The Effect of Personalized Avatars on Self-Presence

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Abstract

In order to achieve a sense of self-presence in a virtual environment, users are represented by avatars. While avatars do not have to resemble individual users or even appear human, the avatar in which a user is embodied in can affect how that user behaves in a virtual environment. Thus, experiments in virtual reality will often manipulate avatar appearance, including personalizing avatars and agents so they resemble individual users. However, the customizable features in avatar creation software may create a biased representation of the participant. In the following paper, we discuss issues in generating custom avatars for experimental purposes and briefly describe the method we use of generating semi-customized avatars for use in a networked virtual environment designed for experimental manipulations. Using a small sample of convenience from an ongoing experiment, we describe participant self-presence ratings while inhabiting these avatars and compare those ratings to the "ground truth" ratings of avatar resemblance to the photographs by research assistant coders. We find a relationship between coder ratings of resemblance and participant ratings of self-presence for a subgroup of participants. Finally, we discuss suggested areas of improvement in avatar generation, including common pitfalls in photographing user faces and customizing avatar bodies and accessories.

Keywords: Avatars, self-presence, customization, virtual reality, embodiment

The Effects of Personalized Avatars on Self-Presence

An increasing amount of social interaction now takes place in virtual spaces where users communicate with avatars that serve as digital representations of themselves (Kaplan & Haenlein, 2009; Anh, Fox, & Bailenson, 2012; Perrin, 2015; Nowak & Fox, 2018). Avatars can vary from a static display photo on discussion forums to mobile and controllable virtual bodies in massively multiplayer online role-playing games (MMORPGs). Avatar appearance can also vary from photorealistic to cartoonish in form. Avatar appearance provides social cues which can affect users' behavior (Allison, Puce, & McCarthy, 2000) and self-presence. Thus, the relationship between appearance, self-presence, and embodiment is an important area of research (Bailenson et al., 2008; Lin & Wang 2014; Nowak & Rauh 2005; Pace, Houssian, & McArthur 2009; Garau, 2006).

User interactions in a virtual space are highly dependent upon presence, meaning the psychological feeling of "being" within an environment and the ability to reference one's perceptions to an "external space outside the limitations of our sensory organs (Heeter, 1992; Sanchez-Vives & Slater 2005; Slater et al., 1995; Loomis 1992)." Presence can be expanded into three main categories: personal (self), social, and environmental (Lee, 2004**)**. Personal (self) presence is defined as the user's perception of physical existence within the virtual world where an avatar represents the self and serves as an extension of the self (Ratan, Santa Cruz, & Vorderer, 2008). Social presence is the ability to interact with other "minds" or entities within the virtual world, such as the "sense of being with another" or the "sense of another through a medium" (Biocca et al., 2003). Environmental presence refers to the interactivity of the environment as it responds to user behavior (Lee, 2004). In this work, we focus on users' levels of self-presence as it relates to avatar appearance.

Self-presence is affected by how embodied a user feels in their avatar (e.g. 'the avatar is a part of me'). Users report higher levels of presence when they feel embodied in their avatars, thereby indicating a tightly knit relationship between presence and embodiment (Slater et al., 2010; Schultze, 2010). Adding to its complexity, embodiment entails both bottom-up and top-down processes (Tsakiris, 2010; Tsakiris & Haggard, 2005). Bottom-up processes represent sensory stimulation of afferent neural pathways, whereas top-down processes represent the cognitive processes that influence interpretation of sensory stimulation, such as accounting for visual features that indicate human resemblance when attributing oneself to an avatar representation (e.g. 'Is this me? We share the same eyes').

Considerable research in social science has used the top-down approach, focusing on what visual features of an avatar are related to feelings of self-presence and how that interacts with embodiment and subsequent behaviors within the virtual space. Studies that focus on manipulating avatar representation to support different identities and varying perspectives report strong psychological effects on user behavior (Peck et al., 2013). In a study where avatar appearance was manipulated as attractive and unattractive avatars, those assigned the 'attractive' avatar were more likely to self-disclose than those assigned an unattractive avatar (Yee & Bailenson 2007). In a similar study (Yee, Bailenson, & Ducheneaut, 2009), height was also manipulated, and users assigned a taller avatar were more confident in negotiations as compared to those in the shorter condition. These findings indicate that users act in accordance with stereotypes or social expectations associated with the appearance of those avatars. It is important to note that in the studies described above, participants inhabited the avatars from the first person perspective and viewed their avatar bodies in the mirror to view their avatar faces (as one views

one's own face in real life), thereby reinforcing the user's connection or identity with their avatar.

Also in support of the significant role of avatar representation on user behavior, the doppelganger effect utilizes the cognitive process of self-referencing to enact behavioral change. The doppelganger effect takes a third person perspective to avatar embodiment, in which a user watches her doppelganger (an avatar that resembles her, but that she has no control over) engage in behaviors (Bailenson, 2012). Akin to the Proteus effect, the doppelganger effect also assumes a strong link between avatar appearance and subsequent behaviors, highlighting the impact of physical resemblance on self-referencing by allowing users to objectively visualize the effects of behavioral change (Fox & Bailenson, 2010; Fox, Bailenson, & Binney, 2009). While it is clear that a strong relationship between avatar appearance and behavioral change exists, what remains unclear is how closely an avatar must resemble its target user in order to effect levels of self-presence within a virtual environment.

Avatar realism in social interactions has often been studied as two components: visual realism and behavioral realism. Visual realism focuses on the avatar's physical appearance, including facial features, skin tone, and body shape while behavioral realism focuses on how realistic gestures and facial expressions are within the context of social interaction. Garau (2006) found that while higher behavioral realism (operationalized as eye gaze) improved communication with a more photorealistic avatar, this was not true for lower realism avatars in the higher behavioral realism condition. Therefore, the combined effect of these two components at the same level (high visual, high behavioral) creates a greater sense of avatar realism, but uneven levels of avatar appearance such as low visual and high behavioral realism can hinder a participant's perceived quality of communication. The relationship between the visual and

behavioral levels of avatar realism on communication were also replicated in Kang et al.'s study (2008) where participants rated avatars in a highly visual realistic (video of a human versus graphic avatar) and highly behavioral realistic environment (static display versus dynamic or animated) as more capable of social interaction than conditions with mismatched levels.

The case for creating realistic avatars for social science research is supported by users' positive perceptions of such avatars. People prefer humanoid avatars that are more gendered (clearly male or female) and attributed greater ratings of attractiveness, credibility, and homophily to the avatar (Schultze, 2010). Suh et al. (2011) found that the more an avatar resembled the participant, the more likely a participant had positive attitudes such as affection and connection towards the avatar in the context of apparel evaluation. Therefore, forming a positive percept towards an avatar affects the participant's intention to use the avatar and thus feel embodied in their avatar representation which implies successful task completion in the virtual world.

While evidence supports the creation of photorealistic avatars to increase users' levels of self-presence and embodiment, it is important to note that these findings reside on a continuum. Despite the push for photorealistic avatars and agents, there is also a potential risk of the uncanny valley effect where users might begin to reject humanoid robots with the highest levels of photo and behavioral realism (Mori, 1970). Although the exact configuration of photo and behaviorally realistic features and traits at which such an effect might take place remains unknown (Yamada, Takahiro, & Keiko 2013), researchers describe the phenomena as an subjective experience in which an interaction with the avatar suddenly becomes negative, without warning. (Brenton et al., 2005; Seyama & Nagayama, 2007; Saygin et al., 2011).

Therefore, researchers must carefully consider the fidelity of avatar photorealism in order to avoid an unexpected uncanny valley effect in users.

In a study conducted by Tinwell et al., (2011) the authors explored potential causes for the uncanny valley, suggesting that the effect may in part be driven by conflicting verbal and visual cues related to emotion. More specifically, when emotion communicated was not paired with corresponding facial expressions (e.g. fear with sad eyes), participants rated animated characters as more uncanny than their human counterparts. While our study did not focus on emotional expression, Tinwell et al.,'s stimulus brings to light an important part of social interaction: the face.

As mentioned previously, humans derive important social cues from facial expression, thereby making the face an important resource for social information processing. There is evidence to suggest a dedicated brain area for facial processing, the fusiform face area (FFA) (Kanwisher, McDermott, & Chun, 1997). The existence of the FFA implies that faces are salient sources of social information used to inform our behavior and thus require a dedicated processing space within the brain to extract facial cues. While the ability to derive meaning from the human face is crucial to social interaction, it is important to note that humans are especially primed to recognize their own face. In a study that compared virtual avatars made to look like the participant and another avatar made in the image of another person, researchers found that virtual avatars made to look like the participant elicited the same P200 waveform that is characterized in self-recognition (Gonzalez-Franco et al., 2016). That is, when a person looks in the mirror, or sees a photo of themselves, the P200 waveform is elicited. This same waveform is also elicited in virtual reality when the avatar is a photorealistic form of the participant. In addition to this study, Waltemate et al., (2018) found that participants given customized photorealistic avatars that

resembled the participant were more likely to report higher levels of presence and embodiment within their virtual avatar as compared to equally photorealistic, but generic, avatars. Therefore, having photorealistic avatars enhances a strong self-recognition effect that is seen in physical reality and can enhance a participant's sense of self-presence and embodiment.

Avatar Creation for Social Science Experimentation

As more social scientists seek to create photorealistic avatars for their participants to embody in experiments, avatar processing workflows that are readily available to the academic community are crucial for research. Considerable research on avatar development includes the use of high end visualization techniques such as photogrammetry to more budget friendly options such as hand-held video input (Ichim, Bouaziz, & Pauly, 2015), Microsoft Kinect (Aitpayev & Gaber, 2012), and body scanning (Tong et al., 2012). However, currently these systems require advanced technical skills to adopt or troubleshoot (Malleson et al., 2017), thereby creating a higher barrier for entry by introducing a steeper learning curve for those getting into the field. Other limitations with the proposed photorealistic methods listed above include the increased amount of time and processing power required.

Another option for researchers interested primarily in investigating social interactions and self-perception in virtual reality is to create multi-software workflows using consumer avatar creation tools such as FaceGen, Daz3D Studio, Adobe Fuse, or Mixamo. However, such systems rely on preset elements and defaults, which introduce inaccuracies that may differentially affect specific groups. There are known issues with avatar creation software that lack racially diverse defaults that represent racial minorities **(**Kafai, Cook, & Fields, 2010**)**, and even if there is an option to select a non-Caucasian appearance, the avatar is sometimes made in the image of a Caucasian template, with the same white facial features attached with an option to change skin

tone (Dietrich, 2013). In addition, there is a lack of body diversity in avatar creation software, with current platforms favoring an overabundance of hypersexualized male and female avatars that are reflected in the fantasy themed body type, hair, and accessories many games share (Consalvo & Harper 2009; Mou & Peng, 2009; Royse et al., 2007). Elderly avatars are also not represented (Cheong, Jung, & Theng, 2011), and hairstyles are also limited due to technical difficulty (Yu, 2001), thereby limiting the potential for avatar diversity within avatar creation software.

In the following pages we briefly describe an expedited avatar creation process for social scientists. To investigate the resemblance of the avatar appearances to the actual participants, we then compare the "ground truth," as operationalized by research assistants' ratings of their resemblance to participant photographs, to the self-presence ratings reported from participants after viewing their avatars in a virtual mirror. Given the results of the rating tasks, we further explored the factor of race. Finally, we discussed strengths and weaknesses revealed by this system, and the next steps for future research.

Creating Semi-customized Avatars

The workflow we describe used several commercial systems in order to create facially customized avatars. A sample Unity scene containing an example of rigged avatar with simple inverse kinematics and a mirror for inducing a sense of embodiment is included in the following shared folder: https://cornell.box.com/s/r1qr84e42ladn0fo55u93x0qbaagnvom. This folder also includes readmes with step-by-step instructions to create, import and rig new avatars.

First front facing and profile (either left or right side) photographs of the participants were required. The photographs should be taken in a passport style fashion without any facial obstructions (e.g. glasses, bangs, or piercings).

The photos were then imported into the commercial facial scanning software, FaceGen, where a 3D model of the face was generated. The facemask was then imported into Daz3D Studio, and combined with a generic avatar body template (Genesis). The hairstyle, hair color, and skin tone were then personalized based on the participants' photos. After finishing the customization, the avatar was clothed and then exported as an FBX file.

The avatar FBX file was then imported into a Unity project file where the avatar's skeleton was rigged using an inverse kinematics approach to allow for natural movement of the upper body. The environment was then networked for dyadic collaboration, which allowed two participants to see each other's avatars and hear each other's voices in virtual reality. Once in the virtual environment, the avatar's height was adjusted to match the participants' own height.

Visual Realism for Avatar Personalizing

Most social science experiments use self-report ratings to examine resemblance, or the physical similarity between a photorealistic avatar and its user (Bailenson et al., 2005; Vasalou, Joinson, & Pitt, 2007; Kim & Sundar, 2012). However, ratings can be biased based on a user's preferences as well as the social contexts in which the avatar was made in and for. In this study, we took a different approach in order to take advantage of an existing dataset. Research assistant coders were asked to rate the visual realism of the avatars compared to the photographs of the actual participants. Thus, the measures in this study were created not only to understand people's attitudes on their own or others' avatars, but also further explore potential factors in the recognition process that may influence raters' perceptions of avatar accuracy, and participants' feelings of self-presence.

Methods and Materials

Participants

Twenty-two participants (20 females; 8 Caucasian/White, 2 African American/Black, 11 Asian/Asian American, and 1 multiracial) were recruited from a large Northeastern university in the United States. All aspects of the experiment were approved by the Institutional Review Board and all participants signed informed consent.

Research Assistant Raters

Thirteen undergraduate research assistants (9 females; 3 Caucasian/White, 4 Asian, 1 African American/Black, 3 Multiracial, and 2 Other/Did not state) rated the visual realism of the avatars.

Materials

Participants wore an Oculus Rift head-mounted display (HMD) with a resolution of 2160 x 1200 at 90Hz and held Oculus Touch controllers in each of their hands (Oculus, 2018).

Procedure

In the first scene, participants stood in front of a virtual mirror and looked at their own customized avatars from the first person view, as shown in Figure 1. During this time, they were instructed to perform a series of movements, such as raising their arms and stepping forward and backward, following the metronome called out by the research staff. The exercise was intended to show participants that they were embodied and had control over the movement of the arms and the head of the customized avatars. Then the mirror was turned off and the participants were connected to another participant to complete a collaborative or competitive task to generate environmental-friendly principles. Finally, they completed a survey about their experience and self-presence. We used the self-presence ratings from this experiment to investigate the success of the avatar personalization process.

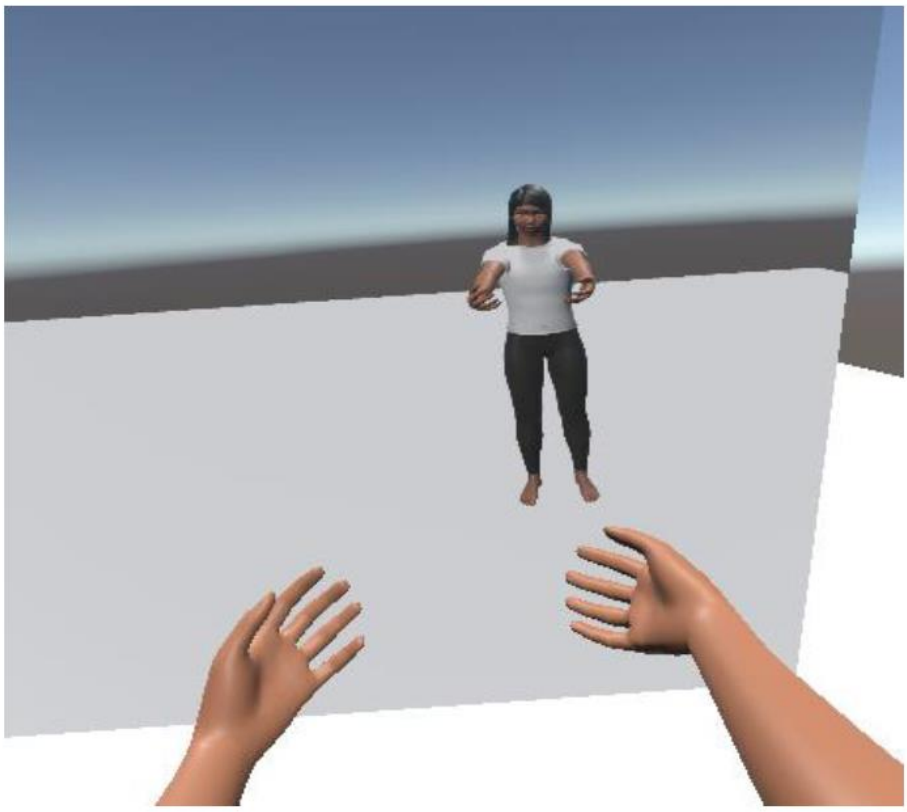

Figure 1. **Photorealistic avatar created in FaceGen and Daz3D.** A participant, embodied in a photorealistic avatar, is checking out her avatar from the first person's perspective. Although the above photograph was taken as if a participant were viewing her avatar diagonally in order to reveal the position of the mirror, participants could see their avatars from the front angle in actual experiments.

Measures

Participants' Self-Presence Task. Four questions ("If something happened to the avatar, it was also happening to me", "The avatar was an extension of me", "The avatar represented my actions well", "The avatar was me") (Won et al., 2014) were averaged to create a measure of self-presence. While these questions did not explicitly ask participants about their avatars'

resemblance to their real life selves, they did provide information about participants' self-presence in the virtual environment, which is a key component of embodiment manipulations in virtual environments. The four questions had a Cronbach's alpha of 0.71. However, removing one of the questions ("If something happened to the avatar, it was also happening to me") boosted the alpha to 0.81. Thus, the remaining three questions were averaged to create the measure of "self-presence". Participants on average reported a low "self-presence" ratings on their avatars (M=2.21, SD=0.84) (Table 1), especially to the statement "the avatar was me" (M=1.82, SD=0.96).

Table 1

Mean and standard deviation of the three "self-presence" ratings from participants

Questions	Mean	SD
The avatar was an extension of me.	2.27	1.08
The avatar represented my actions well.	2.55	0.91
The avatar was me.	1.82	0.96

Resemblance Task. Research assistants were presented a row of three pictures for each participant, one frontal and one side photographs of the participants, and a frontal image of their avatars on a Qualtrics survey. Then they were asked to rate "How much the avatar in the image resembles the photo" in terms of the face/facial features, skin tones, hairstyles, hair color, and body shape of the participants on a 5-point Likert scale (1 = "Does not at all resemble this participant", 5 = "Very strongly resembles this participant"). The presentation order of participants and the ratings of the five body parts were randomized. These results were averaged to create a total scale of "resemblance", which served as the "ground truth" of the avatar ratings.

Finally, the raters reported their own genders and ethnicities. In summary, research assistants reported a low average "resemblance" rating (M=2.91, SD=0.40) (Table 2). Body features, such as face (M=3.08, SD=0.44), hair color (M=3.17, SD=0.74) and body shape (M=3.28, SD=0.26) on average had slightly higher resemblance ratings from research assistants compared to the skin tone (M=2.43, SD=0.90) and hair styles (M=2.60, SD=0.85).

Table 2

Mean and standard deviation of the "resemblance" ratings from research assistants

Rating Features	Mean	SD
Face	3.08	0.44
Skin Tone	2.43	0.90
Hairstyle	2.60	0.85
Hair color	3.17	0.74
Body Shape	3.28	0.26
Resemblance	2.91	0.40

Matching Task. Research assistants were shown six frontal screenshots of avatars and six frontal photographs of the corresponding participants on each page on a survey. The screenshots of the avatars and the photographs were randomly mixed together. Participants were asked to match the avatars to the photographs by putting the labelled numbers of the avatar screenshots in the box in front of each photographs. The presentation order of each page was randomized. In the matching task, the average rater success rate of matching photographs to the corresponding avatar was 62.59% (SD=0.21).

Ranking Task. After finishing the matching task, research assistants were asked to rank the importance of the five body features they referred to (face/facial features, skin tones,

hairstyles, hair color, and body shape) when they matched avatars to participants (1 = "The most important factors", 5 = "The least important factors"). In the ranking task, the top three body features that research assistants valued and referred to when matching participants with their avatars are face/facial features (46.15%), skin tones (30.77%) and hairstyles (38.46%) while 53.85% of the research assistants ranked hair color as the fourth important factors and 84.62% ranked body shape as the least important factors.

Results

There was no significant correlation between participant "self-presence" ratings overall and average "resemblance" rating (r = .19, p=.391, 95% confidence interval [-0.25, 0.57]).

Given the potential problems with avatar representation across race/ethnicity (Lee & Park, 2011; Kafai, Cook, & Fields, 2010; Pace, Houssian, & McArthur, 2009), we next investigated the self-reported race/ethnicity of the participants as a factor. We found a marginally significant interaction between participant race/ethnicity and average resemblance ratings on participants' self-presence ratings, such that Asian participants' ratings correlated negatively with their reported self-presence compared to other participants. For simplicity of further analysis, we dropped the two African-American participants and the single multi-racial participant to create a smaller dataset composed of the Asian and Caucasian participants. We then examined the correlations between self-presence ratings and research assistant ratings for each group (shown in Table 3). While we found positive correlations for Caucasian participants, correlations for Asian participants were negative and non-significant. It is important to note that these results were affected by the perceptions of both the raters and the participants.

Table 3

Correlations between the resemblance ratings from research assistants and self-presence ratings from Asian participants and Caucasian participants respectively.

RA Ratings	**Asian participants' self-presence**	**Caucasian participants' self-presence**
Face	.30	.30
Skin Tone	-.01	.82*
Hairstyle	-.01	.57
Hair color	-.42	.52
Body Shape	-.11	.39
Average	-.06	.85**

*Correlation significant at $p<0.05$

** Correlation significant at $p<0.01$

Discussion

In our exploration of a small convenience sample from an ongoing experiment, we found positive relationships between observer ratings of avatar resemblance to the participants' photographs and reports of self-presence, when participant race was used as a covariate. We then examined our two largest groups of participants, Asian and Caucasian participants, finding overall positive relationships between research assistant ratings of resemblance for Caucasian participants and these participants' own ratings of self-presence. However, this pattern did not hold for the Asian participants. Although this is a preliminary study and thus we cannot draw conclusions with the given limitations of our data set, being a small convenience sample limited to a university's diversity in its student population, there are certain avatar customization norms, such as limited availability of hair styles/color and known issues with lighting that affect skin tone appearance in virtual worlds, that may help to explain the lack of correlation between

research assistant resemblance ratings for Asian participants and their own ratings of self-presence.

Though we created a humanoid avatar with customized facial features, self-presence ratings from participants and resemblance ratings from research assistants were still low overall. When validating different body features of the avatars, skin tone and hairstyle had lower resemblance ratings compared to hair color, facial features, and body shape (Table 2). This finding may be a result of uneven or unnatural lighting in the photographs that distorted the natural skin tones of the participants, in conjunction with a limited variety of non-fantasy hairstyles available for customizing avatars.

The ranking task revealed that research assistant raters valued skin tone and hairstyle over facial features, hair color, and body shape when recognizing avatar faces. The importance of hairstyle mirrors previous avatar customization research conducted by Ducheneaut et al., (2009) which found that hairstyles and hair color were ranked important customization features for participants creating avatars in Second Life, World of Warcraft, and Maple Story. One possible explanation for the importance of hairstyle and hair color, Ducheneaut et al. (2009) note, is the malleability of hair. That is, it is fairly easy, painless and more socially acceptable, to change one's hairstyle as compared to augmenting a body part in order to change one's identity. Changes in hair style and color can dramatically change how a person looks and gives off other identifying cues such as age or other group identifications (Synnott, 1987). However, hair color may not have been valued as an identifying feature in our study due to limited ability to customize hair such that ombre colored hair or participants with highlights were given an average hair color, thereby mitigating the unique identifying effect of hair color.

Contrary to our findings on the importance of skin tone, Ducheneaut et al. (2009), found that skin color was the least important feature for avatar customization. However this discrepancy may be explained by differences in goal based orientations in MMORPGs. Users in MMORPGs have different, game driven, motivations for their avatar's appearance that lead them to choose clothing or accessories as their key identifying features, which in turn lessen the importance of skin tone on appearance (Lin & Wang, 2014; Vasalou & Joinson, 2009; Ducheneaut et al., 2009). Therefore it is important to consider the context in which an avatar is being used when researching the relationship between avatar representation, identification, and self-presence. In line with context, it is also important to note that both skin color and color presentation of faces (e.g. variance in lighting or presentation in black and white versus color) changes the perception of faces with respect to racial categorization of European American and African American faces (Stepanova & Strube, 2009). Thus, it came as no surprise with hair style and skin tone ranking as most helpful identifying features, that these two avatar features were rated as having lower resemblance to photos of the participants, serving as a possible explanation for the reduced overall ratings seen in avatar appearance.

Limitations

This brief experiment had many limitations. First, we used a sample of convenience from an ongoing study. Thus, in the post-task survey, participants were not explicitly asked about their perception of the resemblance of the avatar to themselves. Second, our sample size was very small. Third, the sample in the study was not diverse. In the department from which both the research participants and the research assistants were recruited, women were overrepresented, as

were Asian and Caucasian students. Thus, we are limited in our ability to explain the difference between groups, or to claim that these differences would generalize.

However, we take the opportunity to draw some lessons about avatar creation here. First, we see an unsurprising positive relationship between avatar resemblance (as rated by observers using photographs as the ground truth) and self-presence for Caucasian participants. Second, the aspects of avatar resemblance that are most highly correlated with self-presence ratings in our study are skin tone and hair color, both of which are easily altered by the conditions in which reference photographs are taken, as well as the lighting choices in modeling and game engine software. Thus, we see easy areas of improvement on participant self-reported presence.

We note that when taking the photograph, there are several considerations to take into account: (1) the head should be centered without being tilted to either side of the body, (2) the lighting should be a white light in order to capture the participant's true skin tone, (3) the lighting should be even without shadows or overexposure to one side, and (4) the camera should be held steadily in order to avoid blurriness or distortions.

There is a delicate balance to customization: first, making avatars more physically realistic, thereby portraying users' actual selves; and second, allowing users agency to include or exclude blemishes or imperfections; thereby allowing them to portray their 'ideal self.' This struggle between the virtual representation of ideal and actual self was best captured during the photo taking process. When participants were asked to push their bangs back or take off their glasses, some voiced dismay with the process, stating that they did not want their blemishes to be incorporated into their avatar, or that they do not like how they look without glasses.

Conclusion

Avatar creation in gameplay sheds a light on another facet of identity selection: choosing whether to represent the ideal self or the photorealistic self. Bessiere et. al., (2007) found that users create their avatars in the likeness of their ideal self more than their actual self. In another experiment looking at the effects of user-end avatar customization, Dolgov et al., (2014) found that users were more helpful towards their partners in completing an experimental task than when they were embodied by an avatar customized by a research assistant. Studying the effect of creating an ideal representation has been broadened to looking at the influence of character creation interfaces (CCIs) on avatar customization. McArthur (2017) also noted a difference in a user's level of experience with CCIs; such that part of the user identity is influenced by knowing how much a user can customize, in other words, knowing what the limitations of the system are. This idea could be further extrapolated to participant's rating of embodiment; if they are aware of the limitations of avatar creation, their expectation of likeness may not be high, so they look towards other cues such as hair and skin color to identify whether the avatar looks like them or not.

As virtual reality technology becomes more accessible to the public, an increase in daily social interactions is predicted to take place in 3D virtual spaces, giving social science researchers more ecologically valid environments in which to explore participant reactions to their avatar options. It remains an open question how users will adapt to these parameters. Although commercial avatar creation softwares have greatly improved the variety of customization features within their platforms, they are still far away from inclusive design, as our findings suggest. This leaves us with a larger area of research to explore: Are users aware of the limitations of commercial avatar creation software? If so, do they adapt to these norms when

making judgements about avatar resemblance and self presence? What specific assumptions and norms do users adopt with them? And how do these factor into a user's experience of overall presence and embodiment within a virtual world?

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