusie dat het virtuele lichaam van jou is. De bewegingstaak die je in Virtual Reality hebt uitgevoerd diende als afleiding van het ware doel van de studie, om ervoor te zorgen dat je de vragen zo waarheidsgetrouw mogelijk zou beantwoorden.

Naast de twee factoren die hierboven zijn beschreven, zijn er nog meer vragen meegenomen die invloed kunnen hebben op de relatie van het uiterlijk van het virtuele lichaam op eetgedrag. Zo hebben we bijvoorbeeld vragen gesteld over jouw lichaamsbeeld, tevredenheid met jouw lichaam, jouw inschatting van in hoeverre overgewicht een probleem is, jouw inschatting van in hoeverre je ontvankelijk bent voor het krijgen van overgewicht, in hoeverre je het gevoel had dat het virtuele lichaam van jou was, en in hoeverre je je kon identificeren met het virtuele lichaam.

Tot slot diende de proeftaak ervoor om te kijken of het belichamen van een virtueel lichaam met overgewicht (versus gezond gewicht) leidt tot verschillen in eetgedrag. Om dit te bepalen hebben wij de bakjes van de voedselkeuzetaak achteraf gewogen.

Wil je na het lezen van deze informatie dat we de over jouw verzamelde gegevens uit het onderzoek verwijderen, dan kun je dit de proefleider laten weten. Je kunt ook contact opnemen me de hoofdonderzoeker: n.e.vdwaal@tilburguniversity.edu. Vermeld je participantnummer in deze e-mail.

Wij hopen je zo voldoende op de hoogte te hebben gebracht van het doel van deze studie. Indien er nog vragen zijn dan horen wij dit natuurlijk graag. Nogmaals bedankt voor je deelname!

Vriendelijke groeten,
Het onderzoeksteam