

Wii, Myself, and Size: The Influence of Proteus Effect and Stereotype Threat on Overweight Children's Exercise Motivation and Behavior in Exergames

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Abstract

Objective: Exercise-based videogames, or exergames, provide a promising and novel way to improve exercise attitudes and behavior among overweight children. These digital interventions often allow for customizations of player characters and weave in narratives and goals. Theoretically, the presence of visual identity cues (e.g., avatars) and social category cues (e.g., stereotypes) within the virtual gaming environment are likely to motivate a player's exercise attitudes and behavior in various ways. This study examined the effects of both visual cues (via the Proteus effect) and social cues (via stereotype threat) on overweight children's exercise attitudes and game performance in a virtual running game.

Subjects and Methods: A 2 (avatar body size: Normal versus overweight) × 2 (stereotype threat: Present versus absent) factorial design experiment was conducted with 140 overweight children between 9 to 12 years of age. Dependent variables measured were participants' exercise attitudes, exercise motivation, exercise motivation with regard to the Nintendo® (Kyoto, Japan) Wii™, and their in-game performance.

Results: Multivariate analysis of covariance tests showed that overweight children assigned to avatars of normal body size scored significantly better on all four variables compared with those assigned to avatars of large body size, whereas overweight children assigned to a stereotype threat absent condition scored significantly better on three of the four variables compared with those assigned to avatars of normal body size.

Conclusions: Using avatars with normal body size and not being subjected to stereotypical messages has the potential to increase the effectiveness of exergames among overweight children. Exergame developers should consider designing avatars that are slim and toned and set "weight neutral" goals and challenges. These may provide more motivation and yield greater attitudinal and behavioral changes among overweight children.

Introduction

THE OBESITY EPIDEMIC in the United States and around the world has been linked to excessive intake of calorie-laden foods coupled with an inactive lifestyle.¹ With children spending a significant portion of their daily sedentary time on videogames,² exercise-based videogames (or exergames) suggest a promising and novel way to increase physical activity and improve exercise attitudes among overweight children.³⁻⁷ With research highlighting that it is generally difficult to motivate overweight children to engage in exercise behavior,^{8,9} exergames appear to be a potentially useful tool in promoting exercise attitudes and behavior among this group.

Identity cues are recognized as a major determinant on the possible effects on human behavior experienced in virtual environments.¹⁰⁻¹² One key identity cue has been identified

as the avatar, a digital graphical representation of the user in the virtual environment. Previously, avatars were two-dimensional characters with limited customization options, such as those found in earlier games like the "Ultima" series in the 1990s.¹³ The advent of digital technology has allowed for almost full malleability of avatars, where users can change anything from skin color to facial structure to body shape and size. Popular exergames such as "Wii™ Fit" (Nintendo®, Kyoto, Japan) and "Gold's Gym Cardio Workout" (Ubisoft®, Montreuil-sous-Bois, France) allow players to customize avatars within the game. Although this gives users the chance to manipulate their height and weight within the game, visual identity cues, such as the body size of the avatar, might have an influence on the behavior and performance of the player. Hence, it is essential to examine the effect of visual identity cues in digital health interventions.

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With the increasing customizability of player avatars in videogames, how will the body size of these graphical representations in exergames influence overweight children's attitudes and behaviors in the game? Two theories that tap on the influence of visual and social components of identity cues—the Proteus effect and stereotype threat—may provide some insights.

The Proteus effect

Yee and Bailenson¹⁴ proposed that behavioral shifts can occur via identity cues that exist as graphical representations of users in the form of avatars. The researchers term this the Proteus effect and suggest that individuals infer their expected actions from the appearance of their avatars and then subsequently conform to the behavior. In a study that demonstrated the effect of avatar height on participants' behavior, it was found that participants with taller avatars maintained smaller social distances and were more intimate with the confederate.¹⁴ Subsequent studies found support for the Proteus effect in various virtual environments and settings.^{15,16}

One stream of research on avatars that have emerged revolves around changes in behavior due to observations in the appearance of graphical representations. As the color black is often viewed as more aggressive and negative,^{17,18} subjects given avatars with black robes expressed more antisocial behaviors in virtual group discussions than subjects dressed in white robes.¹⁹ To our knowledge, most research on the impact of visual cues on overweight children has centered on food selection in promoting better dietary habits.^{20,21} The studies mentioned above suggest that visual cues through avatars have the potential to influence overweight children's attitudes and behaviors within an exergame. Given that overweight individuals are generally regarded as being lazy and averse to taking part in physical activity,^{22,23} avatars that are larger in body size should, in line with the Proteus effect, cause participants to infer the corresponding attitudes and behaviors.

Stereotype threat

Although avatars provide the visual aspect of identity cues that can influence one's attitudes and behaviors in the virtual environment, social category cues activated through stereotype threat may provide an alternative explanation. Stereotype threat theory^{24,25} posits that performing in a domain where one is negatively stereotyped produces feelings of anxiety and uncertainty. The discomfort that arises is a result of the knowledge that one's behavior might confirm a negative stereotype that is relevant to the individual. This leads to a poorer performance for individuals who are under a stereotype threat condition compared with those who are not subjected to it.^{26–28} Stereotype threat is concerned with how members of stereotyped groups are influenced by stereotype activation.

Although stereotype threat has been examined in groups such as African American students,²⁴ women,²⁹ and the elderly³⁰ and explored in domains such as math,²⁶ intelligence,²⁷ and leadership goals,³¹ few studies have examined stereotype threat among overweight individuals. Among stereotyped populations, overweight children face one of the most serious forms of negative stereotyping and discrimination.^{32,33} Within regular physical activity settings, Stone

et al.³⁴ found that African Americans performed poorer than whites in a golf task when it was framed as a test of sports intelligence.

Stereotype threat draws the individual's attention away from his or her individuality and causes the subject to identify with the stereotype by focusing on the relevant social category.³⁵ This is similar to deindividuated conditions, where people's perceptions and behavior are dependent on external identity cues. Virtual environments are settings where deindividuation effects are most prominent.³⁶ Yee and Bailenson¹⁵ suggested that such places are likely to activate the Proteus effect because of the presence of the avatar as the external identity cue. Hence, there is reason to believe that an interaction effect exists, where the Proteus effect will be stronger among participants exposed to the stereotype threat present condition.

The goal of this study is to examine the impact of the Proteus effect and stereotype threat in an exergame on overweight children's attitudes and behaviors. Results from this study will contribute to existing literature on the influence of identity cues in the virtual environment and aid researchers in developing more effective exergames. Our research hypotheses are as follows:

- H1_{a,b,c,d}. Overweight children assigned to avatars of normal body size will have better (a) exercise attitude, (b) exercise motivation, (c) motivation to use the Nintendo Wii to exercise, and (d) game performance than overweight children assigned to avatars of large body size.
- H2_{a,b,c,d}. Overweight children assigned to a stereotype threat absent condition will have better (a) exercise attitude, (b) exercise motivation, (c) motivation to use the Nintendo Wii to exercise, and (d) game performance than overweight children assigned to a stereotype threat present condition.
- RQ1. Will there be any interaction effects between avatar body size and stereotype threat?

Materials and Methods

Design

The study used a 2 (avatar body size: Normal versus large) × 2 (stereotype threat: Absent versus present) between-subject factorial design. Table 1 shows the assignment of treatment conditions across gender.

Participants

We conducted a study with 140 overweight students from a junior high school in Singapore. A two-step procedure was conducted to select the students who fit the required profile. First, students currently enrolled in the school's obesity management program were shortlisted. These students were identified by the school as those who needed help in reducing their weight. Participants of the obesity management program were required to engage in additional exercise sessions every week and are given advice on how to have a healthier diet.

Second, the shortlisted students were further screened by a check on their body mass index (BMI) before their participation was confirmed. The BMI is one of the most widely

TABLE 1. ASSIGNMENT OF TREATMENT CONDITIONS ($N=140$)

	<i>Body size avatar</i>	
	<i>Normal</i>	<i>Overweight</i>
Male		
Stereotype threat absent	22	21
Stereotype threat present	21	19
Female		
Stereotype threat absent	16	14
Stereotype threat present	12	15

accepted ways to distinguish individuals of different weight categories.³⁷ Participants' BMI values were obtained from the teachers in charge of the weight management program 4 weeks before the study. Participants had an average BMI of 25.6 kg/m² (standard deviation [SD], 3.63 kg/m²). According to the BMI cutoff points for children defined by the International Obesity Task Force, children between the ages of 9 and 12 years who have a BMI of over 19 kg/m² are considered as overweight.^{38,39} All participants in the study fulfilled this criterion. In total, 83 (59.3 percent) male and 57 (40.7 percent) female students took part in the study. Participants were required to complete a consent form at the point of enrollment. No participant had previous knowledge about the game stimulus that was used.

Stimulus

The exergame platform used for the study was the Nintendo Wii, and the exergame used for the experiment was "Active: Personal Trainer," released by EA Sports, Inc. (Redwood City, CA). A running workout was used, which consisted of a moderate run around a simulated running track.

For manipulation of avatar size, avatars of various body sizes were created within the game. These avatars were pretested with a separate group of students not involved in the study ($n=12$). Two avatars—one of normal body size and the other of large body size—were then selected to be used in the study. They were further remodeled to include both male and female versions of the normal- and large-size avatars. The final avatars were then customized to ensure uniformity in all other design elements. The four avatars used in the study and in-game screenshots are shown in the Appendix.

Procedure

Data collection took place concurrently in three locations at the primary school: A staff gym, an equipment storeroom, and a student welfare room. Each participant was first asked to fill out the Body Shape Questionnaire measuring their body shape concern⁴⁰ and then randomly assigned to one of the four conditions. After becoming familiarized with the exergame system, participants were given a short break. During this time, participants allocated to the stereotype threat present condition were asked to write down their height and weight. Participants allocated to the stereotype threat absent condition were not required to complete this step. Following this, every participant was assigned to an

avatar of the same gender with either a normal or large body size.

Following that, a stereotype threat priming announcement or a nonpriming announcement was made to each participant before the commencement of the game. The participant then started the workout. The time each participant took to complete the workout was noted. At the completion of the running game, participants were asked to fill out a questionnaire that measured their exercise attitude and motivation. After completing a manipulation check, the participant was debriefed. On average, each session lasted half an hour. It took a total of 2 weeks to conduct the study with all 140 participants.

Stereotype threat priming mechanism

The manipulations were based on previous studies on stereotype threat^{41,42} and priming mechanism regarding overweight stereotypes adapted from Seacat and Mickelson.⁴³ In the stereotype threat present condition, participants were asked to indicate their height and weight prior to the prime. Participants who were unsure about their current height and weight were asked to make a guess. A real-time message was then announced to the participant: "Your BMI is above the normal level. This means you are overweight. In this running game, it seems to be the case that people who are not overweight do better than people who are overweight." This is in line with the seminal study of Steele and Aronson²⁴ on stereotype threat by emphasizing participants' group membership. In the stereotype threat absent condition, participants were not asked to indicate their weight and height, nor did they hear any mention of ability differences between normal and overweight people. The announcement they heard was as follows: "In this game, we want to see if playing Wii games will help improve your health."

Measures

Measures consisted of participants' exercise attitudes, exercise motivation, exercise motivation with regard to the Nintendo Wii, and their in-game performance. In addition, participants' BMI and body shape concern were used as covariates. Where possible, items were adapted from past research for the purpose of this study. Table 2 shows the measurement items and their respective Cronbach's alpha values.

Exercise attitudes. For this study, exercise attitudes was measured using seven 5-point bipolar adjective scales as suggested by Rhodes and Courneya⁴⁴ and French et al.⁴⁵ The adjectives were preceded by the statement "Exercising in my leisure time will be...."

Exercise motivation. Ten items were adapted from Tergeron and King⁴⁶ and Zunft et al.⁴⁷ and consisted of a 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5).

Exercise motivation (using the Nintendo Wii). A separate measure of exercise motivation was developed by the authors to assess participants' attitudes toward using the Nintendo Wii for physical activity. The 5-point Likert scale was based on the exercise motivation measure used in this study, and the context for each question was tweaked to fit the virtual environment.

TABLE 2. MEASUREMENT ITEMS

Construct, measurement item	Cronbach's alpha	
Exercise attitude	0.84	
Exercising in my leisure time will be...(Please circle the appropriate number that best describes you.)		
Harmful	1 2 3 4 5	Beneficial
Useless	1 2 3 4 5	Useful
Undesirable	1 2 3 4 5	Desirable
Boring	1 2 3 4 5	Interesting
Stressful	1 2 3 4 5	Relaxing
Unenjoyable	1 2 3 4 5	Enjoyable
Unhealthy	1 2 3 4 5	Healthy
Exercise motivation	0.90	
How far do you agree with the following statements about exercising in general? (from 1 = strongly disagree to 5 = strongly agree)		
Exercise improves my physical appearance.		
Exercise helps me stay in shape.		
Exercise helps me feel more energetic.		
I have fun when I exercise.		
Exercise improves my muscle strength.		
Exercise helps me lose weight.		
Exercise improves my health.		
I feel mentally and spiritually better when I exercise.		
Exercise lets me have contact with my friends.		
Exercise increases my sense of achievement and confidence.		
Exercise motivation (using Nintendo Wii)	0.91	
How far do you agree with the following statements about exercising with the Nintendo Wii? (from 1 = strongly disagree to 5 = strongly agree)		
Exercising with the Wii improves my physical appearance.		
Exercising with the Wii helps me stay in shape.		
Exercising with the Wii helps me feel more energetic.		
I have fun when I exercise with the Wii.		
Exercising with the Wii improves my muscle strength.		
Exercising with the Wii helps me lose weight.		
Exercising with the Wii improves my health.		
I feel mentally and spiritually better when I exercise with the Wii.		
Exercising with the Wii lets me have contact with my friends.		
Exercising with the Wii increases my sense of achievement and confidence.		

Game performance. To measure in-game performance of participants, the total time spent by the subject to complete the workout was recorded by the research assistant. A shorter time spent indicates a better game performance.

Results

A multivariate analysis of covariance was conducted, with participants' gender, BMI, and body shape concern as the covariates. There was no significant difference ($t_{138}=0.042$, $P=0.97$) in the BMI between boys ($\text{mean}_{\text{boys}}=25.7 \text{ kg/m}^2$, $\text{SD}=3.37 \text{ kg/m}^2$) and girls ($\text{mean}_{\text{girls}}=25.6 \text{ kg/m}^2$, $\text{SD}=4.00 \text{ kg/m}^2$). Differences in body shape concern between boys ($\text{mean}_{\text{boys}}=4.44$, $\text{SD}=0.70$) and girls ($\text{mean}_{\text{girls}}=4.23$, $\text{SD}=0.72$) also proved to be not significant ($t_{138}=1.74$, $P=0.08$). Two-tailed statistical tests were conducted using IBM (Armonk, NY) SPSS Statistics version 21, and a P value of 0.05 was used to determine significance.

Avatar size

Results of the analysis supported $H_{2a,b,c,d}$. There was a significant main effect of avatar body size on all four dependent variables. Overweight children assigned to avatars

of normal body size scored significantly better on all four variables compared with those assigned to avatars of large body size. The effect sizes vary from small to moderate, with partial η^2 ranging from 0.04 to 0.11.

Stereotype threat

Analyses supported $H_{2a,b,c}$ but did not provide empirical evidence for H_{2d} . Overweight children assigned to a stereotype threat absent condition scored significantly better on three of the four variables compared with those assigned to avatars of normal body size. The effect sizes were small, with partial η^2 ranging from 0.04 to 0.08. The results are presented in Table 3.

Interaction effects

The two-way multivariate analysis of covariance test did not find any significant interaction effects regarding avatar body size and stereotype threat on the four dependent variables.

Discussion

Consistent with the Proteus effect, overweight children who were assigned avatars of normal body size performed

TABLE 3. MULTIVARIATE ANALYSIS OF COVARIANCE RESULTS OF AVATAR BODY SIZE AND STEREOTYPE THREAT ON DEPENDENT VARIABLES (N=140)

	<i>Body size of avatar</i>		F	<i>Partial η^2</i>
	<i>Normal</i>	<i>Large</i>		
Exercise attitudes	4.20 (0.53)	3.92 (0.44)	17.13 ^b	0.11
Exercise motivation	4.14 (0.59)	3.90 (0.50)	7.75 ^b	0.06
Exercise motivation (Wii)	4.26 (0.48)	4.10 (0.37)	5.49 ^a	0.04
Game performance	78.74 (11.21)	82.79 (8.75)	7.00 ^a	0.05
	<i>Stereotype threat</i>		F	<i>Partial η^2</i>
	<i>Absent</i>	<i>Present</i>		
Exercise attitudes	4.18 (0.42)	3.94 (0.53)	12.21 ^b	0.08
Exercise motivation	4.14 (0.47)	3.89 (0.59)	9.04 ^b	0.06
Exercise motivation (Wii)	4.26 (0.41)	4.10 (0.44)	5.25 ^a	0.04
Game performance	79.62 (10.87)	81.92 (9.47)	2.27	0.02

Data are mean (standard deviation) values. Degrees of freedom = (1, 134). Mean scores refer to adjusted means from multivariate analysis of covariance. Game performance was measured in seconds. A longer time taken translates to poorer game performance. Other measures range from 1 = strongly disagree to 5 = strongly agree.

^a $P < 0.05$, ^b $P < 0.01$.

better in a virtual running game than those assigned avatars of large body size. This finding supports the proposition by Yee and Bailenson¹⁴ that users infer expected behaviors from how their avatars look and conform to those behaviors. Furthermore, this study extends the boundaries of avatar influence beyond behavioral changes. Although support for the Proteus effect has been limited mainly to behavioral observations and measures,^{14,15} significant differences were found in participants' exercise attitude and motivation. These results show that avatar appearances not only influence the behaviors of overweight children, but may also impact their psychological makeup in ways that have not been thoroughly explored.

Findings in our study did not support actual behavioral changes due to stereotype threat. However, there was a significant and distinct influence of stereotype threat on overweight children's psychological beliefs. Clearly, stereotype threat has influenced overweight children's attitude and motivation toward exercise in this study. However, we did not find evidence of a behavioral effect. One possible explanation is that when participants are engaging with the exergame, they exhibited an increased motivation to master the challenge of the game.^{48,49} Children like the presence of a challenging goal and are motivated by a desire to beat the task set before them in videogames.⁵⁰ Hence, it is likely that the stereotype threat acted as a challenge to them, resulting in a short-term burst of excitement within the participants to reach the goal. Once the game is over, the excitement dies down. This may explain the influence of stereotype threat on participants' reports of exercise attitude and motivation after the game, but not on actual performance during the game.

Contrary to expectations, no interaction effects were found between avatar body size and stereotype threat. The outward appearance of avatars alone may not be as strong an identity cue in deindividuated conditions. Studies have found that a user's affinity and connection with avatar may be dependent on factors other than the physical appearance of the avatar, such as personality structure,⁵¹ mass popu-

larity,⁵² and the avatar's role in helping the player complete the game.^{53,54} The avatar used in the study was foreign to the participants and did not contribute to any storyline progress in the game. Hence, other dimensions of the avatar may prove to be a determining factor of the absence of any interaction effects in the deindividuated conditions of stereotype threat.

On the whole, this study has found that not only does the virtual self have the potential to influence the individual, such influence is exerted through specific visual and social components of identity cues. This is an extension of previous research on the influence of identity cues on human behavior in the virtual environment, which has mainly focused on the effects of virtual others on the individual.^{55,56} As it is becoming increasingly prevalent for individuals to interact with others in virtual worlds such as massively multiplayer online role-playing games or online classrooms, it will be interesting to examine the impact of identity cues conveyed by virtual others and the virtual self together and to explore the dynamics between the two.

Theoretical and practical implications

Existing literature has shown the Proteus effect to be present when dimensions of the user avatar such as facial similarity and skin tone are manipulated, resulting in varying levels of behavioral influence.^{57,58} This study has provided evidence that yet another aspect of the user avatar—body size—can impact one's behavior in the digital world. Findings here have also shown that the effects of being negatively stereotyped transcend the boundaries of our natural world and are distinctly evident in the virtual environment.

Research on the effects of stereotype threat has mainly been limited to the study of gender and racial stereotypes^{26,28} and the use of academic tests to ascertain the influence of stereotype threat.^{30,59} Although certainly not definitive, this study has shown that overweight children are just as likely to be impacted by stereotype threat and that the use of measures other than academic tests can and

should be used to test for stereotype threat on a variety of stereotyped populations.

An increasing number of exergames are setting the appearance of user avatars based on players' body weight. The "Wii Fit," for example, churns out avatars of varying body sizes based on the height and weight values that users input into the system. As exercise attitudes and performance have been shown to decrease when overweight children are assigned overweight body weight avatars, giving these children a fixed avatar that is bigger in body size may not be a good idea if the purpose is to encourage them to exercise. Designing avatars that are slim and toned may provide more motivation and yield more positive attitudinal and behavioral changes in children who play the game.

Some exergames, such as the "Wii Fit," display onscreen messages listing down the player's weight. Other games remind overweight players that they have a long way to go before they reach their targeted body weight. Although these measures may seem like goals to players and challenge them to give their best, stereotype threat due to these social category cues may in fact have a greater impact on overweight children's exercise attitude and motivation. In designing exergames to promote physical activity among overweight children, developers of digital health interventions should avoid making any mention of participants' weight and their relative performance. Instead, setting "weight neutral" goals and challenges may help to increase overweight children's exercise attitude and motivation.

Future research

Other than the visual aspect of avatars, other dimensions of graphical representations such as its role in the game and personality structure may play a part in the relationship among the player, the avatar, and his or her subsequent exergame behavior. Future studies can request participants to assess their avatars in terms of identity strength or their relevance to the game.

For this study, exercise attitude and motivation were specifically included as dependent variables as we were interested in examining the impact of avatar body size and stereotype threat on these variables. It is possible that individual differences could have contributed to the significant results to some extent. To control for individual differences, gender, body shape concern, and BMI were included as covariates in the analysis. Future studies can consider including baseline measurements of related attitudinal measures to enhance the robustness of the study.

Findings from this study provide an insight into how developers of digital health interventions and social marketers can improve overweight children's exercise attitudes and performance through the use of various game mechanics within an exergame. Information gained from this and future studies will assist in the deployment of exergames that are effective in getting overweight children to engage in higher levels of physical activity.

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Author Disclosure Statement

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Appendix

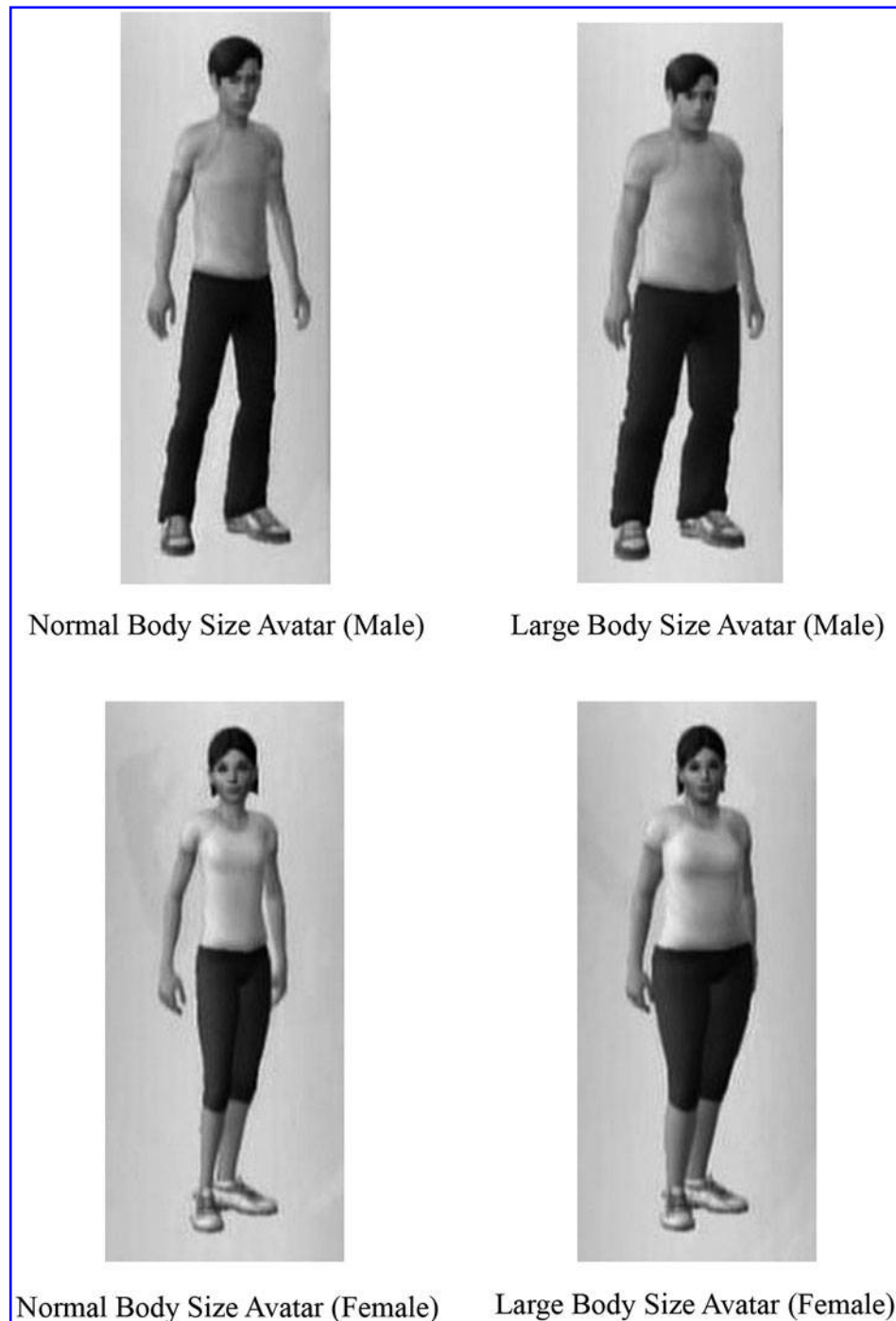


FIG. A1. In-game avatars used in the study.



FIG. A2. In-game screenshot of a normal body size avatar (male).



FIG. A3. In-game screenshot of a large body size avatar (female).