RUNNING HEAD: TRANSFORMED REPRESENTATION

The Proteus Effect: Implications of Transformed Digital Self-Representation on Online and Offline Behavior

Nick Yee & Jeremy N. Bailenson

Stanford University

Nicolas Ducheneaut

Palo Alto Research Center

(in press in *Communication Research*)

Author Contact Information:

Nick Yee, Department of Communication, Stanford University, Stanford, CA 94305.

Phone: 650-559-1702. Email: nyee@stanford.edu

Abstract

Virtual environments allow us to dramatically alter our self-representation. More importantly, studies have shown that people infer their expected behaviors and attitudes from observing their avatar's appearance, a phenomenon known as the Proteus Effect (Yee & Bailenson, 2007). For example, users given taller avatars negotiated more aggressively than users given shorter avatars. Two studies are reported here that extend our understanding of this effect. The first study extends the work beyond laboratory settings to an actual online community. We found that both the height and attractiveness of an avatar in an online game were significant predictors of the player's performance. In our second study, we found that the behavioral changes stemming from the virtual environment transferred to subsequent face-to-face interactions. Participants were placed in an immersive virtual environment and were given either shorter or taller avatars. They then interacted with a confederate for about 15 minutes. In addition to causing a behavioral difference within the virtual environment, we found that participants given taller avatars negotiated more aggressively in subsequent face-to-face interactions than participants given shorter avatars. Together, these two studies show that our virtual bodies can change how we interact with others in actual avatar-based online communities as well as in subsequent face-to-face interactions.

Keywords: Virtual environments, avatars, transformed social interaction

Introduction

Avatars

In virtual environments, an avatar is defined as “a perceptible digital representation whose behaviors reflect those executed, typically in real time, by a specific human being” (Bailenson & Blascovich, 2004, pg. 65). In the current work, we were interested in exploring how our digital representations can affect how we interact with other people, both inside and outside of a collaborative virtual environment (CVE). In the following sections, we will first describe the affordances of CVEs and in particular the ways in which strategic changes to an avatar’s appearance and behavior can change how other people respond to that avatar. We will then turn our attention to whether an avatar can change how a user behaves (instead of how others respond to the avatar). In particular, we will examine precedents in a variety of research areas to help understand how an avatar might change a user’s behavior.

Collaborative Virtual Environments (CVEs)

A CVE is a digital system that allows geographically-separated individuals to interact via networking technology, oftentimes with graphical avatars. Thus, CVEs encompass both digital environments created for communication applications as well as online games created for entertainment purposes. The manner in which a user navigates and interacts with others in a CVE is dependent on the particular system itself. This can range from a joystick or a keyboard in a video game to a headset with translation and rotation tracking in an immersive virtual reality system. Thus, an avatar in an online game is typically driven by hitting specific keys on a keyboard or clicking buttons on the screen with a mouse, while an avatar in an immersive virtual reality system tracks some of the user's movements directly—i.e., when the user walks in the physical world, sensors track how much the user has moved and this is relayed to the rendering system that then redraws the virtual world accordingly.

CVEs allow us to tailor our digital self-representation with a degree of control not possible elsewhere. This encompasses both visual and behavioral changes. First of all, CVEs, whether a 3D online game or just a text-based world, give us a great deal of control over our self-representation. Everything from our age, gender, ethnicity, or height can be dramatically altered or subtly tweaked with a few mouse clicks. Analogous changes to our physical bodies are much more difficult (or impossible) to accomplish. Because digital systems mediate all interactions in a CVE, the digital system can also be programmed to strategically filter and alter our behaviors. This has been referred to as Transformed Social Interaction (TSI, Bailenson, Beall, Loomis, Blascovich, & Turk, 2004).

Transformed Social Interaction (TSI)

Research in computer-mediated environments (Walther, 1996) has shown how the technical affordances of these environments can lead to more intimate interactions. For example, the limited communication channel together with self-presentation biases leads to a positive bias in impressions among interactants. Instead of focusing on the structural affordances of the computer-mediated environment, studies in TSI have shown how strategic changes in an avatar's appearance or behavior can affect how other users interact with that avatar. Two examples of TSI will be described below; the first example involves a strategic behavior filter while the second example involves a strategic appearance filter.

Behavioral mimicry is an example of a strategic behavior filter. Research in communication and social psychology has shown that people automatically mimic each other's speech patterns and posture (Cappella & Panalp, 1981; Giles & Claire, 1979; LaFrance, 1982). Moreover, deliberately mimicking someone can lead to more favorable responses from them (Chartrand & Bargh, 1999; van Baaren, Holland, Steenaert, & van Knippenberg, 2003). Thus, we might expect that an avatar that mimics the user may be judged to be more likeable or persuasive. The impact of behavioral mimicry in digitally mediated environments was tested recently in an experimental setting (Bailenson & Yee, 2005). Participants interacted with an embodied agent which either mimicked their head movements at a four second delay, or played back the head movements of a previous participant. It was found that participants in the mimic condition were more likely to agree with the agent's argument than participants in the non-mimic (i.e., playback) condition.

Another line of studies in TSI has explored a strategic appearance filter that can be applied to avatars. Similarity-based attraction and preference have also been well-documented. Individuals who are similar to us, whether in appearance or beliefs, are rated more positively, perceived as more attractive, and rated as more persuasive than individuals who are less similar to us (Berscheid & Walster, 1979; Brock, 1965; Byrne, 1971; Shanteau & Nagy, 1979). In fact, this similarity bias can be triggered with other seemingly arbitrary similarities. For example, altruistic behaviors can be elicited when another person shares the same birthday (Burger, Messian, Patel, del Prado, & Anderson, 2004). Digital imaging software allows us to experimentally create faces at specific similarities to a participant's face via morphing techniques. In other words, it is possible to specify faces that contain a 20% or 40% contribution from a participant's face. The impact of this facial-similarity manipulation has been tested in a series of studies in voting behavior (Bailenson, Garland, Iyengar, & Yee, 2006; Bailenson, Iyengar, Yee, & Collins, 2006). The results of both studies showed that facial similarity is a powerful cue, changing voting behavior even in high-profile elections where a great deal of other information and partisan biases exist, such as the 2004 presidential election.

These studies in TSI show that subtle changes in an avatar's appearance or behavior can influence how other users interact with the transformed avatar. In the current work, we were interested in a variation of this effect. Instead of exploring how an avatar's appearance can change how other people behave, we were interested instead in how an avatar's appearance can change the user's own behavior. In the next sections, we will consider some precedents in studies of online textual environments, role-playing, behavioral confirmation, and self perception that suggest that avatars can change how the user behaves.

Studies of MUDs

MUDs (multi-user domains) are the textual predecessors to graphical online environments. Bruckman's work (1993) in MUDs has shown how avatars can change a user's behavior. In the case of gender-bending, "many people, both male and female, enjoy the attention paid to female characters. Male players will often log on as female characters and behave suggestively, further encouraging sexual advances" (Bruckman, 1993). The same observation has been noted by Suler (1996) in his participant observation study of the Palace. The Palace expanded on the technological capabilities of existing MUDs. It was a graphical avatar space that was a precursor to the avatar-based online environments available today. As such, the Palace blended the features of graphical CVEs and the ad hoc communities of MUDs. In the Palace, “a seductive, sexy, or simply ‘attractive’ avatar can have a powerful impact on other members”. These anecdotes suggest that a two-way process may be at play. A seductive avatar elicits more attention from other users, but, as Bruckman suggests, the seductive avatar may also enable or embolden the user to act in a more flirtatious manner. This is also reported by Suler. He notes that “many members have told [him] that what they are wearing affects how they behave, as well as influences how others will react to them” (Suler, 1996).

Given that the Palace was a bridge between older text-based MUDs and contemporary graphical environments, it provides a glimpse into the ability of avatars to influence behaviors in many current avatar-driven virtual environments. Indeed, Suler’s observations that an avatar’s appearance can influence its user’s behavior is one of the qualitative findings we seek to explicate empirically in the current work.

Together, these studies suggest that our avatars can change our identities by changing how others interact with us, and more intriguingly, by changing how we behave directly by enabling certain behaviors. In the next section, we will examine research in the role-playing literature that has also shown how temporary roles can produce changes in behavior and attitude.

Role-Playing

The notion that roles can be used to enable certain behaviors is also reflected in the literature on role-playing. Even though much of this research was conducted in face-to-face situations, it nonetheless informs us of the possible effects role-playing can have on a person's behavior. While there have been many studies that employed role-playing as a form of training (Bandura, 1977; MacDonald, Lindquist, Kramer, & McGrath, 1975; McFall & Marston, 1970; Taylor, Russ-Eft, & Chan, 2005; White & Berger, 1976), we will focus here instead on studies that have asked people to pretend to be someone else with different attributes or beliefs to facilitate behavioral change.

One line of research has been referred to as emotional role-playing. In these studies, the goal is to elicit a strong negative emotional reaction as a means to reduce the occurrence of a detrimental behavior. Studies have shown the efficacy of this type of role-playing in smoking cessation in both the short term (Janis & Mann, 1965) and long term (Mann & Irving, 1968). A related line of research is empathic role-playing. Instead of inducing fear, the goal of this type of role-playing is increased empathy for a disadvantaged or minority group by walking a mile in their shoes. Studies in this area have shown changes in attitude toward the disabled (Clore & Jeffery, 1972), people in inter-faith marriages (Levy & Atkins, 1969), and the elderly (Yee & Bailenson, 2006) after taking the perspective of a member of a minority group. A final line of related research is counterattitudinal role-playing. In these studies, participants are asked to make a public statement that is opposite of a belief they hold. These studies have shown that participants align their internal beliefs with their outward statements even if the statements were counterattitudinal (Festinger, 1957; Festinger & Carlsmith, 1959; Janis & King, 1954).

Overall, the research in role-playing has shown that asking people to enact artificial personas can lead to predictable changes in both attitudes (e.g., empathy towards the disabled) and behaviors (e.g., reduced smoking). In the following sections, we will focus more precisely on the psychological processes that might allow an avatar's appearance to influence the user's behavior.

Behavioral Confirmation

One way in which our appearances may change how we behave occurs via *behavioral confirmation*. Behavioral confirmation is the process whereby the expectations of one person (typically referred to as the *perceiver*) cause another person (typically referred to as the *target*) to behave in ways that confirm the perceiver's expectations (Snyder, Tanke, & Berscheid, 1977).

The phenomenon of behavioral confirmation has been demonstrated with regards to many other expectancies and stereotypes, such as hostility (Snyder & Swann, 1978), gender stereotypes (Geis, 1993; Towson, Zanna, & MacDonald, 1989), and racial stereotypes (Word, Zanna, & Cooper, 1974). Thus, in a virtual environment, a perceiver interacting with a target using an attractive avatar may cause the target to behave in a more friendly and charming manner. In fact, the study by Snyder and colleagues itself occurred in a mediated context (i.e., over the telephone). It is important to note that the source of behavioral change from the effects of behavioral confirmation stems from the perceiver rather than the target. It is the perceiver's behavior that in turn causes a change in the target's behavior.

In the current work, however, we were specifically interested in whether an avatar may change a user's behavior directly, rather than via an indirect process during an interaction with another person. In the next section, we will turn to self perception theory to provide such a framework.

Self Perception Theory

So far, the precedents and theoretical frameworks we have examined have been suggestive, but have not provided a specific theory that might explain how an avatar could directly change a user's behavior. Studies in MUDs provided anecdotes by several researchers that users reported altering their behavior when using different avatars, but they did not provide us with a theoretical mechanism for why this change might occur. We then turned to the role-playing literature which provided many empirical examples where temporary roles led to both short-term and long-term changes in behavior and attitude. Most of the artificial personas presented in the role-playing literature, however, do not explicitly show how an avatar's appearance on its own could impact a user's behavior. Finally, we discussed studies in behavioral confirmation, which have shown that an altered self-representation can lead to changes in a person's behavior. On the other hand, the change from behavioral confirmation is a reflexive change; it is an indirect change that stems from another person's perception and induced compliance. In this section, we will consider self perception theory; studies in self perception have shown that altered self-representations can directly lead to changes in a person's behavior.

Self perception theory argues that people infer their own attitudes and beliefs from observing themselves as if from a third party (Bem, 1972). For example, when participants were made to believe that their own heartbeat increased while viewing certain photographs, they rated the people in those photographs as being more attractive (Valins, 1966). This is because participants assumed that a photograph of an attractive person causes heightened arousal which in turn led to an increased heartbeat. When participants observed their heartbeat increase, they inferred that it must have been due to heightened arousal, which in turn implied that the person in the photograph was attractive. Thus, an observation of their own behavior led participants to modify their attitudes.

In addition to observations of one's own behavior, it has also been demonstrated that observations of one's own appearance can lead to changes in behavior. Frank and Gilovich's (1988) paper on the effect of wearing black uniforms best illustrates the causal chain underlying the process. They were interested in whether wearing black uniforms causes athletes to behave more aggressively. In a set of four studies, they first demonstrated that blind coders rated athletes wearing black uniforms as being more aggressive than athletes wearing uniforms of other colors. In the second study, they explored whether athletes wearing black uniforms were more aggressive in actual athletic events. They analyzed past records from the National Football League and the National Hockey League to show that teams wearing black uniforms received more penalties than teams wearing uniforms of other colors. Given that teams often change uniform colors depending on the location of play, Frank and Gilovich were also able to show these penalty differences even within the same teams when they switched uniforms. Of course, this does not rule out the possibility that referees are more likely to perceive an athlete in a black uniform as being more aggressive. Frank and Gilovich showed that this effect indeed existed by asking blind coders to rate game footage in their third study. Thus, in their fourth study, they tried to examine directly whether wearing a black uniform leads to increased aggression in an experimental design. Participants were asked to wear either black or white uniforms. As the dependent measure, participants were asked to select five games (from a list of twenty games) that they would like to compete in. The list of games had been previously rated in terms of how aggressive they were. It was found that participants in black uniforms selected games rated as being significantly more aggressive than participants in white uniforms.

We will now step through the underlying psychological process in Frank and Gilovich's (1988) fourth study in detail. In their paper, Frank and Gilovich explain their findings with a direct application of Bem's self perception theory, arguing that participants in black uniforms observe themselves as if from a third-party to infer their expected attitudes and behavior. In this case, as was found in the first study, people in black uniforms are perceived to be aggressive. Participants in black uniforms thus infer that they are aggressive and behave accordingly. When presented with the choice of games, they select the games that are more aggressive. As Frank and Gilovich argue, "just as observers see those in black uniforms as tough, mean, and aggressive, so too does the person wearing that uniform" (pg. 83). To summarize, an observation of their appearance (i.e., "I am wearing a black uniform") led participants to make inferences about their disposition (i.e., "I am an aggressive person") which in turn led to changes in behavior (i.e., "I will select more aggressive games"). This effect has also been replicated in a digital game-like setting, where users given avatars in a black robe expressed a higher desire to commit anti-social behaviors than users given avatars in a white robe (Merola, Penas, & Hancock, 2006).

The self perception effect has also been shown to lead to behavioral changes more directly (rather than just simply a desire to behave in a certain way). In a study by Johnson and Downing (1979), participants were asked to wear either a nurse's uniform or a costume that resembled a Ku Klux Klan robe. They were then asked to interact with a confederate in a teacher-learner paradigm where they took on the role of the teacher. They were allowed to increase the amount of electric shock delivered to the learner when mistakes were made. It was found that participants in nurse's uniforms delivered less severe shocks than participants in the Ku Klux Klan robes. This study illustrates more directly how self perception can lead to a change in behavior.

Deindividuation and Identity Cues

Another important contextual variable, deindividuation, was explored in Johnson and Downing's (1979) study. Earlier research by Zimbardo (1969) had suggested that deindividuation—a state of decreased self-evaluation due to anonymity or being in a large crowd—led to increased anti-social and anti-normative behaviors. In one study, he found that participants wearing hooded and oversized lab coats (thus rendering them anonymous) delivered longer shocks to learners than participants in normal lab coats. Research by Gergen and his colleagues (1973), on the other hand, had suggested that deindividuation can in fact lead to pro-social behaviors. In their study, couples were left either in a darkened room or a well-lit room. They found that couples in the darkened room were more likely to engage in affectionate behavior compared with couples in well-lit rooms. Johnson and Downing (1979) thus decided to pit these two hypotheses against each other in their study. In addition to the external cue factor (nurse's uniform vs. Ku Klux Klan uniform), they also varied whether participants were deindividuated or not (i.e., with or without name tags). They found that contrary to Zimbardo’s theory, deindividuation did not always result in anti-social behaviors. Instead, deindividuation increased the impact of the identity cues given to the participant. Thus, deindividuation led to fewer shocks when wearing nurse’s uniforms and led to more shocks when wearing Ku Klux Klan robes. In other words, deindividuation increases the self perception reliance on identity cues.

In explaining the underlying mechanism of this effect, Johnson and Downing (1979) invoked the notion of inward vs. outward attention. Individuation, the state in which a person is highly self-aware (e.g., calling them by name or proximity to a mirror), implies a great of attention is focused on internal beliefs, values, and standards of behavior. In such a state, individuals are less influenced by situational cues and closely reference their internal beliefs. On the other hand, deindividuation, through anonymity or membership in a large group, implies a predominantly outward-focused attention which decreases the salience of internal standards and increases the salience of situational cues. In turn, the increased salience of external cues increases their influence on a person’s behavior. Thus, the more deindividuated a person is, the less likely they are to focus their attention inward on internal beliefs and standards, the more likely they are to focus their attention outward on situational cues, and the more likely external cues will influence their behavior.

Other researchers have elaborated that people have multiple layers of the self that include both one’s individual identity and social identities. Thus, “the anonymity in the crowd does not make an individual lose awareness of individual identity, so much as shift from a personal identity to a social identity” (Postmes, Spears, & Lea, 1998, pg. 693).

When made anonymous, deindividuation increases an individual’s conformity to their social identity rather than their individual identity. This has been referred to as the Social Identity Model of Deindividuation Effects. In this sense, this final step of the deindividuation process is highly similar to self perception theory. When an individual is deindividuated, they conform to behaviors associated with the norms of the local context, which include identity cues from their own clothing. For example, deindividuated individuals in a nurse’s uniform begin to conform to the social role of nurses.

Given that users of virtual environments are typically made anonymous, we might infer that deindividuation occurs in these environments. Indeed, this has been suggested by a variety of researchers (Kiesler, Siegel, & McGuire, 1984; Lee, 2006; McKenna & Bargh, 2000). And empirical findings have also supported this claim. For example, in one study (Postmes, Spears, & Lea, 2000), participants were more likely to conform to group norms when deindividuated (in web-based forums) and more likely to exert an independent identity when individuated (in face-to-face meetings). Together, these findings suggest that identity cues, such as an avatar’s appearance, may have a heightened impact on a user’s behavior via self perception in virtual environments. In other words, users might infer their own attitudes and behaviors from their avatar’s appearance.

Deindividuation helps explain the contexts in which the effects of self perception may be augmented. At first glance, it may appear that self perception theory and deindividuation theory operate on the basis of very different assumptions. Self perception theory is based on observing the self, while deindividuation occurs when the self is erased. On closer inspection, both theories hinge on external cues—“Since I am wearing a black uniform, I guess I must be someone who …". As such, the distinction is not I vs. Not I, but rather, "inward attention" vs. "outward attention" (or individual identity vs. social identity) as mentioned earlier. More importantly, deindividuation theory helps explain where the effects of self perception may be stronger. Indeed, in Johnson and Downing's study (1979), the results showed that the external cues (nurse's uniform vs. Ku Klux Klan robe) led to a behavioral difference even in the individuated condition, but this effect was augmented in the deindividuated condition. Thus, our review of both literatures suggests that virtual environments, where deindividuation occurs, is a likely place where context cues, such as avatar appearance changes, are likely to change a person's behavior via self perception.

The Proteus Effect

While previous studies in self perception theory have relied largely on cues based on costumes and uniforms, digital environments provide users with customization tools that allow them to change their avatars' appearances, whether this is the length of their avatars' hair or the clothing their avatars are wearing. In other words, digital environments allow us to explore how, for example, an avatar's attractiveness or height may change a user's behavior. In the case of attractiveness, studies have shown that attractive individuals are perceived to possess a constellation of positive traits (Dion, Berscheid, & Walster, 1972) - that they are more extraverted, friendlier, and so forth. In light of self perception theory, just as participants in black uniforms infer an aggressive disposition and in turn behave more aggressively, participants in attractive avatars may infer a friendly and extraverted disposition and behave in a friendlier manner. And in the case of avatar height, given that taller people are perceived to be more confident and more likely to be in positions of power (Stogdill, 1948; Young & French, 1996), participants in taller avatars may conform to those expectations. Thus in general, we may expect users to make inferences about their expected dispositions from their avatar's appearance and then conform to the expected attitudes and behavior, a phenomenon that has been referred to as the *Proteus Effect* (Yee & Bailenson, 2007).

Studies in experimental settings have demonstrated the Proteus Effect in immersive virtual reality (Yee & Bailenson, 2007). In a series of two studies, it was found that the attractiveness or height of participants' avatars had a significant impact on how they interacted with a confederate. In the first study, participants were given avatars with faces that had been pre-tested for attractiveness. After viewing their virtual self-representation in a virtual mirror, they interacted with a confederate. To filter out the possibility that confederates interacted with participants differently due to behavioral confirmation, confederates always saw the participant with an average-rated face. In other words, confederates were blind to condition. The experimenters found that participants in attractive avatars walked closer and disclosed more personal information to the confederate than participants in unattractive avatars. These findings supported the hypothesis that users in more attractive avatars conformed to the expectation that attractive people are friendlier and more extraverted.

In the second study, participants were assigned to avatars that were 10 cm shorter, 10 cm taller, or the same height as the confederate. Participants then performed a money-splitting negotiation task with the confederate. The participant and the confederate were asked to split a hypothetical pool of $100 in alternating rounds. Given that taller people are perceived to be more confident (Young & French, 1996), it was hypothesized that users in taller avatars would conform to this expectation and be more aggressive in making splits in their own favor and less likely to yield to unfair splits made against them than users in shorter avatars. The experimenters found that participants in taller avatars offered significantly more unfair splits (in their own favor) than participants in shorter avatars. Participants in taller avatars were also significantly more likely to reject an unfair offer by the confederate than participants in shorter avatars. Thus, these findings suggest that participants conformed to the expectations of their avatar's height. Together, these two studies showed that even small changes to our avatars can lead to immediate and significant changes in how we behave and interact with other people in a virtual environment. On the other hand, there were several limitations to the previous studies that the current work will try to address.

Generalizability to Actual Online Communities

While the previous laboratory findings helped establish causality and showed that manipulations to digital self-representation can indeed change a user's behavior, they failed to convincingly generalize to interactions in actual online communities. Here, we use the term "online community" to refer to a set of people who regularly interact via a particular online environment. This is in contrast to a typical laboratory scenario where a pair of users interacts once and never interacts again. While social interaction in an online community and in a virtual reality laboratory are very different, it should be noted that the causal framework outlined based on self perception theory depends on the user's avatar only, and not the presence of other avatars, or social interaction with other avatars. Thus, the Proteus Effect should be expected to operate in virtual environments where users are presented with avatars, whether this is in a virtual reality laboratory or an online community.

First of all, previous experimental studies in the Proteus Effect don’t generalize to online communities because social interactions in online communities are neither limited to dyadic interactions or to short, scripted responses. On the other hand, it may be difficult to ascertain causality in a field study. This is the tension driven by the inherent tradeoffs between mundane realism and experimental control; some researchers have proposed that virtual environments could potentially bridge that divide (Blascovich et al., 2002). In our case, however, implementing experimental manipulations on all users in an actual online environment was not feasible, so instead, we devised an observational field study. Nevertheless, showing that the Proteus Effect occurs in an actual online community is crucial for advancing our theoretical understanding of the effect, and provides an important complement to the laboratory findings.

Secondly, showing that the Proteus Effect does occur spontaneously in an unprompted, unscripted online community would allow generalizing the effect beyond a small sample of undergraduate students. Specifically, as other studies have shown, the behaviors and attitudes of college students may not be representative of the general population (Bailenson, Shum, Atran, Medin, & Coley, 2002; Iyengar, 2002). And while the typical college student ranges from 18-22 years of age, typical users of online games range from 11 to 70, with a mean of around 26 (Yee, 2006). Thus, showing the Proteus Effect in an actual avatar-based community would also increase the generalizability of the finding.

Persistence of Behavioral Changes

Another important question that has not been addressed is the duration of the Proteus Effect outside of the digital setting. For example, given that the average user of online role-playing games spends 20 hours per week interacting with other people via their avatar (Yee, 2006), it is important to understand whether behavioral changes that occur due to the Proteus Effect in digital environments persist in subsequent face-to-face settings.

According to self perception theory, people often infer their expected behaviors and attitudes by observing their own appearance or behavior as if from a third-person perspective. In fact, it has been shown that even deliberately role-played behavior can subsequently serve as a source for self-perception. Kopel and Arkowitz (1974) asked participants to role-play either being calm or upset in a series of electric shocks. In a subsequent set of shocks, participants were then asked to rate how painful the shocks were. It was found that participants in the calm condition rated the shocks as less painful than those participants in the upset condition.

Virtual environments provide a unique setting for implementing this type of behavioral self-perception. Instead of overtly asking participants to role-play a particular behavior, we can employ the Proteus Effect to produce the desired behavior. Thus for example, users in taller avatars are expected to behave more confidently in the virtual environment. Users may then infer from their virtual interactions that they are fairly confident. On the other hand, users in shorter avatars may infer that they are not that confident. In other words, the behavioral changes that stem from the Proteus Effect in a virtual environment may be expected to carry over to subsequent face-to-face interactions via self-perception. This is particularly likely because such a manipulation minimizes any overt direction of the user's behavior (i.e., via explicit scripts in traditional role-playing).

Overview of Studies

To address whether the Proteus Effect occurs in an actual online community and whether the effect transfers to face-to-face settings, we conducted two studies that addressed each of the previous limitations in turn. In the first study, we sought to complement our experimental findings with data from an actual avatar-based online community with thousands of daily users - the online game *World of Warcraft* (WoW).

As we have seen, taller people are perceived to have higher self-esteem (Young & French, 1996). Research has also shown that physical height is positively correlated with self-esteem and performance, and that this in turn is positively correlated with workplace success (Judge & Cable, 2004). Thus, we hypothesized that:

H1. Taller attractive avatars in WoW would outperform shorter avatars.

Attractive people are also perceived to have a large set of positive attributes, and many of these attributes are linked to performance variables, such as perceived self-esteem (Dion et al., 1972), status (Kalick, 1988) and competence (Jackson, Hunter, & Hodge, 1995). Thus, users in attractive avatars may conform to these expectations. In addition, in online games where users can leverage social support to increase personal performance, users in attractive avatars may also benefit from being friendlier and thus having a larger and stronger social network than users in unattractive avatars.

H2. More attractive avatars in WoW would outperform less attractive avatars.

It is important to note that neither height nor attractiveness have any direct functional benefit in the game—for example, tall avatars do not walk faster than shorter avatars and attractive avatars do not have special skills.

In the second study, we tested our hypothesis that the Proteus Effect creates a unique self-model that users may subsequently model outside of the virtual environment. To this end, we replicated the previous study of avatar height with the addition of a face-to-face negotiation task after participants had been in the virtual environment. We hypothesized that:

H3. Participants in taller avatars would be more aggressive negotiators inside the virtual environment than participants in shorter avatars.

H4. Participants who had been in taller avatars would be more aggressive negotiators in a face-to-face interaction outside of virtual environment than participants who had been in shorter avatars.

Study One

Avatar Choice in World of Warcraft

WoW is an online game where users interact via customized avatars. Users move their avatars via the keyboard and mouse, and mostly communicate with other users via typed chat. In the character creation portion of the game, users are asked to choose a male or female avatar from one of eight races (e.g., gnomes, elves, humans). Within each selected race, there are a small predefined set of fairly limited faces and hair styles that users can choose from. Once an avatar is created, its physical appearance cannot later be changed in the game (excluding temporary disguise and transformation effects and spells).

In WoW, races have specific visual traits that tend to be highly similar within a race, but highly dissimilar between races. For example, all Gnomes are short and in fact have the exact same height, while all Night Elves are tall and also all have the exact same height. Or for example, all Night Elves have glowing eyes and pointed ears, while all Orcs have hunched backs and rougher facial features. Thus, height and attractiveness vary mildly within a race in WoW, but tend to vary a great deal between races. While avatars of the same race all have the same height, given that it would be difficult to measure the attractiveness of thousands of avatars, we used an avatar's race as a proxy for their attractiveness.

Method

Data Collection. The main measure of performance in WoW is known as *levels*, a rank of progression between 1 and 60. Game-play in WoW is largely structured around attaining higher levels by completing a variety of tasks. We implemented an automated script that performed a *census* every 15 minutes on three WoW servers. The census gathered information about all unique characters such as their race, their location, and the level they were currently at within the game. To ensure we did not simply sample characters that were online at a given time of day or day of the week, we collected census data from these three servers over a period of seven days (2016 independent censuses were conducted). We then extracted all unique characters from our census data points. Altogether, our sample yielded 76,843 individual characters. The average character level was 23.6 (SD = 20.08).

Attractiveness. To calculate the average attractiveness of each of the eight races that serve as avatars in the game, we captured screenshots of each race from the character generation segment of the game. The character generation segment has a "random generation" option that allows a user to randomly select and combine one of the possible hair styles, face textures, skin tones and hair colors available of the selected race. We used this random generation feature to generate sample avatars of each race. Because the gender of every character can also be selected, we captured the first four randomly generated avatars for every race and gender. Thus, altogether, we generated 64 images of WoW avatars.

Twenty-two undergraduate students were presented with these 64 images in randomized order and were asked to rate the attractiveness of every avatar. They responded on a 7-point bi-polar fully-labeled scale ranging from "Extremely Unattractive" (1) to "Extremely Attractive" (7). The average attractiveness ratings of each of the eight races are shown in Table 1.

Height. To calculate the height of every race, we measured the number of pixels of their avatar's height in a digital imaging application. The height of all avatars of each race is held constant in WoW. In other words, all Gnomes have the same height; all Night Elves have the same height, and so on. The heights of the eight races are presented in Table 1.

Results and Discussion

A multiple regression with character height, character attractiveness, and the interaction term as the independent variables and character level as the dependent variable revealed the overall model was significant (*Adj.* $R^2 = .01$, $F[3, 76839] = 214.13$, $p < .001$).

In the case of large sample sizes, the effect size is often a better indicator of the model than the significance value (which is often inflated). According to Cohen (1988), an R^2 of .01 would be considered to be small.

Character height was a significant predictor in the model ($\beta = .07$, $t[76839] = 19.74$, $p < .001$). Character attractiveness was also a significant predictor in the model ($\beta = .03$, $t[76839] = 7.58$, $p < .001$). The interaction term was also significant ($\beta = .04$, $t[76839] = 8.90$, $p < .001$). When we solve the regression equations for the combination of minimums and maximums for character height and attractiveness, we find the following. Among short characters, unattractive characters are expected to be higher level (21.2) than attractive characters (12.77). The slope of this and all following contrasts are significantly different from 0 with a p-value of less than .02. Among tall characters, unattractive characters (23.29) are expected to be lower level than attractive characters (29.87). These contrasts can also be framed with attractiveness as the reference point. Among attractive characters, tall characters (29.87) are expected to be higher level than short characters (12.77). Among unattractive characters, tall characters are expected to be higher level (23.29) than short characters (21.2). When everything is combined, the data suggest that tall attractive characters are expected to be the highest level while short attractive characters are expected to be the lowest level.

As would have been expected, tall attractive avatars are most likely to be the highest level. On the other hand, it was surprising to find an interaction effect where short attractive characters were expected to have the lowest performance. One possible explanation is that short attractive avatars appear child-like and would be more associated with concepts of playfulness and casualness rather than the confidence and competence that would be associated with tall attractive avatars. In hindsight, it was probably naïve to assume that traits combine in a perfectly linear manner. This pattern of backlash effects is also seen elsewhere in the literature in virtual agents. Behavioral and visual realism of agents much match to produce high social presence. When the two forms of realism mismatch (e.g., high visual realism paired with low behavioral realism), the outcome is worse than with an agent of low levels of both forms of realism (Bailenson et al., 2005). We see a similar pattern in our data. High levels of attractiveness and height produce the best results, low levels of both produce an intermediate result, and the mismatched conditions produced the worst results.

Overall, the findings suggest that avatar height and attractiveness do play a role in character performance in an online game and tall attractive avatars do outperform other avatars, but that these physical attributes may interact with each other in unexpected ways. Thus, it is not as simple as stating that attractive avatars tend to outperform unattractive avatars. Nevertheless, these findings show that an avatar's appearance can influence a user's behavior in an online environment. In Study Two, we examine whether these behavioral changes persist when users leave the virtual environment.

Study Two

Method

Design. In a between-subjects design in an immersive virtual reality system, participants were randomly assigned to have an avatar that was shorter or taller than a confederate who was of the opposite gender. We relied on demographic data to assign the base height and height differences in the study. From the NHANES 2003-2004 data set (NCHS, 2004), we calculated the mean and standard deviation of height among Caucasians aged 18 to 22 in the US population. The mean height was 171.5 cm (or 5 feet and 7.5 inches) with a standard deviation of 10.2 cm. While men and women have different average heights, we decided to use the same base height across all conditions to avoid confounding height with gender in the experimental design. In our study, the confederate's avatar had a base height of 172 cm. In the short condition, participants were 10 cm shorter than the confederate. In the tall condition, participants were 10 cm taller than the confederate. Thus the size of our manipulations in the short and tall conditions was about one standard deviation in height. In our study, the confederate was blind to the height condition and the participant's avatar always appeared to the confederate as the same height. In cases where this would create a problem in maintaining eye gaze, trigonometry was used in the background to correct the eye gaze angle so participants and confederates could make eye contact appropriately. In other words, confederates did not know the experimental condition and always perceived the participant as the same height as themselves.

Participants. Participants were 40 undergraduate students (18 female, 22 male) who were paid ten dollars for their participation. Participants were evenly divided into the tall and short conditions (balanced by gender).

Materials. In the room where the study took place, a black curtain divided the room. To ensure that confederates and participants were not biased by the attractiveness each other's real faces, confederates stayed behind this black curtain until the virtual reality interaction began. The virtual room was modeled after the physical room the participants were in, approximately 3 meters by 8 meters with white undecorated walls.

Apparatus. The immersive virtual reality equipment allowed participants to wear a helmet-like head-mounted display and move naturally in the physical environment to move in a virtual environment. Unlike typical computer games where users use joysticks to move their avatars, an immersive virtual system allows users to walk in a virtual environment by walking in the physical environment. When a user moves in any direction in the physical environment, the virtual environment adjusts accordingly, and thus it appears to the user that they have moved the same amount in the virtual world at the exact speed that the user moved physically. The same is true for head movement. To look around the virtual environment, a user would tilt or turn their head in the physical world and the virtual environment would be updated accordingly.

Participants wore an nVisor SX[1] head-mounted display (HMD) that featured dual 1280 horizontal by 1024 vertical pixel resolution panels that refreshed at 60 Hz. The simulated viewpoint was continually updated as a function of the participants' head movements, which were tracked by a three-axis orientation sensing system. The position of the participant along the x, y, and z planes were tracked via an optical tracking system (WorldViz PPT[2]). See Figure 2 for the equipment setup.

Procedure. Participants were told that the goal of the experiment was to study social interaction in VR environments and that they would be having a conversation with another person in VR. Once the VR world was loaded, participants saw themselves in a room that was exactly the same dimensions as the physical lab room they were in. The confederate's avatar was visible across the virtual room.

The confederate followed a strict verbal script that was displayed in their HMD. Their nonverbal behaviors were not scripted and they were instructed to use natural head movements when interacting with the participant. First, participants were greeted by the confederate. The confederate then asked the participants to introduce themselves.

A negotiation task that had shown behavioral differences in confidence between users placed in short and tall avatars in a previous study (Yee & Bailenson, 2007) was used in this study. After the introductory phase, the lead research assistant explained the money sharing task – a variation of the Ultimatum Game (Guth, Schmittberger, & Schwarze, 1982). A hypothetical pool of $100 was to be split between the confederate and the participant. One of the two would designate a split. The other would either accept or reject the split. If the split was accepted, the money would be shared accordingly. If the split was rejected, neither would receive any money. The participant was told there would be four rounds of this game and that the lead research assistant would alternate as to who would be making the split for each round. In other words, the participant made the split in the first round, then the confederate made the split in the second round, and so forth.

The participant always designated the split in the first and third rounds. The confederate was instructed to always accept a split as long as it did not exceed $90 in favor of the participant. The confederate always designated a split of 50/50 in the second round and 75/25 (in the confederate's favor) in the fourth round. These two ratios were chosen to represent a fair and unfair split.

After the money sharing task, the participant was taken out of the virtual setting. Before the HMD was removed from the participant, the researcher closed the curtains. The participant was then told that they would perform the money sharing task again, but this time face to face with the other person. Both the participant and confederate were seated 2 meters from each other before the curtain was opened again and the money sharing task was performed again. Seating the participants ensured that physical differences in height were minimized in the face-to-face interaction and thus reduced noise introduced into the study design.

Negotiation Task Performance Measure. The split offers were recorded by the research assistant during the negotiation task. Altogether, there were three decisions of interest in each negotiation task - the participant's first offer, their second offer, and whether they accept or reject the unfair offer. Consistent with findings from a previous study of avatar height (Yee & Bailenson, 2007), we predicted that participants in tall avatars would be more likely to make unfair splits in their own favor (in both their first and second offer) than participants in short avatars. We also predicted that participants in tall avatars would be less likely to yield and accept the unfair split made against them than participants in short avatars.

Results

A series of repeated measures ANOVAs were conducted with Trial (in VR and outside VR) as the within-subject factor, Height Condition (short and tall) as the between-subject factor, and the three decisions (first offer, second offer, acceptance of unfair offer) were used successively as the dependent variables.

In the repeated measures ANOVA with the first offer as the dependent variable, there was a significant main effect of Height Condition (*F*[1,38] = 4.75, *p* = .04, η^2 = .11). Participants in the tall condition (*M* = 54.56, *SE* = 1.04) were significantly more likely to offer splits in their own favor than participants in the short condition (*M* = 51.37, *SE* = 1.04). There was also a significant main effect of Trial (*F*[1,38] = 4.34, *p* = .04, η^2 = .10). Participants interacting face-to-face were significantly more likely to offer splits in their own favor (*M* = 53.75, *SE* = 1.00) than participants inside of VR (*M* = 52.18, *SE* = .60). The interaction was not significant (*F*[1,38] = .16, *p* = .69, η^2 = .003).

In the repeated measures ANOVA with the second offer as the dependent variable, the main effect of Height Condition was not significant (*F*[1,38] = .13, *p* = .71, η^2 = .003). There was, however, a significant main effect of Trial (*F*[1,38] = 28.39, *p* < .001, η^2 = .23). Participants interacting face-to-face were significantly more likely to offer splits in their own favor (*M* = 64.8, *SE* = 1.67) than participants inside of VR (*M* = 55.48, *SE* = 1.15). The interaction was not significant (*F*[1,38] = .06, *p* = .81, η^2 < .001). Table 2 displays the means and standard deviations across conditions and trials.

And finally, to analyze the dichotomous measures of acceptance of the unfair offers, we ran two logistic regressions using the acceptance rates as the dependent variables and height as the independent variable. In the trial within VR, the regression model was not significant χ^2(1, *N* = 40) = .90, *p* = .34, *Cox and Snell R-Square* = .02. Height was not a significant predictor of acceptance *B* = -.61, *p* = .34. In the trial outside of VR, the regression model also was not significant, χ^2(1, *N* = 40) = 1.62, *p* = .20, *Cox and Snell R-Square* = .04. Height was also not a significant predictor of acceptance *B* = -.82, *p* = .21.

In sum, the effect of height was significant on the first split but not the second split or the final acceptance. This unexpected finding may suggest that a self perception effect is present, but that it quickly dissipates. This would imply that self perception effects triggered in virtual environments have little impact on subsequent face-to-face interactions. On the other hand, the effect of height on the first split appeared in both the virtual and face-to-face task. Thus, a dissipation explanation does not fully explain why the effect emerges again during the first split in the negotiation task outside of VR. If a dissipation effect were in play, then we would expect the Height condition to no longer have an influence outside of VR. We will consider this mixed finding in more detail in the Discussion section.

The table of means suggests that participants were more likely to increase the split in their own favor in the second split. One potential explanation is that the first "testing the waters" split provides a better glimpse at individual confidence, and that participants in general become more aggressive over time as they get more comfortable with the task and the confederate. Also, previous studies have shown that different contextual factors may influence the outcome of splits in terms of whether experimental manipulations cause changes in behavior in early rounds or later rounds of negotiation (Bolton, 1991).

It was also found that participants in general split more in their own favor face-to-face than in the virtual environment. Because trial order was confounded with trial context (in vs. out of VR), it is difficult to determine the exact reason for this finding. One potential explanation for this effect is that the participants received an unfair split from the confederate from the first trial and were more willing to be aggressive in the second trial (i.e., the face to face trial always came after the virtual trial) to offset another potential unfair split in the second trial. This might also explain why the effect of Trial is so large during the second offer in the face-to-face trial, as this is the participant's last offer in the game before what they probably suspect is another unfair offer from the confederate. Thus, the effect of Trial may be an artifact of the ordering rather than an effect of face-to-face interaction. On the other hand, these two unexpected findings show that a negotiation task performed in series does not provide a clean measure for the intended effects.

While the effect of height was only significant in the first split, this effect was consistent in both the virtual and face-to-face trials. Thus, the study provided some tentative evidence that the Proteus Effect may persist in subsequent face-to-face interactions.

Discussion

In our observational study of an actual avatar-based online environment, our findings partially supported H1 and H2. Tall attractive avatars were found to outperform other combinations of avatars, but the interaction effect suggests that certain combinations of height and attractiveness (i.e., short attractive avatars) may produce unexpected results. Thus, it is not as simple as saying that attractive avatars always outperform unattractive avatars. In Study Two, we found tentative evidence that a user's representation inside a virtual environment can impact how they behave with others in both the virtual setting as well as face-to-face settings even after they are no longer in their avatar, thus partially supporting H3 and H4.

In Study Two, we found a consistent effect across trials where the effect of Height was significant in the first split but not the second split or the final acceptance. Had the effect of Height not been significant outside of VR, we might have concluded that this would have been predicted by the diminished effect of deindividuation in the face-to-face context. In other words, given that deindividuation augments the effect of self perception, the face-to-face condition may have been expected to completely wash out the effects of the avatar manipulation. The findings suggest, however, that the effect of identity cues in the virtual environment still had an effect even when the context shifted to face-to-face and participants were less deindividuated. This suggests that the self perception effect lingers even when deindividuation has been diminished. One theoretical implication is that deindividuation can be used as a scaffolding to trigger enhanced self perception effects that might be expected to linger even when the deindividuation scaffold is later removed. While previous studies have examined differences between individuated and deindividuated groups, our findings here suggest that the deindividuation scaffold might be used to trigger effects that normally would not occur in the individuated state.

Another potential explanation for the diminishing effect is that the effect of self perception from the avatar diminishes over time from the moment of exposure given that the participants are not exposed to the avatar again for the remainder of the trials. Thus, the effect of size perception is largest during the first split. This explanation, however, also does not fully account for the re-emergence of the height effect in the face-to-face condition. After all, the participant is not exposed to the avatar again when they exit the virtual environment. On the other hand, our theoretical framework for why Proteus Effect may transfer to a subsequent face-to-face scenario was driven by self perception of the *virtual behavior*. Thus, when participants first return to the physical environment, their virtual behaviors produce a new self perception effect—"I am someone who is willing to negotiate aggressively". And again, this effect diminishes rapidly but is still able to affect the first split. In short, the first self perception effect (inside VR) is driven by an observation of the avatars' appearance. And the second self perception effect (outside VR) is driven by an observation of their own previous behavior within VR.

There were some limitations to our studies. An obvious one is the lack of causal evidence of the Proteus Effect in Study One. While that data is only correlational, the results from the avatar-based online community are consistent with our previous experimental findings. The use of a single-item measure for rating avatar attractiveness may be a cause for concern given the moderate standard deviations, but single-item ratings of attractiveness have been used in other studies (Diener, Wolsic, & Fujita, 1995; Snyder et al., 1977). Also, Study One was also unable to take into account the potential explanation that users choose avatars that reflect their own personalities—i.e., tall people are competitive and more successful in the physical world and are more likely to choose tall avatars and behave consistently in the virtual world. And unlike our laboratory studies where confederates were always blind to condition, behavioral changes in an online game may occur because other players treat taller avatars differently than they treat shorter avatars, i.e., behavioral confirmation (Snyder et al., 1977). Thus, with our current data, it is not possible for us to tease apart the relative contributions of the Proteus Effect from behavioral confirmation.

Furthermore, the unexpected interaction effect suggests that certain combinations of height and attractiveness may produce unexpected results. In hindsight, it was probably naïve to expect combinations of physical traits to be perfectly linear and not interact in unexpected ways. In light of self perception theory, a confluence of contradictory cues would not likely resolve in a coherent direction of influence. On the other hand, this does invite examination of whether there is a hierarchy among cues such that certain cues are more likely to be salient during self perception. There is also the possibility that cues mean different things in different contexts. For example, in an environment like WoW where combat is the primary activity, unattractiveness may be associated with a hardy, war-weathered fighter and thus code for competence and power. Thus, cues in the physical world may not transfer into themed virtual worlds directly. Future research in this area should be cautious of this fluidity of cues and the risks of combining cues.

Some people might also wonder why users would choose unattractive or short avatars to begin with. In Study One, 18% of players chose the two shortest races (i.e., Gnomes and Dwarves) and 18% of players chose the two most unattractive races (i.e., Orcs and Undead). Thus, a little over one-third of players selected the shortest and most unattractive races in WoW. While not the goal of the current study, it would indeed be interesting to explore the motivations for avatar selection. An interesting hypothesis is that individuals who choose these avatars perceive themselves to be short or unattractive (i.e., have low self-esteem).

There were also limitations with Study Two. As we have noted, the results of the negotiation task were not consistent with each other although the pattern of both trials do offer tentative evidence for the effect. The findings also showed an unexpectedly large effect size of the trial condition (VR vs. face-to-face). While the effect size of trial condition was comparable to that of the height condition in the first offer, the effect size of trial condition was significantly larger than that of the height condition in the second offer. As mentioned before, this may be due to the ordering of the task rather than an effect of the face-to-face condition. The participants, suspecting a repeat of the unfair offer from the confederate at the end of what would have been the last negotiation task, may have tried to pre-empt the unfair split with one of their own. Thus, the second offer in the second trial was significantly larger than those in any other trial. A final limitation was that we tested whether effect persisted only a few minutes after the virtual interaction. Thus, it is not clear whether this effect persists beyond the short term. The possible extraneous effects due to the confound of trial order and trial context suggest that future studies should use different tasks to examine the effects rather than the same task over again.

There are several implications of the current research. First of all, we had previously determined that an avatar’s appearance can change how people behave in virtual environments inside the laboratory (Yee & Bailenson, 2007). In the current work, we extended the finding to actual online communities in which people socialize for large amounts of time, and also show that this effect occurs outside of highly controlled experimental settings. On the level of the virtual community (Rheingold, 1993), these results imply that the design and implementation of avatars may have an effect on shaping the emergent social norms and interaction patterns.

Secondly, we found some evidence that the Proteus Effect carries over into subsequent interactions, even in face-to-face situations. While the results are tentative, they suggest that a short exposure in a virtual environment can lead to an observable behavioral difference in subsequent face-to-face interactions. Future studies can clarify the duration and effect of these virtual manipulations.

The current work also points to several research opportunities. First of all, it would be interesting, as mentioned before, to examine the motivations for avatar selection. In particular, we might gain interesting insights as to the personality traits that might lead a user to pick a particular avatar. A related idea is to explore the relative contribution of choice and behavioral confirmation in avatar-based interactions. If an additive effect were found, it would suggest that our avatars shape our behaviors in and out of virtual worlds far more significantly than studies in the Proteus Effect have shown. Secondly, these findings prompt the study of long-term participation in virtual worlds with similar avatars. For users who regularly spend 20 hours a week in a digital avatar, might their online behavioral repertoire shape and become part on their face-to-face behavioral repertoire over time? This is an important question as more and more people spend time in their digital bodies.

As more and more people don their avatars to interact in virtual environments for business, learning, and entertainment purposes, it becomes more and more important to understand how our avatars change our behavior in turn. While avatars are usually perceived as something of our own choosing, it is also the case that our avatars come to influence our behaviors and interactions with others. Early rhetoric in virtual worlds and identity often employed metaphors of liberation and fluidity (Barlow, 1996; Turkle, 1995), but more recent studies have shown just how porous and entangled virtual and physical worlds are. For example, rules of personal space and eye gaze aversion in virtual worlds actually follow well-known rules of nonverbal behavior (Yee, Bailenson, Urbanek, Chang, & Merget, 2007) even though the modality of movement is entirely different (i.e., mouse and keyboard as opposed to arms and legs). And our current work shows how this process can occur in the opposite direction. The behavioral repertoire that is shaped by our digital avatars in virtual environments carries over into physical settings. Together these studies suggest that neither the virtual nor the physical self can ever truly be liberated from the other. What we learn in one body is shared with other bodies we inhabit, whether virtual of physical.

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Footnotes

1. The nVisor SX is a head-mounted display sold by Virtual Realities. For more technical information, see: http://www.vrealities.com/nvisorsx.html

2. The Precision Position Tracker is an optical tracking system sold by WorldViz. For more technical information, see: http://www.worldviz.com/products/ppt/index.html

Author Brief Biographies

Nick Yee is currently a post-doctoral student in the Department of Communication at Stanford University. His research interests are in social interaction and self-representation in virtual environments.

Jeremy N. Bailenson is an assistant professor in the Department of Communication at Stanford University. His main area of interest is the phenomenon of digital human representation, especially in the context of immersive virtual reality.

Nicolas Ducheneaut is a research scientist in the Computing Science Laboratory at the Palo Alto Research Center (PARC). His research interests include the sociology of online communities, computer-supported cooperative work, and human-computer interaction.

Table 1

Average attractiveness and height ratings of races in World of Warcraft.

	Attractiveness Mean (SD)	Height (in pixels)
Dwarf	2.97 (1.70)	299
Gnome	3.48 (1.54)	194
Human	4.71 (1.53)	447
Night Elf	3.10 (1.83)	515
Orc	2.05 (1.68)	424
Tauren	2.60 (1.70)	495
Troll	2.47 (1.65)	462
Undead	2.13 (1.75)	457

Table 2

Summary of means and standard deviations of the splits offered by participants and whether they accepted the unfair offer.

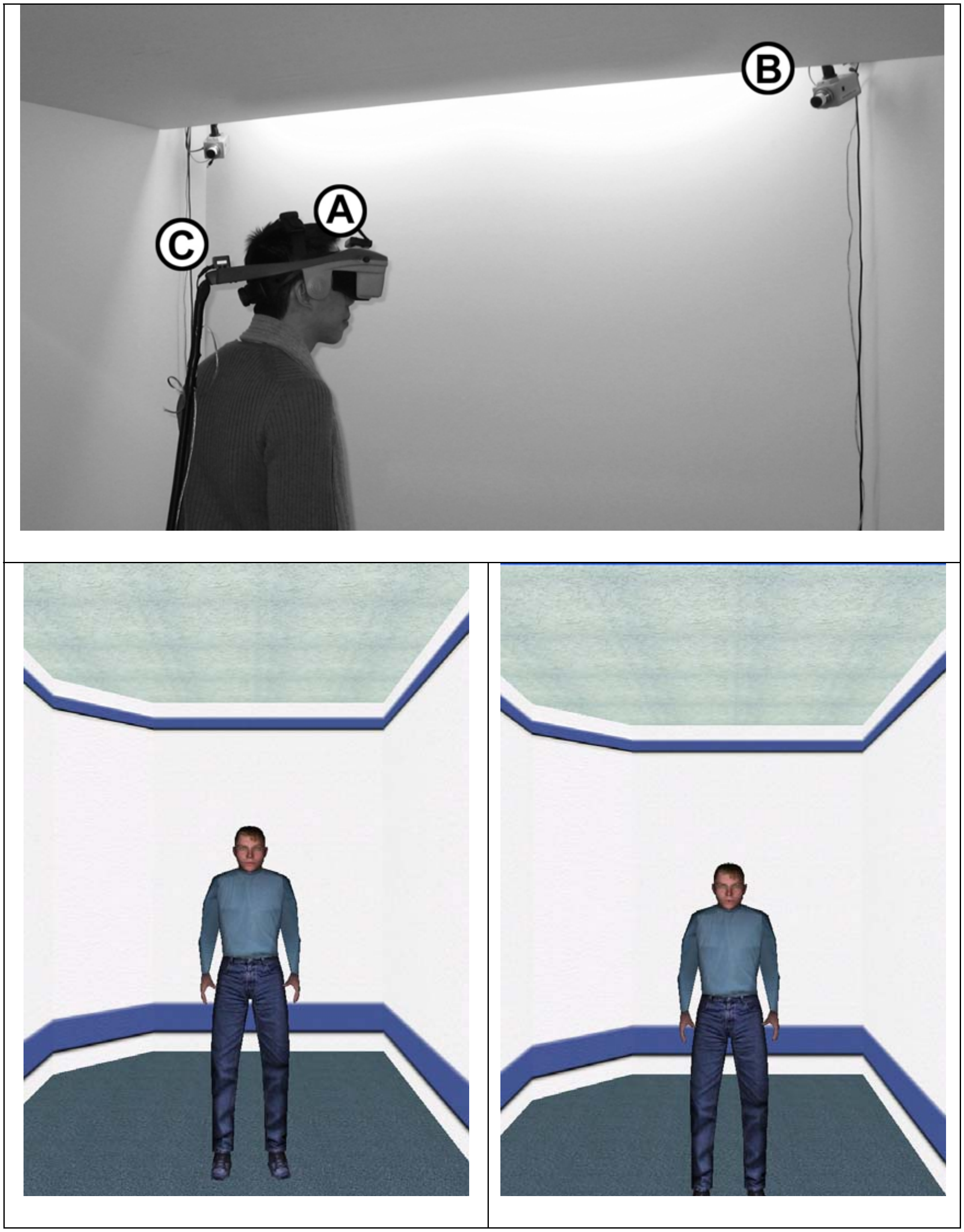
	Condition	Split One	Split Two	Accept Unfair
Inside VR				
	Tall	53.62 (5.09)	54.85 (7.36)	55%
	Short	50.73 (1.79)	56.10 (7.18)	40%
Outside VR				
	Tall	55.50 (8.10)	64.60 (11.00)	55%
	Short	52.00 (3.77)	65.00 (10.13)	35%

Figure Captions

Figure 1. Examples of a short avatar (A), an attractive avatar (B), a tall avatar (C), and an unattractive avatar (D) which were randomly generated from World of Warcraft.

Figure 2. Top panel shows the physical equipment worn by the participant: (A) the head-mounted display, (B) the camera that tracked translation, and (C) the accelerometer that tracked head rotation. Bottom left panel shows point of view from the starting position of the participant in the short condition. Bottom right panel shows point of view from the starting position of the participant in the tall condition.


A
B
C
D


B
A
C