



Black immersive virtuality: Racialized experiences of avatar embodiment and customization among Black users in social VR

Cyan DeVeaux^{a,*},, Euyg Han^a, Zora Hudson^{b,c}, Jordan Egelman^{d,e}, James A. Landay^f, Jeremy N. Bailenson^a

^a Department of Communication, Stanford University, United States

^b Department of English, Stanford University, United States

^c Department of Math, Stanford University, United States

^d Department of Psychology, University of Colorado Boulder, United States

^e Department of Sociology, University of Colorado Boulder, United States

^f Department of Computer Science, Stanford University, United States

ARTICLE INFO

Handling editor: Matthieu Guittot

Keywords:

Avatars
Avatar embodiment
Race
Social virtual reality

ABSTRACT

Previous research has uncovered racialized avatar experiences in desktop virtual worlds, but less attention has been given to how this has evolved into the more immersive medium of social virtual reality (VR). Leveraging Intersectional Tech and the Virtual Identity Discrepancy Model as frameworks, we report on findings from two complementary studies aimed at understanding the avatar embodiment experiences of Black users on VRChat, a popular social VR platform. Study 1 draws on interview findings ($n = 11$) to examine how Black users navigate, negotiate, and respond to avatar-based racial inequity and defaults of whiteness in this immersive context. Participants took on racialized burdens and immersive repercussions when curating their digital appearance, including embodied glitches, navigating racialized encounters with avatar creators, relying on DIY solutions (e.g., learning avatar creation), and conscious consideration of the marginalization of Black virtual bodies when selecting their representation. Study 2 extends these findings with a quantitative experimental study ($n = 41$) that examined how the discrepancy between physical and virtual attributes influenced Black users' psychological experience in social VR while manipulating their avatar's visibility. Avatar discrepancy was negatively correlated with spatial presence and, in the absence of a virtual mirror, avatar discrepancy was negatively correlated with avatar embodiment. We use these mixed-methods findings to identify new perspectives on the embodied consequences of racial discrepancies in social VR, underscoring the privilege of immersion. By centering perspectives from Black users and discussing implications for designers and researchers, we expand avatar research on the multi-faceted experiences of racially marginalized users in social VR and Black virtuality.

1. Introduction

Over the past decade, social virtual reality (VR) has become an emerging digital context for socialization, collaboration, work, and play with millions of global users (Han et al., 2023; McVeigh-Schultz & Ibister, 2022; PlayerCounter, 2023; Sykownik et al., 2021). Unlike desktop virtual worlds, head-mounted displays (HMDs), controllers, and body-worn trackers enable real-time syncing between a user's physical movements and their avatar's movements (Sanchez-Vives et al., 2010). This novel form of avatar-mediated communication, combined with the customization of one's virtual appearance, can make the experience of

wearing avatars in social VR feel personal (Freeman & Maloney, 2021) and provide an embodied outlet for "acting out" identities (Freeman & Acena, 2022). There are also behavioral (Yee & Bailenson, 2007) and psychological (DeVeaux et al., 2023; Jo et al., 2017; Suk & Laine, 2023) implications of embodying avatars in VR. Past research has documented a Proteus Effect in VR where users conform to the expected behaviors of their avatar based on its virtual appearance (Yee & Bailenson, 2006).

As a result of these psychobehavioral consequences and experiential differences that uniquely distinguish physically embodied avatars, understanding the novel self-presentation practices and avatar-based experiences of social VR users has become a recent agenda in human-

* Corresponding author. 450 Jane Stanford Way Bldg 120, Stanford, CA, 94305, United States.
E-mail address: cyanjd@stanford.edu (C. DeVeaux).

computer interaction (HCI) research. This small but growing body of work has sought to understand the nuance of avatar-mediated communication in this immersive context, interrogating how users wish to curate their embodied appearances, feel towards their avatars, and behave in them (Freeman & Maloney, 2021; Maloney et al., 2020; Moustafa & Steed, 2018; Oyanagi et al., 2022). The process by which users develop practices and perceptions of their avatars can sometimes be tied to their lived identities. Avatars serve as proxies for the self in virtual worlds (Manninen & Kujanpää, 2007; Zhang et al., 2022). In social VR, the deeply immersive nature of this proxy can elicit a desire to align certain aspects of the actual self with the self portrayed in-headset (Freeman & Maloney, 2021). However, not all users have historically had equal opportunities to express themselves online. In addition to the harassment that users with stigmatized identities can face (Gray, 2014; TaeHyuk Keum & Hearn, 2022), technological constraints can prevent users from curating appearances that align with their virtual self-concept (Dietrich, 2023).

In an effort to promote inclusive design practices in the growing medium of social VR, past scholars have conducted research centering the avatar experiences of users with marginalized identities, such as people with disabilities (Gualano et al., 2023; Zhang et al., 2022, 2023), women between the ages of 40 and 65+ (Morris et al., 2023), and LGBTQ users (Acena & Freeman, 2021; Freeman & Acena, 2022). However, a notable gap in this literature, and understudied topic in the broader canon of VR research, is an in-depth understanding of the avatar experiences of Black users in VR (Hatfield et al., 2022; Peck et al., 2021). This is problematic for a number of reasons, including its potential to introduce design bias that unequally disfavors Black users (Peck et al., 2021), the historical precedent of Black users encountering representation issues in desktop virtual worlds (Passmore et al., 2018; Passmore & Mandryk, 2018), and how it can perpetuate a presumption of whiteness. Moreover, results drawn from predominantly white samples are not sufficiently representative of all humans (Henrich et al., 2010).

We address this empirical gap through two complementary studies on the racialized experiences of avatar embodiment among Black social VR users. Grounded in Gray's (2020) Intersectional Tech Framework and Jin's (2012) Virtual Identity Discrepancy Model (VIDM), we aim to highlight any racialized friction in this process and understand the unique and embodied consequences of avatar racial representation in social VR. Gray's (2020) Intersectional Tech framework seeks to comprehend the “*visual, textual, and/or oral engagement of the black body, originating from the digital and moving into the physical (or vice versa)*.” This interdisciplinary framework is built on the understanding that physical realities of racial inequity are reflected in digital space and that the practices of Black users stemming from this are complex and intersectional (Collins & Bilge, 2016; Rankin & Han, 2019). VIDM is an extension of Higgin's (1987) self-discrepancy theory (SDT), which highlights how inconsistencies between different self-states may cause discomfort. VIDM brings this theory into a virtual context to demonstrate links between virtual self-representation and its sociopsychological implications.

Study 1 qualitatively seeks to understand barriers to inclusive avatar systems in social VR through in-depth interviews with Black VRChat users ($n = 11$). The interviews aim to capture how Black users navigate, negotiate, and respond to avatar-based racialized experiences. In doing so, we illuminate how systemic racism implicitly and explicitly influences avatar systems, cultures, and practices in social VR.

Building on a finding from Study 1 on how the visual of one's avatar representation could impact one's sense of immersion, Study 2 examines this relationship further. In particular, we use quantitative findings from an experimental study ($n = 41$) to examine how the discrepancy between physical and virtual attributes influences Black users' psychological experience in social VR. In line with the emphasis on mirrors in social VR culture and body transfer literature (Fu et al., 2023; Slater et al., 2010), we manipulated the presence of a virtual mirror to vary the visual salience of participants' avatars while immersed in VR.

Furthermore, to more accurately capture avatar differences discerned by this sample, the measure of perceived discrepancy included a number of visual attributes that have shown to be relevant to Black representation but are missing in past avatar discrepancy literature (Ducheneaut et al., 2009; Passmore & Mandryk, 2018). We augment understanding of participants' perceived sense of avatar discrepancy by analyzing their behavior during the customization process.

Accordingly, we use these two studies to address the following research questions:

RQ1. How do Black users navigate, negotiate, and respond to avatar-based racial inequity in social VR?

RQ2. What are the unique, embodied, and psychological consequences of perceived avatar discrepancies in social VR among Black users? How does the visual salience of one's avatar influence this dynamic?

This paper makes several significant contributions to the Media Psychology, VR, HCI, and Game Studies communities. First, we offer new perspectives on the embodied consequences of racial discrepancies in social VR that game developers can use to understand how to create more positive and inclusive user experiences (Kaye, 2016). Second, while past work on virtual worlds have established links between avatar similarity with embodiment (DeVeaux et al., 2023; Suk & Laine, 2023), presence (Jin, 2012; Jo et al., 2017; Rahill & Sebrechts, 2021), self-awareness (Arvanitidou, 2016; Hooi & Cho, 2012; Vasalou et al., 2007), and self-affirmation (Pringle, 2015), we extend this work into the naturalistic, social context of social VR and with a population of users that have been underrepresented in the formulation of these findings. Third, by presenting, to our knowledge, the first in-depth empirical studies on the experience of Black users in social VR, we aim to inspire researchers to incorporate and center the perspectives of racially marginalized users in future work.

2. Related work

We ground this inquiry in prior research across Game Studies, Media Psychology, and HCI. This section first situates this work in existing scholarship on digital games as racial projects and social VR as an emerging context for avatar embodiment. We then describe past work exploring mirrors as a vehicle for avatar-centered experiences and the psychological effects of avatar discrepancy.

2.1. Digital games as racial projects and Black user experience

As a visual medium, technological advancements in computer graphics technology have allowed digital games to incorporate detailed imagery into gameplay experiences (Richard & Gray, 2018). While this increase in visual complexity enabled games to incorporate more detailed characters, narratives, and mechanics of play, it also brought greater salience to racial themes emerging in this context (Richard & Gray, 2018). Representation of Black digital bodies in games became limited, insufficient, and based on stereotypes as whiteness became privileged as the default (Dietrich, 2023; Leonard, 2003; Norwood, 2021; Passmore & Mandryk, 2018). Historically, when Black characters were not absent altogether, Black male characters were mainly found in sports gaming titles and Black female characters were mainly props and bystanders (Leonard, 2009; Norwood, 2021). Options for customizing Black avatars were lacking as well, contributing to a number of incidences of Black users voicing a desire for more accurate representation (Passmore & Mandryk, 2018; St. Fleur & deWinter, 2021). User-generated avatar systems have also produced discrepancies in representation between Black avatars and their white counterparts (Kafai et al., 2010). While progress has been made (Dietrich, 2023; Freeman & Maloney, 2021), avatar racial disparities still exist (Dietrich, 2023) and have evolved into more immersive visual technologies such as augmented reality (Peck et al., 2022). The normative whiteness that

inadequate Black representation in games reinforces is compounded by presumptions of whiteness among players (Kendall, 2002).

As Gray (2014) explains, “*because our virtual bodies bring physical world manifestations into virtuality ... we begin to replicate real-world inequalities into virtual space.*” This inequality has rendered Blackness in virtual environments invisible, hypervisible, and stigmatized (Gray, 2012). In an ethnographic study of the linguistic profiling of African-American males in Xbox Live, Gray (2012) details the normalization of anti-Black racism in gaming and showcases the interconnectedness of virtual and physical identity among Black users. Racist interactions and other discriminatory online practices can break Black users’ sense of immersion in games (Passmore et al., 2018) and cause identity threat (Lee & Park, 2011). Amidst this reality, the practices of Black users are multifaceted and varied, with some deracializing their identities while others center their intersectional identities and build community around them (Gray, 2020; Richard & Gray, 2018). These social and cultural hierarchies that exist within the realm of digital games sustain it as a racial project, or what Omi and Winant (1994) describe as, “*simultaneously an interpretation, representation, or explanation of racial dynamics, and an effort to re-organize and redistribute resources along particular racial lines.*” Virtual environments generate and sustain social meaning and racialized ideas (Ewick & Silbey, 1995; Leonard, 2003; Nakamura, 2009). They operate under what Fletcher (2022) theorizes as the magic circle of whiteness, where, in addition to adhering to a set of rules of play (Huizinga, 2014), users are subject to “*white cultural logistics.*”

Nonetheless, Black users have existed and persisted in digital gaming (Everett, 2009; Russworm & Blackmon, 2020). Counteracting omissions of Black women in the history of digital gaming, Russworm and Blackmon (2020) present an article framed as a mixtape of the “*vibrant Black feminist gaming counter-public*” and Rankin and Han (2019) document the range of gameplay experiences among Black college women. That said, the experiences of Black users in digital games have been an understudied topic in the literature (Richard & Gray, 2018).

Social VR has also received little attention from researchers as an emerging backdrop for Black digital praxis and racialized experiences. Racism in social VR has only recently been uncovered in the literature and has focused primarily on its manifestation through hate speech directed toward marginalized users (Blackwell et al., 2019; Freeman, Zamanifarid, et al., 2022; Freeman & Maloney, 2021; MacArthur et al., 2024). This emerging form of embodied racial harassment in social VR can feel more realistic than similar behaviors in non-immersive contexts due to the heightened sense of presence in VR environments (Freeman, Zamanifarid, et al., 2022; Sabri et al., 2023). These findings are on par with definitions of racism that view it primarily through the lens of isolated direct attacks derived from personal matters and individual racists. However, racism is also a systemic issue, where “*collective practices, mechanisms, and behaviors*” reproduce racial hierarchy (Bonilla-Silva, 2021). Whereas previous work has disentangled the propagation of systemic racism in social-technical systems (Bhimull et al., 2022; Nakamura, 2009), social VR has not yet been empirically examined as a backdrop for this phenomenon. The present paper aims to address this empirical gap and explore how Black virtuality, defined by Darke (2023) as “*the way that Black bodies, Black cultures, and Black identities are constructed and consumed in a virtual space,*” emerges within this immersive, social context.

2.2. Social VR as an emerging context for avatar embodiment

Social VR is an emerging ecology of platforms where users interact with each other in 360-degree immersive virtual environments using head-mounted displays (HMDs). Unlike desktop virtual worlds, social VR enables a novel form of avatar-mediated interaction where physical body movements are tracked and rendered on to a user’s virtual body. The physical body, as opposed to a mouse or keyboard, becomes “*the immediate and sole interface between the physical self and the digital self*”

(Freeman & Maloney, 2021). This embodied interaction, alongside voice chat and other avatar design features, enables social VR users to communicate using both verbal and nonverbal cues (e.g., gesture, haptic feed, and gaze) (Kolesnichenko et al., 2019; Wei et al., 2022). Moreover, it can promote a sense of virtual body ownership (Freeman & Acena, 2022; Fu et al., 2023; Sanchez-Vives et al., 2010; Slater, 2008), make avatars feel more realistic than in desktop virtual worlds (Freeman & Maloney, 2021), influence user behavior (Yee & Bailenson, 2007), and shape dynamics of social interaction in this immersive context (Kolesnichenko et al., 2019).

With this embodied context in mind, understanding how the design of avatar systems in social VR shapes users’ immersive experiences has been a recent area of focus in HCI research. In-game mechanics, such as modifying avatar appearance (Kolesnichenko et al., 2019; Smith & Neff, 2018), proxemics (Kolesnichenko et al., 2019; McVeigh-Schultz et al., 2018, 2019), social mechanics (Kolesnichenko et al., 2019; McVeigh-Schultz et al., 2018, 2019), and environmental context (Fu et al., 2023; Han et al., 2023), have been shown to influence users’ embodied experiences. For example, incorporating features that allow users to curate their self-presentation and view themselves located within their avatar body provides them with an embodied outlet to explore and “*act out*” their identities (Freeman & Acena, 2022; Freeman & Maloney, 2021; Fu et al., 2023; Turkle, 1994). Therefore, an affordance of social VR is the control one has over their embodied appearance. While social VR appears to better support the representation needs of a diverse set of users compared to desktop virtual worlds (Freeman & Maloney, 2021), an emerging thread of literature suggests that representation gaps still exist (Javier et al., 2024). Past work has found this to be the case for persons with disabilities and women between the ages of 40 and 65+ attempting to make self-similar avatars (Morris et al., 2023; Zhang et al., 2022). In particular, users from these backgrounds have voiced a desire for a greater range of hair color gradations, body types, and assistive device options (Morris et al., 2023; Zhang et al., 2022). This issue is complicated by Freeman and Maloney’s (2021) finding that many social VR users construct their avatar appearance to appear similar to their physical selves and the dearth of research on the avatar experiences of racial minorities in social VR.

We expand this literature by presenting the first in-depth, empirical analysis of the racialized avatar-based experiences of Black users in social VR. We uncover how racially biased value systems have been embedded within this emerging sociotechnical domain and investigate the embodied consequences of discrepant avatars. In doing so, we leverage some of the psychological constructs emphasized in past work detailed below.

2.3. Mirrors as a vehicle for avatar-centered technocultural activity and embodiment

As illustrated by past research and technocultural activity emerging in social VR, virtual mirrors play an important role in the avatar experience. Body transfer lab studies have used virtual mirrors to induce avatar embodiment, the psychological experience of one’s virtual body as their own body (Lee, 2004), in VR (Slater et al., 2010). Similarly, they have been used in Proteus Effect research, where after spending a period of time wearing an avatar in front of a virtual mirror, users conform to the expected behaviors of their avatar based on its virtual appearance (Yee & Bailenson, 2006). Outside of these lab-based examples, users in social VR have separately developed a culture of socializing around virtual mirrors to enhance their sense of embodiment and construct self-awareness (Fu et al., 2023).

2.4. The psychological effects of avatar discrepancy in virtual environments

Extending Higgins’ (1987) self-discrepancy theory (SDT), Jin (2012) describes the distance between a user’s virtual identity and their actual

identity as virtual self-discrepancy. This construct, and similar ones (e.g., avatar similarity), have been operationalized differently across literature. Some scholars have asked participants to rate their overall perceived discrepancy between different qualities of their avatar (e.g., behavior and attributes) and sense of how well their avatar represents them (Jin, 2012; Midha & Nandedkar, 2012). Others have experimentally manipulated the visual similarity between the avatars and participants (Jo et al., 2017; Salagean et al., 2023; Suk & Laine, 2023). And relevant to the present inquiry, there is a thread of research that measures discrepancy through perceived differences between attributes of the avatar self and the physical self (DeVeaux et al., 2023; Hooi & Cho, 2014; Messinger et al., 2008; Rahill & Sebrechts, 2021; Suh et al., 2011). Some of the attributes rated in these measures include body, hair, skin color, gender, height, weight, and eye color (Hooi & Cho, 2014; Messinger et al., 2008; Rahill & Sebrechts, 2021; Suh et al., 2011). However, many of these scales have lacked in accounting for several characteristics that are important for more racial representation among Black users (e.g., hair texture, nose shape, skin undertone) (Passmore & Mandryk, 2018; St. Fleur & deWinter, 2021). Without accounting for these attributes, research investigating avatar discrepancy may lack a nuanced understanding of the effects of embodying avatars with racial differences.

What is known are a number of psychological consequences of discrepant avatars based on the measures above. In non-immersive virtual environments, embodying self-similar avatars has been associated with higher perceived feelings of presence (Jin, 2012; Rahill & Sebrechts, 2021), self-awareness (Arvanitidou, 2016; Vasalou et al., 2007), self-affirmation (Pringle, 2015), and positive attitude towards their avatar (Suh et al., 2011). While this topic has been less explored in the context of immersive virtual environments, prior work has demonstrated links between discrepancy and avatar embodiment (DeVeaux et al., 2023; Mal et al., 2024), presence (Jo et al., 2017; Schwind et al., 2017), and pro-social behavior (Herrera & Bailenson, 2021) in VR. Tangential to this line of work includes a thread of research examining implicit bias reduction among white participants embodying Black avatars (Banakou et al., 2016; Hasler et al., 2017; Peck et al., 2013).

Much of the prior literature in this space has either not included the racial demographic information of participants or has lacked representation of Black users (Hatfield et al., 2022; Peck et al., 2021). This issue is part of a broader problem in the canon of VR research where race, ethnicity, and culture are seldom assessed (Peck et al., 2021). Given disparities in avatar representation that exist for Black users of virtual worlds (Passmore & Mandryk, 2018), the generalizability of these findings comes into question (Peck et al., 2021). In this paper, we address this by focusing on the experiences of Black users and using a critical lens to understand the psychological implications of avatars in social VR. In particular, we measure the constructs of avatar embodiment (DeVeaux et al., 2023; Jo et al., 2017; Suk & Laine, 2023), presence (Bailey et al., 2009; Jin, 2012; Jo et al., 2017; Rahill & Sebrechts, 2021), self-awareness (Arvanitidou, 2016; Hooi & Cho, 2012; Vasalou et al., 2007), and self-affirmation (Kang & Kim, 2020; Pringle, 2015) based on their prominence in avatar literature. Whereas the avatar embodiment and presence measures aim to gauge users' sense of feeling present within their virtual context, the measures of self-awareness and self-affirmation provide insight into participants' virtual self-reflection. Moreover, as most of these constructs have been linked to immersion (Cummings & Bailenson, 2016; Hooi & Cho, 2012), we selected them because they provide insight into the quality of user experience in VR.

3. Study context

We investigate the research questions and apply the above frameworks using the following platforms: VRChat for social VR (Study 1 and Study 2) and Ready Player Me for avatar customization (Study 2).

3.1. VRChat

VRChat is a social VR platform (See Fig. 1) available for download on VR headsets and desktop computers. We selected this platform due to its popularity in the social VR community. In January 2023, the platform reached a peak of over 92,000 users online at the same time (Nem, 2023). Additionally, at the time of writing, VRChat was the highest-ranked social VR entry on Steam's list of most-played VR-supported games (SteamDB, 2023). Avatars are generated by the users of the platform. Users may embody avatars created by themselves or others by several methods, such as selecting publicly available avatars at avatar worlds or uploading an avatar to the platform. In Study 1, participants were pre-existing VRChat users who selected avatars based on their preferred method. In Study 2, avatars created by participants in Ready Player Me were uploaded to VRChat.

3.2. Ready Player Me

Ready Player Me is an avatar creation interface (See Fig. 2) that allows users to customize 3D avatars and integrate them into live or in-development gaming applications (Ready Player Me, 2023). Its interoperable avatars can be customized on either a computer or mobile device. Users may customize one of the platform's default avatars or an avatar made based on their photo. Ready Player Me has been regarded as an extended reality (XR) platform playing a critical role in social VR's recent growth (Billinghurst et al., 2023). We selected Ready Player Me for Study 2 due to its popularity and several other reasons. First, the platform enables users to customize a range of avatar attributes, including clothing, eyes, eyebrows, face, glasses, hairstyle, lip, make-up, mask, nose, and skin tone. Second, the avatars on the platform have a neutral style that exists somewhere between realistic and abstract (Ready Player Me, 2021). This neutrality helps mitigate the effects of the uncanny valley (MacDorman et al., 2009) while providing enough fidelity for the expression of identity (Mori et al., 2012; Ready Player Me, 2021). Lastly, Ready Player Me can easily upload avatars directly to VRChat.

3.3. Hardware and VR equipment

In Study 1, participants used their own personal VR and/or desktop equipment. All HMD users had, at a minimum, head and hand movements tracked. In Study 2, participants used Meta Quest 2 headsets (standalone head-mounted display with 1832×1920 resolution per eye, 104.00° horizontal FOV, 98.00° FOV, 90Hz refresh rate, and six-degree-of-freedom inside-out head and hand tracking, 503 g) and two hand controllers (126 g).

4. Study 1

Prior work has uncovered barriers to accurate and equitable racial representation of avatars in virtual worlds. Yet, little empirical work has examined this issue in the context of social VR, a sociotechnical system where embodying avatars is experientially different from non-immersive environments. To address this gap, we conducted an interview study of Black users' avatar experiences on VRChat.

This study was part of a broader IRB-approved virtual ethnography, conducted by the first author, on understanding how identity and social cultures manifest in social VR.

5. Methods

In this section, we describe the participants and outline the methods for recruitment, data collection, and analysis for Study 1.



Fig. 1. VRChat users networked together in an immersive virtual world.

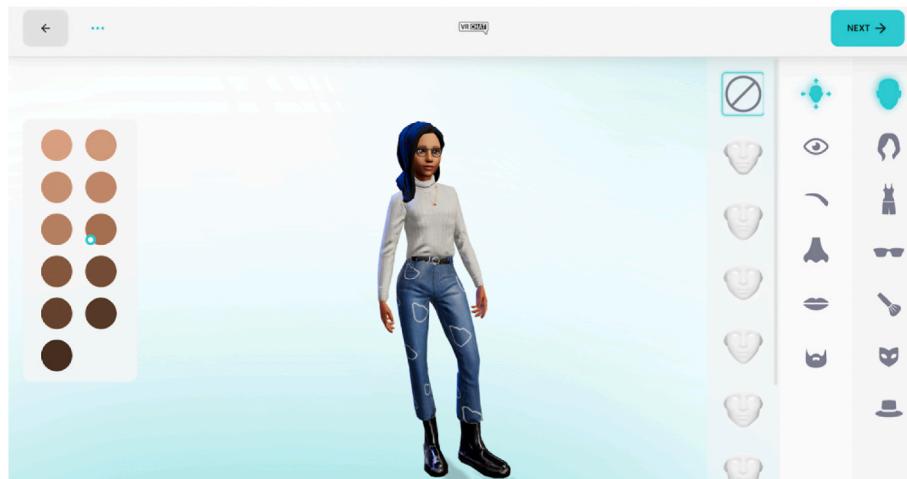


Fig. 2. Ready Player Me Interface as of August 2023.

5.1. Participants and recruitment

We present findings from in-depth interviews with 11 VRChat users who self-identified as Black, African, or African-American.¹ The first author recruited participants by posting recruitment messages on 18+ VRChat communities on Discord, contacting VRChat users with a public social media presence, and snowball sampling. The first author interviewed VRChat users between January 2022 and September 2022. Interviews were semi-structured, consisting of pre-written and improvised questions. The interview method was chosen based on participant preference and accessibility (See Table 1). Interviews on VRChat took place in a virtual world selected by the participant or first author. Synchronous interviews lasted approximately 45 min. Participants were offered compensation of a \$25 Amazon gift card.

5.2. Data collection and analysis

We employed open inductive coding and exploratory analysis to understand the interview data. Earlier interviews inspired the topics addressed in this paper and informed questions in later interviews. We continued collecting interview data until saturation was reached and recurring themes were identified. Inspired by McDonald and colleagues' (2019) guidelines for qualitative HCI Practice, we took an approach that aimed to capture recurring topics relevant to this inquiry and then connected them to establish broader themes. In line with these guidelines, we constructed themes that did not necessarily have to "align with the most prevalent set of codes but instead those that are salient to the research question or inquiry." (McDonald et al., 2019)

Before each interview, participants were asked whether they consented to have their interview audio or video recorded. Recorded interviews were transcribed using transcription software and edited for qualitative analysis. Notes were taken during sessions that were not recorded. The first author thematically evaluated the transcriptions and notes. Interviews with thematic topics relevant to race were further divided into subthemes detailed in the results section. Because pronouns were not systematically collected in this dataset, we use "they" as a gender-neutral singular pronoun when referencing participants.

¹ Participants were not required to reveal their real identity during interviews. Demographic information about race, gender, and age was occasionally revealed during interviews and systematically collected later in the interview period through an optional Qualtrics form. We used this information to narrow the sample reported in this study.

Table 1

Study 1 demographic information. Note: Black=Black or African American, Hispanic or Latinx=Hispanic, Latina, Latino, or Latinx, Indigenous=Indigenous, Native American, Alaska Native, or First nations.

ID	Race/Ethnicity	Gender	Age	Technology	Interview Method
1	Black	N/A	N/A	HMD	VRChat
2	Prefer to self-describe: Somali and Swedish	Non-Binary, Genderqueer, and/or Gender Fluid	24	HMD	VRChat
3	Black, Hispanic or Latinx, Indigenous, White	Cisgender Woman	18	N/A	Google Docs
4	Black	Cisgender Woman	25	N/A	Google Docs
5	Black	Cisgender Woman	23	HMD	VRChat
6	Black, White	N/A	N/A	HMD	VRChat
7	Black	N/A	N/A	HMD	VRChat
8	Black	Cisgender Man	28	HMD	VRChat
9	Black, Hispanic or Latinx	Non-Binary, Genderqueer, and/or Gender Fluid	21	HMD	VRChat
10	Black	N/A	N/A	HMD	VRChat
11	Black	Transgender Man	20	N/A	Discord

6. Results

In this section, we identify three major themes that encapsulate the racialized experiences of Black users on VRChat. The first and second themes—(1) Defaults of whiteness as standard—The complexities of colorism in VRChat and (2) Racialized burdens working around non-inclusive avatar cultures and systems—address how Black users navigate, negotiate, and respond to avatar-based racial inequity in social VR (**RQ1**). The third theme—(3) Embodied glitches and the unique psychological salience of racially discrepant avatars in VR—explores the unique, embodied, and psychological consequences of perceived avatar discrepancies in social VR (**RQ2**).

6.1. Defaults of whiteness as standard—The complexities of colorism in VRChat

Despite previous work urging the importance of diverse avatar representation (Passmore & Mandryk, 2018), colorism was still an issue on VRChat, as evidenced by the predominance of white and light-skinned human avatars on VRChat. Participants voiced how difficult it was to find avatars with non-white appearances.

"We do have many different types of avatars, species, and styles, but you must keep in mind that there are more of these avatars than ones that represent brown or Black people." (P3)

"That's why I mostly felt underwhelmed, even though it's a game with so many different possibilities of what you can and can't do, for it to mostly be Eurocentric." (P5)

These quotes are emblematic of the simultaneously limitless and limited landscape of avatars available in VRChat. Their responses described how, amidst the wide variety of avatars available on the platform, it was easier for them to find non-human avatars than to find Black or brown ones. These sentiments were echoed by other participants who had difficulty finding avatars that matched their preferred skin tone, hair texture, and other physical features. Interestingly, this was the case for a participant who preferred non-human avatars as well. P9, who primarily wore furry, or anthropomorphic animal, avatars, expressed how difficult it was to find such avatars with afro-textured hair. The process by which avatars were constructed also exhibited the standard of whiteness on the platform. Some avatars on the platform were customizable in-game through toggles. However, some participants noted that, in their experience, skin tone customization was infrequent and always started with white as the default when first trying on the avatar (See Fig. 3).

Most participants expressed a desire to wear avatars reflective of their racial identity. However, the avatar practices of Black users are not monolithic. Some Black users embody skin tones on human avatars different from their own. Reasons cited by participants were as a survival tactic to avoid racial harassment, especially in public lobbies, and due to the lack of racially diverse avatar options. Relevant to the survival

tactic reasoning, many participants articulated experiences encountering racism on the platform. P3 described being stalked, harassed, and having their computer crashed by others *"just because [their] avatar was a darker shade than theirs."* Interviews highlighted that Black users employ a variety of approaches to navigate these interactions, including seeking other platforms with better moderation, blocking users, directly addressing their aggressors, and seeking safe spaces and communities of color on the platform. Connected to the present inquiry, there was also some degree of consideration for their susceptibility to racial harassment when selecting an avatar. P1, who found it important to wear Black avatars, explained that *"it wasn't until I found the avatar that represented me that I experienced [racial harassment] because they flat out called me a slur. So from there, I was just like, you know, what? Sometimes you just got to politely check people."* Wearing an avatar that represented them came with the risk of racist attacks and mental preparation to defend themselves. That said, they also described coming across other Black users who wore non-Black avatars because they *"don't feel like dealing with the harassment."*

P7's choice to occasionally wear white avatars stemmed from their experience that the more specialized a category of avatar is, the more limited its racial diversity. They explained coming across specialized avatars with cool animation features that were unavailable in their skin tone. They stated, *"It really upsets me. So many nice avatars have pale skin."* This was a side-effect of avatar creators constructing avatars without creating versions with alternate skin textures. P7's response



Fig. 3. Example of a skin tone customizable avatar that defaulted to a white skin tone on its initial try-on.

showcases how the lack of avatar diversity could lead to deciding between achieving an aesthetic or functionality and a preference for racial resemblance. Thus, regardless of whether participants chose to embody Black or non-Black human avatars, this decision was a conscious one shaped by the systemic inequities on the platform.

6.2. Racialized burdens working around non-inclusive avatar cultures and systems

For those seeking Black avatars, responses from participants revealed that some users attempt to commission one but have to navigate racialized encounters with avatar creators. Given the voluntary nature of avatar creation, P2 described that avatar creators generally make the avatars they want. This culture generally accepted that people are not forced to create avatars that they would prefer not to. However, it does affect users seeking Black avatars. Multiple participants noted some resistance from avatar creators in making avatars with non-white appearances. They described that when users asked avatar creators if they could edit a pre-existing avatar to have a darker skin tone or tried commissioning an original darker-skinned avatar, it was not uncommon to be rejected and told to do it themselves with little guidance. As P1 described,

"I've even spoken with people [of color] and when they ask to do a commission, they get told 'No, I don't make avatars like that. I don't make avatars with that type of hair texture. I only do straight hair, I don't know how to do the skin tones.'" (P1)

Similarly, P4 mentioned, *"When Black or brown people buy avatars most of the time we have to do the changing to the skin textures ourselves, because the creators are just lazy even if there are packs of skin tones available."* In other words, Black and brown users often had the additional burden of modifying commissioned avatars' skin textures. While P2 did not see the principle of denying a request to be a problem, P1 found it to be a racial microaggression. However, there was a general acknowledgment across several interviews that creators could do a better job of pointing customers to resources on how to change the skin color of their avatar if they denied their request, especially given the technical knowledge needed to accomplish it. P3 articulated that they had *"been privately messaged so many times because people who buy models want to make them brown but have no idea how to and sometimes even give up and waste their money."* It is not guaranteed that someone who is commissioning an avatar has the expertise to modify it; therefore, as P3's quote highlights, there are potential financial burdens that Black users face if they spend money on avatars that they have issues editing.

Given the underrepresentation of non-white avatars on the platform, racialized encounters with avatar creators, and desire to embody avatars that resembled them, many participants turned towards learning how to create their own avatars. They cited a desire to create avatars with their skin tone or other physical attributes, such as body size, as one of their motivations for learning Unity and Blender. P3's motivation for avatar creation extended beyond just themselves. They spoke on their drive to create avatars that helped Black and brown girls *"feel seen."* Although not an avatar creator, P1 created online content on where to find Black and brown avatars that tens of thousands of people have since viewed. This form of content creation holds importance because, as indicated by P11, Black users use videos, forum posts, word of mouth, and other external sources to help find avatars that represent them.

It is also worth noting that although participants explained that the avatar creator community on VRChat has taken steps to increase avatar diversity, there were still disparities in assets and tutorials to help facilitate this process.

6.3. Embodied glitches and the unique psychological salience of racially discrepant avatars in VR

The unique consequences of avatar racial disparities in social VR

were observed through descriptions of the psychological salience of racially discrepant avatars and the phenomenon of embodied glitches. Social VR's heightened sense of presence affected how participants experienced their avatars, as participants described feeling immersed in their VR avatars. However, interviews also revealed experiences where wearing avatars that did not align with how one wanted to present themselves brought them out of their sense of immersion. This misalignment is something that P8 described experiencing while wearing white human avatars. They discussed an earlier time in their VRChat experience when they could not find suitable human avatars with dark skin tones and resorted to wearing white avatars instead. While those avatars had fun animated expressions, wearing a different virtual skin color did not *"sit right"* with them. They explained,

"When I first had tried VR, I was like, wait, this is cool. That's actually me moving my arm. That's actually me moving my body. That's me doing those actions and stuff. So it's like, when I'm in those other avatars that don't really look like or represent me, it feels like I've been placed in someone else's body. And it's just kind of weird, kind of creepy." (P8)

The same was the case for P10, who described an experience cloning a dark-skinned avatar from a friend, realizing the avatar defaulted to a white skin tone, and saying, *"Oh my God, why is it white?"* In other words, they used VRChat's cloning feature to wear the dark-skinned avatar they saw their friend wearing, but while the model of the avatar was copied, the skin color was not. Their hands did not feel correct until they changed the skin tone with a customization toggle. P8 and P10's anecdotes reveal how embodying avatars with discrepant skin tones prevented them from being able to fully immerse themselves in social VR.

The consequences of the high degree of immersion also become apparent when considering embodying an avatar with glitches. Participants spoke on the technical issues that sometimes occur more in darker-skinned avatars than their lighter-skinned counterparts. P5 expressed that sometimes avatar creators do not always take the time to make sure that everything is correct when it comes to creating dark-skinned avatars.

"I've had some [dark-skinned avatars] where even the eye color is the same tone as the rest of the body, which is a huge no-no. A lot of the times the teeth will also match the color, which happens when they're rushing to make skin tone adjustments in whatever photo editor software." (P5)

As for P4, they mentioned having difficulty finding Black and brown avatars with properly rendered afro-textured hair. These points were corroborated by a non-Black participant who was a part of the broader ethnographic sample, who noticed a disparity between their white

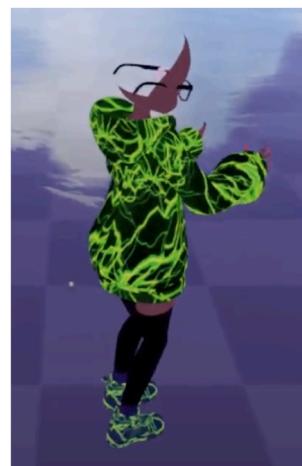


Fig. 4. Participant sharing their avatar with the hair turned off which breaks the head model by default.

avatars and the one dark-skinned version they had. In particular, the dark-skinned avatar was the only avatar with its hair turned off by default (See Fig. 4). To these participants, the racial diversity of human avatars, even on a technical level, felt like an afterthought. These anecdotes reveal technical disparities between white and non-white avatars that users, in turn, embody.

In sum, findings from Study 1 reveal the complex ways in which Black VRChat users navigate racial disparities in avatar representation. These findings, however, only begin to uncover the unique implications of immersive VR as a mediator for these embodied disparities. To deepen understandings of the qualitative findings on the embodied consequences of racial disparities obtained in Study 1, we obtain quantitative insights on the topic through an experimental study in Study 2.

7. Study 2

Leveraging experimental methods, Study 2 explores how the discrepancy between physical and virtual attributes influences Black users' psychological experience in social VR. This follow-up was inspired by the qualitative findings surrounding how the salience of one's avatar, alongside its racial representation, can affect one's sense of immersion. First-person points of view and virtual mirrors offered different perspectives for participants to view and reflect on their avatars in VRChat. However, the question remained of how one visually sees their avatar can shape the relationship between racialized avatar discrepancies and the user's psychological experience. We manipulate the presence of a virtual mirror to examine the role of avatar visual salience in this relationship. This experimental study was approved by Stanford University's IRB.

8. Methods

In this section, we describe the participants and detail the study design, procedure, and methods for data collection and analysis for Study 2.

8.1. Participants

A total of 41 adults who monoracially and multiracially self-identified as Black or African American participated in this in-person study located in a lab at Stanford University (See Table 2).² Although 41 participants is a modest sample size for experiments in VR, this is currently one of the largest sample sizes of Black participants for an in-person, experimental social VR research study to our knowledge. The sample consisted of 27 cisgender women and 14 cisgender men who ranged in age from 19 to 42 ($M = 24.63$, $SD = 5.03$). Prior to this study,

Table 2

Study 2 demographic information. Note: Black=Black or African American, Hispanic or Latinx=Hispanic, Latina, Latino, or Latinx, Indigenous=Indigenous, Native American, Alaska Native, or First Nations.

Race/Ethnicity	n
Black	30
Black, Hispanic or Latinx	4
Black, White	3
Black, Hispanic or Latinx, White	1
Black, Indigenous	1
Black, Indigenous, White	1
Black, Prefer to self-describe: African	1

33 never used VR, seven rarely used VR, and one sometimes used VR. Contrasting Study 1's sample of pre-existing, frequent social VR users, Study 2's sample offers insight into the experiences of VR novices. Participants were recruited through email outreach, social media, word of mouth, and the Stanford Communication Department's participant pool system.

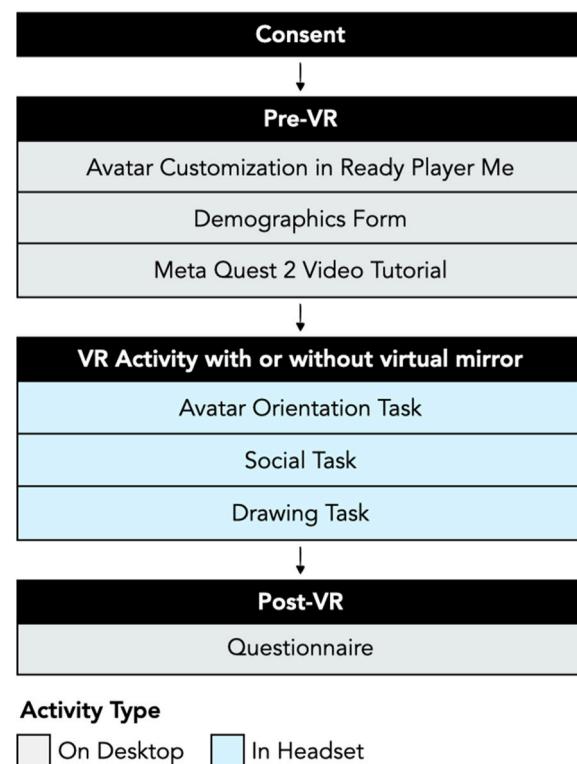
8.2. Condition: Mirror versus no mirror

To manipulate the visual salience of one's avatar, we randomly assigned participants to one of two mirror conditions. In mirror condition ($n = 21$), a virtual mirror was present throughout their time in VR. Because mirrors were absent by default in the virtual environments chosen for this study, participants in this condition were asked to toggle their mirrors on each time they entered a new environment. In the no mirror condition ($n = 20$), there were no mirrors present throughout their time spent in VR.

8.3. Procedure

Participants in this between-subjects study were randomly assigned to a mirror condition. They experienced the study in groups of one to three participants based on sign-ups, where groups experienced the same mirror condition. Fig. 5 summarizes the study procedure. After completing a consent form, each participant was brought into a private setting with access to a desktop computer or laptop. Research personnel introduced participants to the Ready Player Me platform and asked them to spend up to 8 min customizing an avatar to create one that "looked and felt" like them. Once avatar customization was complete, participants completed a demographics form and watched a Meta Quest 2 tutorial video as research personnel set up the VR and uploaded their avatars to VRChat.

Next, participants were invited into a shared physical space to spend around 20 min in social VR using Meta Quest 2 headsets. One to two researchers were present during this portion of the study, with the first



Activity Type

On Desktop In Headset

Fig. 5. Study 2 procedure.

² Findings reported in Study 2 stem from a larger sample of 88 participants who took part in this study. Based on the theoretical focus of this paper, we chose to only report data from the 41 Black participants.

author guiding participants through their VRChat experience via desktop in a neutral robot avatar and an additional researcher remaining on standby to assist with potential technical difficulties. While in VRChat, participants engaged in three separate tasks in three separate pre-determined virtual settings created by users of the VRChat platform³ where virtual mirrors could be toggled on or off (See Fig. 6). Participants in the mirror condition were instructed to toggle on the mirror after arriving at each world. The three tasks consisted of an avatar orientation task, a social task, and a drawing task (See Fig. 6). They were selected based on activities observed during Study 1's ethnography and the body transfer literature.

In the first world, participants engaged in an avatar orientation task where they completed a series of body poses and familiarized themselves with their virtual bodies. Participants in the mirror condition were instructed to stand in front of a mirror as they completed this exercise. In the second world, participants engaged in a social task where groups spent the duration getting to know each other, and solo participants shared information about themselves with the second researcher who joined them in VR. This enabled solo participants to still experience a social element of social VR despite engaging in the other tasks alone. Participants in the mirror condition were instructed to look into the mirror, where all communication partners were visible, as they spoke to each other.

In the final world, participants engaged in an open-ended drawing task with a 3D pencil. Participants in the mirror condition were instructed to remain within a virtual boundary where a large mirror would remain in their sight line. Following the VR portion, participants were guided back to their computers and completed a questionnaire while having access to a visual of the avatar they created. On average, this entire study took each participant 1 hour. Each participant was compensated with a \$25 Amazon gift card or course credit.

8.4. Data collection

We collected data from two sources: (1) questionnaires and (2) video and audio recordings of avatar customization and in-VR sessions.

Questionnaires. Each participant completed a questionnaire with the following measures⁴:

Avatar Discrepancy: Avatar discrepancy represents the perceived differences between an avatar's attributes and their physical attributes. This was measured based on DeVeaux and colleagues' (2023) adapted version of Ducheneaut and colleagues' (2009) attribute discrepancy scale. Participants were invited to "imagine [themselves] and [their] avatar standing side-by-side" and compare a number of attributes on a 7-point scale (1 = Very similar, 7 = Very dissimilar). This scale assessed a number of attributes, including features that are important for representation generally and among Black users. Specifically, it accounts for discrepancies in accessory, aesthetic, body, eye color, eye shape, fashion, gender expression, hair color, hair texture, hairstyle, nose shape, lip shape, skin color, skin undertone, and race (Ducheneaut et al., 2009; Passmore & Mandryk, 2018).

Avatar Embodiment: Avatar embodiment was measured using 16 items on a 7-point embodiment scale (1 = Never, 7 = Always) developed by Peck and Gonzalez-Franco (2021).

Social Presence: Social presence was measured using three items on a 7-point scale (1 = Strongly disagree, 7 = Strongly agree) adapted from Herrera, Oh, and Bailenson (2018).

Spatial Presence: Spatial presence was measured using three items on

³ The VRChat worlds used in this study were *Art museum* by Kireya, *[JP] the bike shed on a rainy day* by tar_bin, and *Steps of the Campanula - カンパニュラの足音* by EstyOctober.

⁴ Although avatar realism was collected as a measure, we removed it from the scope of this analysis due to its overlap with the avatar discrepancy measure.

a 7-point scale (1 = Strongly disagree, 7 = Strongly agree) adapted from Oh, Herrera, and Bailenson (2019).

Self-Affirmation: Self-affirmation was measured using a 14-item 5-point scale (1 = Not at all, 5 = A great deal) adapted from Napper and colleagues' (2009) self-appraisal scale.

State Self-Awareness: The state of self-awareness was measured using an abbreviated version of Wegner and Giuliano's (1980) self-focus linguistic implications form. We selected five sentences from the questionnaire where each had one missing word, and participants were provided with pronouns to fill in the blanks. As prior work has established a link between personal pronoun usage (e.g., I and me) and self-focused attention, the number of sentences with personal pronouns selected was summed to produce a self-awareness score. In line with prior work, participants completed this form immediately after their VR experience (Vasalou et al., 2007).

Video Recordings of Avatar Customization and in-VR Sessions.

Each participant had the option to provide additional consent to be video and audio recorded during the study. Participants who consented to recording had their screen and audio recorded during avatar customization.

8.5. Data analysis

To evaluate the relationship between perceived avatar discrepancy and psychological constructs of interest (avatar embodiment, social presence, spatial presence, self-affirmation, and self-awareness), we conducted an exploratory analysis where the six constructs from the questionnaires were analyzed using Pearson's correlations. These correlations informed what variables were selected to be included in linear models predicting and being predicted by avatar discrepancy. We initially included group size (solo vs group) as a covariate for linear mixed-effects models because the presence of others (both physically and virtually) may account for some of the variance in embodiment and presence. However, this resulted in a singular fit, where group size as a random effect contributed very little variance to each model, and as a result, group size was dropped from the models. We report effect sizes and their confidence intervals for each linear model. We used the "r2glmm" package in R for calculating the R² and 95% confidence interval values (Edwards et al., 2008; Jaeger et al., 2017).

We augmented the understanding of perceived discrepancy by capturing metrics of participants' behavior during the avatar customization process. We use this method to provide insight into participants' attentional focus (McArthur, 2017). To accomplish this, two authors reviewed each avatar customization recording to identify which customization behaviors occurred (e.g., hair selection) and when. One author went first, and the second re-reviewed recordings for additional accuracy. This behavior timeline was used to generate percentages of time participants spent browsing through each customizable attribute. We used Pearson's correlations to identify relationships between customization behavior and perceived discrepancies of individual attributes. Participants who did not consent to recording were not a part of this analysis.

9. Results

In this section, we present quantitative findings that address the psychological consequences of avatar discrepancy and how this dynamic is influenced by a virtual mirror (**RQ2**). The first set of findings—Avatar discrepancy and the psychological experience of Black users in social VR—analyzes correlations between avatar discrepancy and the selected psychological constructs of interest based on mirror condition. To investigate the direction of these relationships and the interaction effects of the mirror further, constructs that yielded significant correlational findings were used in linear models. The second set of findings—Assessing the user experience of avatar customization—derives behavioral insights from the users' customization

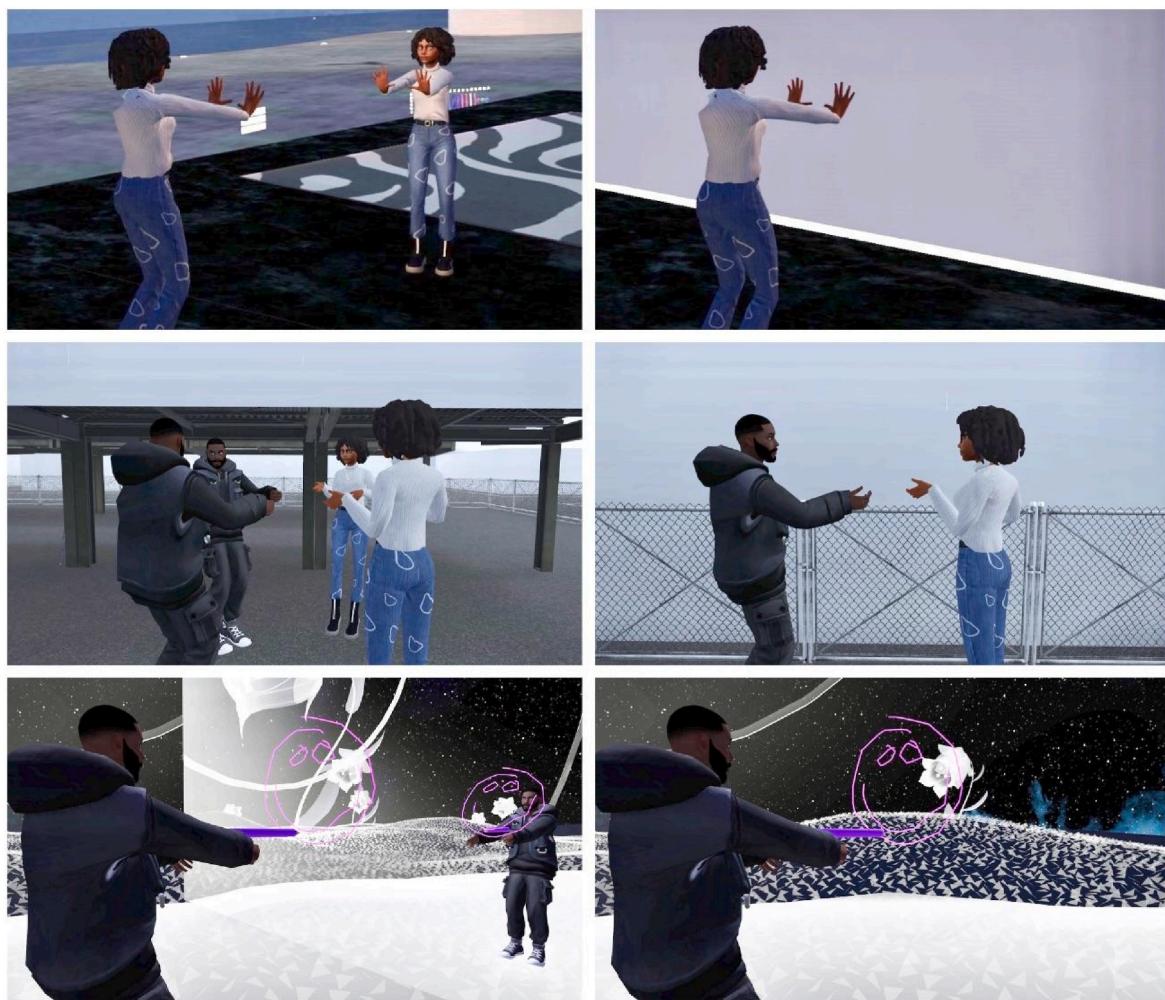


Fig. 6. Study 2 in-VR activities by mirror condition. Left column: mirror condition. Right column: no mirror condition. Top row: avatar orientation task. Middle row: social task. Bottom row: drawing task.

process and how it correlated with the perceived discrepancy of individual attributes. Descriptive statistics for each measured construct are located in the Supplementary Material.

9.1. Avatar discrepancy and the psychological experience of Black users in social VR

We first set out to understand the relationship between avatar discrepancy and the psychological experience of the participants quantitatively. First, avatar discrepancy was negatively correlated with spatial presence ($r = -0.328, p = 0.037$). That is, participants feeling less presence inside their virtual environment was linked to embodying an avatar perceived as more different from their physical self. To deepen the understanding of these relationships, we re-performed these correlations by mirror conditions (See Table 3). We found that the presence or absence of a mirror influenced the significance of the relationships between avatar discrepancy, avatar embodiment, and spatial presence. Whereas avatar discrepancy correlated significantly with avatar embodiment ($r = -0.567, p = 0.011$) and spatial presence ($r = -0.589, p = 0.006$) in the no mirror condition, these relationships were not significant in the mirror condition. In other words, when participants could see themselves in a virtual mirror, there was no connection between discrepancy and embodiment.

To investigate the role of the mirror further, we ran linear models that tested the interaction between mirror condition, avatar discrepancy, avatar embodiment, and spatial presence. In a model that

Table 3

Correlations between Avatar Discrepancy and the other psychological measures. Results displayed in bold indicate statistical significance.

Construct	Avatar Discrepancy					
	All Participants (n = 41)		Mirror Condition (n = 21)		No Mirror Condition (n = 20)	
	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>
Avatar Embodiment	-0.177	0.281	0.058	0.808	-0.567	0.011*
Spatial Presence	-0.328	0.037*	-0.281	0.218	-0.589	0.006**
Social Presence	-0.096	0.552	-0.028	0.903	-0.263	0.263
Self-Affirmation	-0.270	0.088	-0.258	0.259	-0.296	0.204
Self-Awareness	0.159	0.320	0.226	0.325	0.074	0.757

predicted avatar discrepancy as a function of the avatar embodiment and mirror condition results showed a significant interaction effect between embodiment and mirror condition, $F(1, 35) = 4.698, p = 0.037, R^2 = 0.118, 95\% \text{ CI } [0.003, 0.357]$. However, there were no significant main effects of avatar embodiment, $F(1, 35) = 3.334, p = 0.076, R^2 = 0.002, 95\% \text{ CI } [0.000, 0.143]$, or mirror condition, $F(1, 35) = 3.414, p = 0.073, R^2 = 0.161, 95\% \text{ CI } [0.012, 0.406]$, on avatar discrepancy individually. These findings suggest that the relationship between

avatar embodiment and discrepancy depends on whether the participants could view themselves through a virtual mirror. We also tested a model that predicted avatar embodiment as a function of the avatar discrepancy and mirror condition. There was not a significant main effect of avatar discrepancy, $F(1, 35) = 2.077, p = 0.158, R^2 = 0.002$, 95% CI [0.000, 0.144], and mirror condition, $F(1, 35) = 2.528, p = 0.121, R^2 = 0.126$, 95% CI [0.004, 0.367], nor was there a significant interaction between avatar discrepancy and mirror condition, $F(1, 35) = 3.396, p = 0.074, R^2 = 0.088$, 95% CI [0.001, 0.318].

In a model predicting avatar discrepancy based on spatial presence and mirror condition, spatial presence had a significant main effect, $F(1, 37) = 7.830, p = 0.008, R^2 = 0.058$, 95% CI [0.000, 0.265], whereas mirror condition, $F(1, 37) = 2.630, p = 0.113, R^2 = 0.063$, 95% CI [0.000, 0.273], and the interaction between mirror condition and spatial presence, $F(1, 37) = 1.551, p = 0.221, R^2 = 0.040$, 95% CI [0.000, 0.235], did not. In a model predicting spatial presence based on avatar discrepancy and mirror condition, avatar discrepancy, $F(1, 37) = 6.530, p = 0.015, R^2 = 0.064$, 95% CI [0.000, 0.275], had a significant main effect, while mirror condition, $F(1, 37) = 4.121, p = 0.050, R^2 = 0.044$, 95% CI [0.000, 0.241], and the interaction between avatar discrepancy and mirror condition, $F(1, 37) = 0.433, p = 0.515, R^2 = 0.012$, 95% CI [0.000, 0.169], did not. These results suggest an association between avatar discrepancy and one's sense of presence within their virtual environment.

9.2. Assessing the user experience of avatar customization

Using a behavioral metric of participant actions during the avatar customization process, we gained additional insights into participants' attentional focus and user experience when creating their digital self-representations. After determining the percentage of time spent on each attribute's selection page, we found that many participants spent most of their time looking through clothing and hair selection options (See Fig. 7).

To further understand the psychological implications of this data, we conducted Pearson's correlations between perceived discrepancies of individual attributes and percentages of time spent customizing attributes. To narrow the number of discrepancy and time percentage categories, we used a theoretically motivated approach that narrowed the attributes of interest to ones that have been shown to be representationally important to Black users. For the discrepancies, we selected participants' perceived measures of individual discrepancy for hair

texture, hairstyle, lip shape, nose shape, race, skin color, and skin undertone based on past work (Ducheneaut et al., 2009; Passmore & Mandryk, 2018) and DeVeaux and colleagues' (2023) scale. Respectively, we selected the percentages of time spent on hair selection, lip selection, nose selection, and skin tone selection to compare the discrepancies against. This analysis yielded one significant finding, a positive correlation between race discrepancy and percentage of time spent on hair selection ($r = 0.443, p = 0.010$). In other words, participants feeling as though the race of their avatar was more different from their own race was linked to spending more time browsing the hair customization options. All other examined correlations were insignificant.

10. Discussion

Situated in one of the most utilized social VR platforms (SteamDB, 2023), these findings illuminate disparities in avatar racial representation and their novel implications in social VR for Black users. In line with Intersectional Tech (Gray, 2020), the digital realities of Black users in VRChat reflected some physical realities. Given the consequential effects of colorism, defaults of whiteness, and racial harassment on the platform, Black users navigated the digital expression of their intersectional identities and undertook racialized burdens in complex ways (RQ1). This included navigating racialized encounters with avatar creators, relying on DIY solutions (e.g., learning avatar creation), and conscious consideration of the marginalization of Black virtual bodies when selecting their representation. While most participants in Study 1 desired to wear avatars reflective of their racial identity, Black users can have varied approaches in how they choose to represent themselves in VR. However, results from this paper's ethnographic inquiry demonstrate that, regardless of their approach, their choices can still be influenced by inequities on the platform. Hence, we provide insight into how systemic racism shapes avatar practices in social VR.

In accordance with VIDM (Jin, 2012), there were also psychological implications of perceived inconsistencies between avatar appearance and physical appearance, especially when the full appearance of an avatar was less visible (RQ2). This section explicates the embodied consequences of avatar racial disparities in highly immersive, virtual environments. We use these findings to highlight barriers to inclusive avatar embodiment in social VR (See Table 4) and detail implications for designers and researchers of social VR.

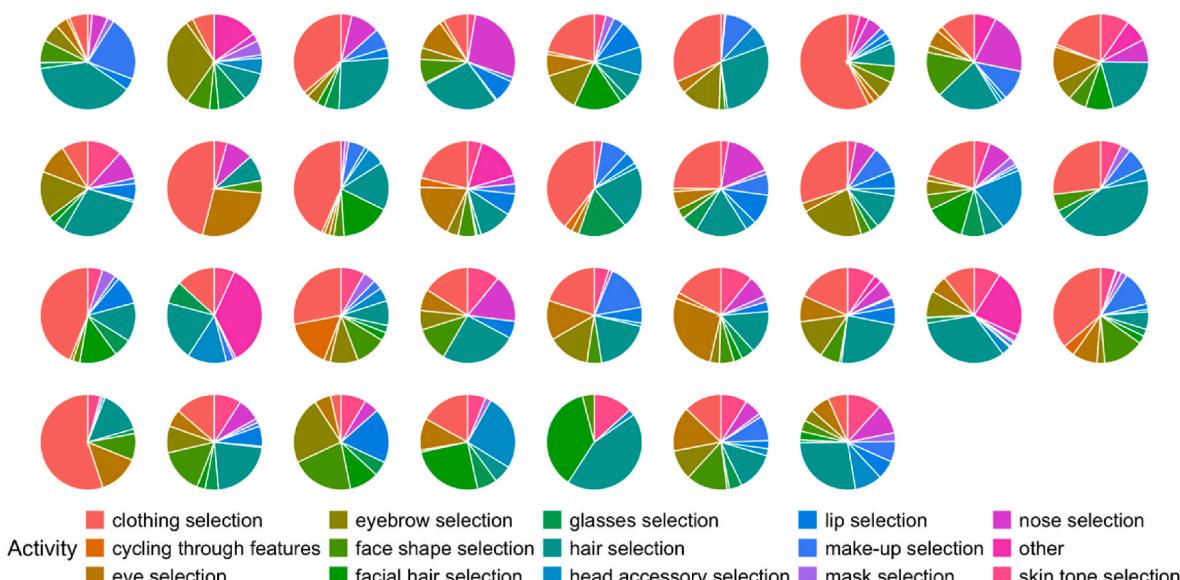


Fig. 7. Percentage of time spent on each customization behavior by participant.

Table 4

Non-exhaustive list of barriers to inclusive avatar embodiment in social VR.

Category	Description	Examples
Embodied Glitches and Rendering Issues	Unexpected technical errors and rendering issues that are tied to one's body in immersive virtual space	Texturing of eye and teeth with skin tone (Study 1) Missing hair asset by default (Study 1) White-washing or miscoloring of selected skin tone (Study 2) Improper rendering of Afro-textured hair (Study 1)
Embodied Design Bias	Hierarchical design choices that manifest while a user embodies their avatar	Default to white skin tone in customizable avatars (Study 1)
Disruptions to Immersion	Immersive consequences of avatar discrepancy when aiming for self-representation in VR	Greater avatar discrepancy was associated with less spatial presence (Study 2) In the absence of a virtual mirror, greater avatar discrepancy was associated with less avatar embodiment and less spatial presence (Study 2)
Survival Tactics for Embodied Racial Harassment	Avatar-based survival tactics that users employ as a defense against embodied racial harassment	Embodying non-Black avatars to avoid harassment (Study 1) Mentally preparing to defend oneself against harassment when choosing to wear a Black avatar (Study 1)

10.1. New perspectives on embodied consequences of racial discrepancies in social VR

While the literature on desktop virtual worlds and VR has established the psychological and embodied consequences of discrepant avatars, this paper sheds light on the racialized nuance of this dynamic in the more naturalistic, immersive context of social VR. We highlight *embodied glitches*, *avatar racial discrepancies shaping the embodiment experience*, and *immersive consequences of embodied racial harassment* as new perspectives on racialized experiences in social VR.

10.1.1. Embodied glitches

Hierarchies and inconsistencies between avatars can reveal social exclusivities that exist within an avatar system (McArthur et al., 2015; Nakamura, 2013) and may be magnified by the experiential differences of avatar embodiment in social VR. Similar to past work illuminating the privileging of rendering white bodies in computer graphics (Kang & Kim, 2020; Peck et al., 2022), participants in Study 1 indicated examples of glitches and rendering problems that occurred in Black and brown avatars but not in their white counterparts. It is worth mentioning that a glitch occurred in Study 2 where one participant's dark-skinned avatar was white-washed (i.e., the whitening of skin tone) upon entering social VR. It should be noted that these issues, when experienced from an HMD, are not observed from the larger distance that a third-person perspective and desktop typically afford. Brought into the context of the visuomotor synchrony and first-person perspective of wearing VR avatars, these glitches may become more personally tied to a person's body. Having to embody glitches physically represents a novel form of how racial bias can be experienced when avatars are brought into immersive contexts. Building on the concept of glitch, we highlight the *embodied glitch* as a technical error that is tied to one's body in immersive virtual space and the *embodied racialized glitch* as one associated with the construction of racial identity.

10.1.2. Avatar racial discrepancies can shape the embodiment experience in social VR

The highly immersive nature of social VR has distinct consequences

for avatar discrepancy. Embodying an avatar distant from the physical self can influence a user's psychological experience. It has been shown that virtual self-discrepancy affects feelings of presence (Jin, 2012; Schwind et al., 2017). The results expand on this by understanding the implications of racial discrepancies between virtual and physical attributes. Study 1 participants' descriptions of how they felt wearing white avatars showed that skin tone mismatches could break the sensation of presence. The medium of VR heightened feelings of discomfort as they saw their movements map onto a white virtual body. It is plausible that if someone goes into a social VR experience hoping to create an avatar that is a similar or ideal version of themselves but is unable to do so, that can have consequences on how present they feel in their virtual body. This is especially important given the findings that representation issues can impact Black users more heavily. As evidence from Study 2 suggests, negative psychological implications of avatar discrepancies can be more apparent when one's avatar is less visible to a user in social VR. When no virtual mirror was present in social VR, greater perceived avatar discrepancy was negatively associated with avatar embodiment and spatial presence. While DeVeaux and colleagues' (2023) similarly identify a negative relationship between avatar embodiment and perceived discrepancy, this work expands on this by demonstrating the role of the mirror as a potential buffer in this relationship. These results might be surprising, as one might hypothesize that seeing more of your avatar through a mirror might make discrepancies feel more apparent and impede the process of embodiment further. However, a potential explanation for these results could be that because mirrors have been shown to induce virtual body ownership in VR (Fu et al., 2023; Slater et al., 2010), the absence of a mirror may make the process of embodiment within discrepant avatars more difficult. It is also possible that viewing an avatar in a virtual mirror reinforces its behavioral realism. As behavioral realism is more influential than photographic realism (Blascovich et al., 2002), this process might help mitigate perceptions of avatar differences.

10.1.3. Immersive consequences of embodied racial harassment

Although racial harassment on virtual platforms is not a new phenomenon (Gray, 2012; Passmore et al., 2018), it has novel consequences in social VR. Given the highly immersive nature of social VR, harassment can feel more physicalized than in non-immersive social virtual mediums (Freeman, Maloney, et al., 2022). Thus, embodied harassment has become an emerging topic in social VR research (Freeman & Acena, 2022; Freeman, Zamanifar, et al., 2022; Ramirez et al., 2023; Schellenberg et al., 2023). In line with prior work, the findings from Study 1 demonstrate that embodying avatars with stigmatized identities, in this case, Black avatars, can increase users' vulnerability to racial harassment. This paper, however, offers insights into how Black users address this novel form of harassment and its immersive consequences. While the findings show that the practices of how Black users navigate this harassment are not monolithic, they still have to negotiate the expression of their digital identities in this embodied context that stigmatizes their virtual bodies. For some, that could mean embodying a non-Black avatar to mitigate racial harassment from others. Given the notable proportion of social VR users that prefer racially aligned avatars (Freeman & Maloney, 2021) and the psychological consequences of discrepant avatars described above, it is plausible that this survival-based tactic of trying to conceal a marginalized identity could negatively impact a Black users' sense of immersion while in VR. For others, that could mean prioritizing the representation of their Blackness despite the potential backlash. We posit that this, too, can break immersion. Being racially harassed in VR can deny Black users the privilege to engage in escapism, an immersion-based concept in game studies literature characterized by "mental diversion from real-life issues" (Hussain et al., 2021). Moreover, it can impede how engrossed (Jennett et al., 2008) they feel in VR by simultaneously calling attention to their racialized existences in-game and real life. Similar to what is suggested by Passmore and colleagues (2018), immersion, even in the highly

immersive medium of VR, becomes a privilege. Illustrative of Intersection Tech, embodied racial harassment produces a mapping between physical and digital realities that can potentially break Black users' sense of immersion in social VR.

10.1.4. Limitations

Several limitations should be acknowledged. First, both studies centered on VRChat as a social VR platform. Therefore, we are missing qualitative accounts from Black users who use other social VR platforms with different avatar cultures and quantitative findings in different virtual environments. Furthermore, sampling bias impacts the generalizability of the findings. In Study 1, although multiple recruitment methods were used, participants were primarily recruited from VRChat Discord groups. This creates a bias towards the perspectives of VRChat users who supplement their experience with outside digital communities. In Study 2, participants primarily had little to no prior VR experience. Additionally, both studies' findings could be strengthened with a larger sample size. A larger sample size in Study 1 could have further unpacked the nuance and diversity of perspectives of how Black users perceive and navigate non-inclusive elements of VRChat's avatar culture. In Study 2, the limited sample size could impact the generalizability of the findings. We would also like to acknowledge that the sample of participants in Study 1 were primarily Black users who chose to stay on VRChat despite the challenges they have faced. We, therefore, miss valuable perspectives from users who decided to leave the platform altogether perhaps due to racial harassment and avatar representation issues.

11. Conclusion

As social VR platforms continue to grow in size and popularity, it is pivotal to identify, combat, and prevent biases in their design that marginalize Black users. The development of diverse avatar systems plays an important role in cultivating inclusive social VR platforms, especially when considering the medium's immersive form of avatar-mediated interaction. This paper highlights a presence of absence of Black and brown avatars and disparities between how well Black users were able to visually represent their racial identity compared to white users on VRChat, the most popular social VR platform. We also show that these disparities have unique implications within this medium, where embodying a dissonant avatar could impact a user's sense of avatar embodiment and spatial presence. The evidence from this paper suggests that there are still barriers to equal and accurate representation of Black avatars in VR and that these barriers add additional burdens for Black users. This work contributes to a growing research agenda on self-presentation and identity practices in social VR. We hope that this paper can help contribute to making social VR a more inclusive environment.

CRediT authorship contribution statement

Cyan DeVeaux: Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Eugy Han:** Writing – review & editing, Methodology, Investigation. **Zora Hudson:** Writing – review & editing, Formal analysis, Data curation. **Jordan Egelman:** Writing – review & editing, Investigation, Formal analysis. **James A. Landay:** Writing – review & editing, Investigation, Formal analysis. **Jeremy N. Bailenson:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors wish to thank Dr. Angèle Christin for her continued support, feedback, and mentorship throughout this research. The authors also thank Dr. Breauna Spencer for her support during writing revisions, Dr. Kishonna Gray for her input on our qualitative findings, and Dr. Valerie Jones Taylor for her guidance on experimental study design. In addition, the authors wish to thank Dr. Andrea Cuadra, Beleicia Bullock, Dr. Jane E. Jordan Troutman, Natalie Neufeld, and Portia Wang for their feedback on different iterations of this manuscript. The authors would also like to thank Alicia Purpur, Arya Marwaha, Brian Beams, Caroline Graham, Diego Padilla, Francis Santiago, and Gracie Sandman for their support in preparing for and running the experimental study. The authors would also like to thank the VRChat communities that participated in this study and kindly guided the first author through learning about the platform. Finally, the authors would like to acknowledge that this research was partially supported by Zoom Video Communications, Inc. and Stanford Wearable Electronics Initiative (eWEAR), and that the lead author is partially supported by the National Science Foundation Graduate Research Fellowships Program.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.chb.2025.108639>.

Data availability

The data that has been used is confidential.

References

- Acena, D., & Freeman, G. (2021). My safe space": Social support for LGBTQ users in social virtual reality. In *Extended abstracts of the 2021 CHI conference on human factors in computing systems* (pp. 1–6). <https://doi.org/10.1145/3411763.3451673>
- Arvanitidou, Z. (2016). Creation of the social identity through the dressing and the representation of the virtual body in virtual internet communities. *Academic Journal of Interdisciplinary Studies*. <https://doi.org/10.5901/ajis.2016.v5n3sp1233>
- Bailey, R., Wise, K., & Bolls, P. (2009). How avatar customizability affects children's arousal and subjective presence during junk food–sponsored online video games. *CyberPsychology and Behavior*, 12(3), 277–283. <https://doi.org/10.1089/cpb.2008.0292>
- Banakou, D., Hanumanthu, P. D., & Slater, M. (2016). Virtual embodiment of white people in a black virtual body leads to a sustained reduction in their implicit racial bias. *Frontiers in Human Neuroscience*, 10. <https://doi.org/10.3389/fnhum.2016.00601>, 601–601.
- Bhimull, C., Hecht, G., Jones-Imhotep, E., Mavhunga, C., Nakamura, L., & Siddiqi, A. (2022). Systemic and epistemic racism in the history of technology. *Technology and Culture*, 63(4), 935–952.
- Billinghurst, M., Cesar, P., Gonzalez-Franco, M., Isbister, K., & Williamson, J. (2023). *Dagstuhl seminar 23482: Social XR: The future of communication and collaboration*. Dagstuhl. <https://www.dagstuhl.de/seminars/seminar-calendar/seminar-details/23482>.
- Blackwell, L., Ellison, N., Elliott-Deflo, N., & Schwartz, R. (2019). Harassment in Social Virtual Reality: Challenges for Platform Governance. *Proceedings of the ACM on Human-Computer Interaction*, 3(CSCW), 1–25. <https://doi.org/10.1145/3359202>
- Blascovich, J., Loomis, J., Beall, A. C., Swinth, K. R., Hoyt, C. L., & Bailenson, J. N. (2002). Immersive virtual environment technology as a methodological tool for social psychology. *Psychological Inquiry*, 13(2), 103–124. https://doi.org/10.1207/S15327965PLI1302_01
- Bonilla-Silva, E. (2021). What Makes Systemic Racism Systemic? *Sociological Inquiry*, 91(3), 513–533. <https://doi.org/10.1111/soin.12420>.
- Collins, P. H., & Bilge, S. (2016). *Intersectionality*. Polity Press.
- Cummings, J. J., & Bailenson, J. N. (2016). How immersive is enough? A meta-analysis of the effect of immersive technology on user presence. *Media Psychology*, 19(2), 272–309. <https://doi.org/10.1080/15213269.2015.1015740>
- Darke, A. M. (2023). Black virtuality [lecture]. *ADE for games communities workshop and speaker series*. University of Waterloo. <https://uwaterloo.ca/games-institute/black-virtuality>.
- DeVeaux, C., Han, E., Landay, J. A., & Bailenson, J. N. (2023). Exploring the relationship between attribute discrepancy and avatar embodiment in immersive social virtual reality. *Cyberpsychology, Behavior, and Social Networking*, 26(11), 835–842. <https://doi.org/10.1089/cyber.2023.0210>
- Dietrich, D. R. (2023). Reexamining avatars of whiteness: Changes in racial presentation of video game player characters. *Sociation*, 22(1). https://sociation.ncsociolog.yassoc.org/wp-content/uploads/2023/03/avatarwhiteness_proof_final.pdf.

- Ducheneaut, N., Wen, M.-H., Yee, N., & Wadley, G. (2009). Body and mind: A study of avatar personalization in three virtual worlds. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 1151–1160). <https://doi.org/10.1145/1518701.1518877>
- Edwards, L. J., Muller, K. E., Wolfinger, R. D., Qaqish, B. F., & Schabenberger, O. (2008). An R^2 statistic for fixed effects in the linear mixed model. *Statistics in Medicine*, 27(29), 6137–6157. <https://doi.org/10.1002/sim.3429>
- Everett, A. (2009). *Digital diaspora: A race for cyberspace*. State University of New York Press.
- EWICK, P., & Silbey, S. S. (1995). Subversive stories and hegemonic tales: Toward a sociology of narrative. *Law & Society Review*, 29, 197.
- Fletcher, A. (2022). Black gamer's refuge: Finding community within the magic circle of whiteness. In *The routledge companion to media anthropology*. Routledge.
- Freeman, G., & Acena, D. (2022). "Acting out" queer identity: The embodied visibility in social virtual reality. In *Proceedings of the ACM on human-computer interaction* (Vol. 6, pp. 263:1–263:32). CSCW2. <https://doi.org/10.1145/3555153>.
- Freeman, G., & Maloney, D. (2021). Body, avatar, and me: The presentation and perception of self in social virtual reality. In *Proceedings of the ACM on human-computer interaction* (Vol. 4, pp. 1–27). CSCW3. <https://doi.org/10.1145/3432938>.
- Freeman, G., Maloney, D., Acena, D., & Barwulor, C. (2022). (Re)discovering the physical body online: Strategies and challenges to approach non-cisgender identity in social virtual reality. In *CHI conference on human factors in computing systems* (pp. 1–15). <https://doi.org/10.1145/3491102.3502082>
- Freeman, G., Zamanifarid, S., Maloney, D., & Acena, D. (2022). Disturbing the peace: Experiencing and mitigating emerging harassment in social virtual reality. In *Proceedings of the ACM on human-computer interaction* (Vol. 6, pp. 1–30). CSCW1. <https://doi.org/10.1145/3512932>.
- Fu, K., Chen, Y., Cao, J., Tong, X., & Lv, R. (2023). "I Am a mirror dweller": Probing the unique strategies users take to communicate in the context of mirrors in social virtual reality. In *Proceedings of the 2023 CHI conference on human factors in computing systems* (pp. 1–19). <https://doi.org/10.1145/3544548.3581464>
- Gray, K. L. (2012). Deviant bodies, stigmatized identities, and racist acts: Examining the experiences of African-American gamers in Xbox Live. *New Review in Hypermedia and Multimedia*, 18(4), 261–276. <https://doi.org/10.1080/13614568.2012.746740>
- Gray, K. (2014). *Race, gender, and deviance in Xbox live: Theoretical perspectives from the virtual margins* (0 ed.). Routledge. <https://doi.org/10.4324/9781315721378>
- Gray, K. L. (2020). *Intersectional Tech: Black users in digital gaming*. LSU Press.
- Gualano, R. J., Jiang, L., Zhang, K., Won, A. S., & Azenkot, S. (2023). "Invisible illness is No longer invisible": Making social VR avatars more inclusive for invisible disability representation. In *The 25th international ACM SIGACCESS conference on computers and accessibility* (pp. 1–4). <https://doi.org/10.1145/3597638.3614480>
- Han, E., Miller, M. R., DeVeaux, C., Jun, H., Nowak, K. L., Hancock, J. T., et al. (2023). People, places, and time: A large-scale, longitudinal study of transformed avatars and environmental context in group interaction in the metaverse. *Journal of Computer-Mediated Communication*, 28(2), Article zmac031. <https://doi.org/10.1093/jcmc/zmac031>
- Hasler, B. S., Spanlang, B., & Slater, M. (2017). Virtual race transformation reverses racial in-group bias. *PLoS One*, 12(4), 1. <https://doi.org/10.1371/journal.pone.0174965>
- Hatfield, H. R., Ahn, S. J. G., Klein, M., & Nowak, K. L. (2022). Confronting whiteness through virtual humans: A review of 20 years of research in prejudice and racial bias using virtual environments. *Journal of Computer-Mediated Communication*, 27(6), Article zmac016. <https://doi.org/10.1093/jcmc/zmac016>
- Henrich, J., Heine, S. J., & Norenzayan, A. (2010). The weirdest people in the world? *Behavioral and Brain Sciences*, 33(2–3), 61–83. <https://doi.org/10.1017/S0140525X0999152X>
- Herrera, F., & Bailenson, J. N. (2021). Virtual reality perspective-taking at scale: Effect of avatar representation, choice, and head movement on prosocial behaviors. *New Media & Society*, 23(8), 2189–2209. <https://doi.org/10.1177/1461444821993121>
- Herrera, F., Oh, S. Y., & Bailenson, J. N. (2018). Effect of behavioral realism on social interactions inside collaborative virtual environments. *Presence: Teleoperators and Virtual Environments*, 27(2), 163–182. https://doi.org/10.1162/pres_a_00324
- Higgins, E. T. (1987). Self-discrepancy: A theory relating self and affect. *Psychological Review*, 94(3), 319–340. <https://doi.org/10.1037/0033-295X.94.3.319>
- Hooi, R., & Cho, H. (2012). Being immersed: Avatar similarity and self-awareness. In *Proceedings of the 24th Australian computer-human interaction conference* (pp. 232–240). <https://doi.org/10.1145/2414536.2414576>
- Hooi, R., & Cho, H. (2014). Avatar-driven self-disclosure: The virtual me is the actual me. *Computers in Human Behavior*, 39, 20–28. <https://doi.org/10.1016/j.chb.2014.06.019>
- Huizinga, J. (2014). *Homo ludens* ils 86 (0 ed.). Routledge. <https://doi.org/10.4324/9781315824161>
- Hussain, U., Jabarkhail, S., Cunningham, G. B., & Madsen, J. A. (2021). The dual nature of escapism in video gaming: A meta-analytic approach. *Computers in Human Behavior Reports*, 3, Article 100081. <https://doi.org/10.1016/j.chbr.2021.100081>
- Jaeger, B. C., Edwards, L. J., Das, K., & Sen, P. K. (2017). An R^2 statistic for fixed effects in the generalized linear mixed model. *Journal of Applied Statistics*, 44(6), 1086–1105. <https://doi.org/10.1080/02664763.2016.1193725>
- Javier, M., Wheeler, S., Ni, Q., Drivas, M., Wong, K. G., Fitzsimmons, S., et al. (2024). The alt-self: Investigating the inclusivity of self-avatar representations in social VR. In *Companion proceedings of the 2024 annual symposium on computer-human interaction in play* (pp. 131–138). <https://doi.org/10.1145/3665463.3678783>
- Jennett, C., Cox, A. L., Cairns, P., Dhoparee, S., Epps, A., Tijss, T., et al. (2008). Measuring and defining the experience of immersion in games. *International Journal of Human-Computer Studies*, 66(9), 641–661. <https://doi.org/10.1016/j.ijhcs.2008.04.004>
- Jin, S.-A. A. (2012). The virtual malleable self and the virtual identity discrepancy model: Investigative frameworks for virtual possible selves and others in avatar-based identity construction and social interaction. *Computers in Human Behavior*, 28 (6), 2160–2168. <https://doi.org/10.1016/j.chb.2012.06.022>
- Jo, D., Kim, K., Welch, G. F., Jeon, W., Kim, Y., Kim, K.-H., et al. (2017). The impact of avatar-owner visual similarity on body ownership in immersive virtual reality. In *Proceedings of the 23rd ACM symposium on virtual reality software and technology* (pp. 1–2). <https://doi.org/10.1145/3139131.3141214>
- Kafai, Y. B., Cook, M. S., & Fields, D. A. (2010). "Blacks deserve bodies too!": Design and discussion about diversity and race in a tween virtual world. *Games and Culture*, 5(1), 43–63. <https://doi.org/10.1177/1555412009351261>
- Kang, H., & Kim, H. K. (2020). My avatar and the affirmed self: Psychological and persuasive implications of avatar customization. *Computers in Human Behavior*, 112, Article 106446. <https://doi.org/10.1016/j.chb.2020.106446>
- Kaye, L. (2016). Applying psychology within games development: What can the gaming industry learn from the discipline?. In *Applied cyberpsychology: Practical applications of cyberpsychological theory and research* (pp. 179–196). Springer.
- Kendall, L. (2002). *Hanging out in the virtual pub: Masculinities and relationships online*. University of California Press.
- Kolesnichenko, A., McVeigh-Schultz, J., & Isbister, K. (2019). Understanding emerging design practices for avatar systems in the commercial social VR ecology. In *Proceedings of the 2019 on designing interactive systems conference* (pp. 241–252). <https://doi.org/10.1145/3322276.3322352>
- Lee, K. M. (2004). Presence, explained. *Communication Theory*, 14(1), 27–50. <https://doi.org/10.1111/j.1468-2885.2004.tb00302.x>
- Lee, J.-E. R., & Park, S. G. (2011). "Whose second life is this?" How avatar-based racial cues shape ethno-racial minorities' perception of virtual worlds. *Cyberpsychology, Behavior, and Social Networking*, 14(11), 637–642. <https://doi.org/10.1089/cyber.2010.0501>
- Leonard, D. (2003). "Live in your world, play in ours": Race, video games, and consuming the other. *Simile: Studies in Media and Information Literacy Education*, 3(4), 1–9. <https://doi.org/10.3138/sim.3.4.002>
- Leonard, D. (2009). An untapped field: Exploring the world of virtual sports gaming. In *Handbook of sports and media* (pp. 426–441). Routledge.
- MacArthur, C., Kukshinov, E., Harley, D., Pawar, T., Modi, N., & Nacke, L. E. (2024). Experimental disparities in social VR: Uncovering power dynamics and inequality. *Frontiers in Virtual Reality*, 5, Article 1351794.
- MacDorman, K. F., Green, R. D., Ho, C.-C., & Koch, C. T. (2009). Too real for comfort? Uncanny responses to computer generated faces. *Computers in Human Behavior*, 25 (3), 695–710. <https://doi.org/10.1016/j.chb.2008.12.026>
- Mal, D., Döllinger, N., Wolf, E., Wenninger, S., Botsch, M., Wienrich, C., et al. (2024). Am I the odd one? Exploring (in)congruencies in the realism of avatars and virtual others in virtual reality. *Frontiers in Virtual Reality*, 5, Article 1417066. <https://doi.org/10.3389/fvrir.2024.1417066>
- Maloney, D., Freeman, G., & Wohin, D. Y. (2020). "Talking without a voice": Understanding non-verbal communication in social virtual reality. In *Proceedings of the ACM on human-computer interaction* (Vol. 4, pp. 175:1–175:25). CSCW2. <https://doi.org/10.1145/3415246>
- Manninen, T., & Kujanpää, T. (2007). The value of virtual assets: The role of game characters in MMOGs. *International Journal of Business Science and Applied Management*, 2(1), 21–33.
- McArthur, V. (2017). The UX of avatar customization. In *Proceedings of the 2017 CHI conference on human factors in computing systems* (pp. 5029–5033). <https://doi.org/10.1145/3025453.3026020>
- McArthur, V., Teather, R. J., & Jenson, J. (2015). The avatar affordances framework: Mapping affordances and design trends in character creation interfaces. In *Proceedings of the 2015 annual symposium on computer-human interaction in play* (pp. 231–240). <https://doi.org/10.1145/2793107.2793121>
- McDonald, N., Schoenebeck, S., & Forte, A. (2019). Reliability and inter-rater reliability in qualitative research: Norms and guidelines for CSCW and HCI practice. In *Proceedings of the ACM on human-computer interaction* (Vol. 3, pp. 1–23). CSCW. <https://doi.org/10.1145/3359174>
- McVeigh-Schultz, J., & Isbister, K. (2022). A "beyond being there" for VR meetings: Envisioning the future of remote work. *Human-Computer Interaction*, 37(5), 433–453. <https://doi.org/10.1080/07370024.2021.1994860>
- McVeigh-Schultz, J., Kolesnichenko, A., & Isbister, K. (2019). Shaping pro-social interaction in VR: An emerging design framework. In *Proceedings of the 2019 CHI conference on human factors in computing systems* (pp. 1–12). <https://doi.org/10.1145/3290605.3300794>
- McVeigh-Schultz, J., Márquez Segura, E., Merrill, N., & Isbister, K. (2018). What's it mean to "Be social" in VR?: Mapping the social VR design ecology. In *Proceedings of the 2018 ACM conference companion publication on designing interactive systems* (pp. 289–294). <https://doi.org/10.1145/3197391.3205451>
- Messinger, P. R., Ge, X., Stroulia, E., Lyons, K., Smirnov, K., & Bone, M. (2008). On the relationship between my avatar and myself. *Journal For Virtual Worlds Research*, 1(2). <https://doi.org/10.4101/jvwr.v1i2.352>
- Midha, V., & Nandedkar, A. (2012). Impact of similarity between avatar and their users on their perceived identifiability: Evidence from virtual teams in Second Life platform. *Computers in Human Behavior*, 28(3), 929–932. <https://doi.org/10.1016/j.chb.2011.12.013>
- Mori, M., MacDorman, K., & Kageki, N. (2012). The uncanny valley [from the field]. *IEEE Robotics and Automation Magazine*, 19(2), 98–100. <https://doi.org/10.1109/MRA.2012.2192811>
- Morris, M. E., Rosner, D. K., Nurius, P. S., & Dolev, H. M. (2023). "I don't want to hide behind an avatar": Self-representation in social VR among women in midlife. In

- Proceedings of the 2023 ACM designing interactive systems conference* (pp. 537–546). <https://doi.org/10.1145/3563657.3596129>
- Moustafa, F., & Steed, A. (2018). A longitudinal study of small group interaction in social virtual reality. In *Proceedings of the 24th ACM symposium on virtual reality software and technology* (pp. 1–10). <https://doi.org/10.1145/3281505.3281527>
- Nakamura, L. (2009). Don't hate the player, hate the game: The racialization of labor in world of warcraft. *Critical Studies in Media Communication*, 26(2), 128–144. <https://doi.org/10.1080/15295030902860252>
- Nakamura, L. (2013). *Cybertypes: Race, ethnicity, and identity on the internet* (0 ed.). Routledge. <https://doi.org/10.4324/9780203699188>
- Napper, L., Harris, P. R., & Epton, T. (2009). Developing and testing a self-affirmation manipulation. *Self and Identity*, 8(1), 45–62. <https://doi.org/10.1080/15298860802079786>
- Nem, V. G. (2023). VRChat breaks records with 92,000 simultaneous users! Medium. https://medium.com/@nemchan_nel/vrchat-breaks-records-with-92-000-simultaneous-users-9464a33f3561.
- Norwood, R. (2021). Coding blackness: A history of black video game characters. Wired. <https://www.wired.com/story/black-character-history-video-games/>.
- Oh, C., Herrera, F., & Bailenson, J. (2019). The effects of immersion and real-world distractions on virtual social interactions. *Cyberpsychology, Behavior, and Social Networking*, 22(6), 365–372. <https://doi.org/10.1089/cyber.2018.0404>
- Omi, M., & Winant, H. (1994). *Racial Formation in the United States: From the 1960s to the 1990s* (2nd ed.). Routledge.
- Oyanagi, A., Narumi, T., Lugrin, J.-L., Aoyama, K., Ito, K., Amemiya, T., et al. (2022). *The possibility of inducing the Proteus effect for social VR users*.
- Passmore, C. J., Birk, M. V., & Mandryk, R. L. (2018). The privilege of immersion: Racial and ethnic experiences, perceptions, and beliefs in digital gaming. In *Proceedings of the 2018 CHI conference on human factors in computing systems* (pp. 1–19). <https://doi.org/10.1145/3173574.3173957>
- Passmore, C. J., & Mandryk, R. (2018). An about face: Diverse representation in games. In *Proceedings of the 2018 annual symposium on computer-human interaction in play* (pp. 365–380). <https://doi.org/10.1145/3242671.3242711>
- Peck, T. C., & Gonzalez-Franco, M. (2021). Avatar embodiment: A standardized questionnaire. *Frontiers in Virtual Reality*, 1, Article 575943. <https://doi.org/10.3389/fvr.2020.575943>
- Peck, T. C., Good, J. J., Erickson, A., Bynum, I., & Bruder, G. (2022). Effects of transparency on perceived humanness: Implications for rendering skin tones using optical see-through displays. *IEEE Transactions on Visualization and Computer Graphics*, 28(5), 2179–2189. <https://doi.org/10.1109/TVCG.2022.3150521>
- Peck, T. C., McMullen, K. A., & Quarles, J. (2021). DiVRsify: Break the cycle and develop VR for everyone. *IEEE Computer Graphics and Applications*, 41(6), 133–142. <https://doi.org/10.1109/MCG.2021.3113455>
- Peck, T. C., Seinfeld, S., Aglioti, S. M., & Slater, M. (2013). Putting yourself in the skin of a black avatar reduces implicit racial bias. *Consciousness and Cognition*, 22(3), 779–787. <https://doi.org/10.1016/j.concog.2013.04.016>
- PlayerCounter. (2023). VRChat player count and statistics 2023—how many people are playing? Player Counter. <https://playercounter.com/vrchat/>.
- Pringle, H. M. (2015). Conjuring the ideal self: An investigation of self-presentation in video game avatars. *Press Start*, 2(1), 1–20.
- Rahill, K. M., & Sebrechts, M. M. (2021). Effects of Avatar player-similarity and player-construction on gaming performance. *Computers in Human Behavior Reports*, 4, Article 100131. <https://doi.org/10.1016/j.chbr.2021.100131>
- Ramirez, E. J., Jennett, S., Tan, J., Campbell, S., & Gupta, R. (2023). XR embodiment and the changing nature of sexual harassment. *Societies*, 13(2), 36. <https://doi.org/10.3390/soc13020036>
- Rankin, Y. A., & Han, N. (2019). Exploring the plurality of black women's gameplay experiences. In *Proceedings of the 2019 CHI conference on human factors in computing systems* (pp. 1–12). <https://doi.org/10.1145/3290605.3300369>
- Ready Player Me. (2021). 3D avatars: Finding balance between realistic and abstract. <https://readyplayer.me/blog/abstract-realistic-3d-avatars-balance>.
- Ready Player Me. (2023). Integrate an advanced character creator into your game in days-Ready Player Me. Ready Player Me. <https://readyplayer.me/>.
- Richard, G. T., & Gray, K. L. (2018). Gendered play, racialized reality: Black cyberfeminism, inclusive communities of practice, and the intersections of learning, socialization, and resilience in online gaming. *Frontiers: A Journal of Women Studies*, 39(1), 112. <https://doi.org/10.5250/fronjwomestud.39.1.0112>
- Russworm, T. M., & Blackmon, S. (2020). Replaying video game history as a mixtape of black feminist thought. *Feminist Media Histories*, 6(1), 93–118. <https://doi.org/10.1525/fmh.2020.6.1.93>
- Sabri, N., Chen, B., Teoh, A., Dow, S. P., Vaccaro, K., & Elsherief, M. (2023). Challenges of moderating social virtual reality. In *Proceedings of the 2023 CHI conference on human factors in computing systems* (pp. 1–20). <https://doi.org/10.1145/3544548.3581329>
- Salagean, A., Crellin, E., Parsons, M., Cosker, D., & Stanton Fraser, D. (2023). Meeting your virtual twin: Effects of photorealism and personalization on embodiment, self-identification and perception of self-avatars in virtual reality. In *Proceedings of the 2023 CHI conference on human factors in computing systems* (pp. 1–16). <https://doi.org/10.1145/3544548.3581182>
- Sanchez-Vives, M. V., Spanlang, B., Frisoli, A., Bergamasco, M., & Slater, M. (2010). Virtual hand illusion induced by visuomotor correlations. *PLoS One*, 5(4), Article e10381. <https://doi.org/10.1371/journal.pone.0010381>
- Schulenberg, K., Li, L., Freeman, G., Zamanifar, S., & McNeese, N. J. (2023). Towards leveraging AI-based moderation to address emergent harassment in social virtual reality. In *Proceedings of the 2023 CHI conference on human factors in computing systems* (pp. 1–17). <https://doi.org/10.1145/3544548.3581090>
- Schwind, V., Knierim, P., Tasci, C., Franczak, P., Haas, N., & Henze, N. (2017). "These are not my hands!": Effect of gender on the perception of avatar hands in virtual reality. In *Proceedings of the 2017 CHI conference on human factors in computing systems* (pp. 1577–1582). <https://doi.org/10.1145/3025453.3025602>
- Slater, M. (2008). Towards a digital body: The virtual arm illusion. *Frontiers in Human Neuroscience*, 2. <https://doi.org/10.3389/neuro.09.006.2008>
- Slater, M., Spanlang, B., Sanchez-Vives, M. V., & Blanke, O. (2010). First person experience of body transfer in virtual reality. *PLoS One*, 5(5), Article e10564. <https://doi.org/10.1371/journal.pone.0010564>
- Smith, H. J., & Neff, M. (2018). Communication behavior in embodied virtual reality. In *Proceedings of the 2018 CHI conference on human factors in computing systems* (pp. 1–12). <https://doi.org/10.1145/3173574.3173863>
- SteamDB. (2023). Most played VR supported games Steam charts. SteamDB. <https://steamdb.info/charts/?category=402>
- St Fleur, A., & deWinter, J. (2021). "Unfiltered and true to itself": How content creators represent the black community in "the sims 4". *American Journal of Play*, 13, 297–319.
- Suh, K.-S., Kim, H., & Suh, E. K. (2011). What if your avatar looks like you? Dual-Congruity perspectives for avatar use. *MIS Quarterly*, 711–729.
- Suk, H., & Laine, T. H. (2023). Influence of avatar facial appearance on users' perceived embodiment and presence in immersive virtual reality. *Electronics*, 12(3), 583. <https://doi.org/10.3390/electronics12030583>
- Sykownik, P., Graf, L., Zils, C., & Masuch, M. (2021). The most social platform ever? A survey about activities & motives of social VR users. *2021 IEEE Virtual Reality and 3D User Interfaces (VR)*, 546–554. <https://doi.org/10.1109/VR50410.2021.00079>
- TaeHyuk Keum, B., & Hearns, M. (2022). Online gaming and racism: Impact on psychological distress among black, asian, and Latinx emerging adults. *Games and Culture*, 17(3), 445–460. <https://doi.org/10.1177/15554120211039082>
- Turkle, S. (1994). Constructions and reconstructions of self in virtual reality: Playing in the MUDs. *Mind, Culture and Activity*, 1(3), 158–167.
- Vasalou, A., Joinson, A. N., & Pitt, J. (2007). Constructing my online self: Avatars that increase self-focused attention. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 445–448). <https://doi.org/10.1145/1240624.1240696>
- Wegner, D. M., & Giuliano, T. (1980). Arousal-induced attention to self. *Journal of Personality and Social Psychology*, 38(5), 719–726. <https://doi.org/10.1037/0022-3514.38.5.719>
- Wei, X., Jin, X., & Fan, M. (2022). Communication in immersive social virtual reality: A systematic review of 10 Years' studies (arXiv:2210.01365). arXiv. <http://arxiv.org/abs/2210.01365>.
- Yee, N., & Bailenson, J. N. (2006). Walk a mile in digital shoes: The impact of embodied perspective-taking on the reduction of negative stereotyping in immersive virtual environments. In *Proceedings of PRESENCE* (Vol. 24, pp. 1–9), 26.
- Yee, N., & Bailenson, J. (2007). The Proteus effect: The effect of transformed self-representation on behavior. *Human Communication Research*, 33(3), 271–290. <https://doi.org/10.1111/j.1468-2958.2007.00299.x>
- Zhang, K., Deldari, E., Lu, Z., Yao, Y., & Zhao, Y. (2022). "It's just part of me:" understanding avatar diversity and self-presentation of people with disabilities in social virtual reality. In *Proceedings of the 24th international ACM SIGACCESS conference on computers and accessibility* (pp. 1–16). <https://doi.org/10.1145/3517428.35444829>
- Zhang, K., Deldari, E., Yao, Y., & Zhao, Y. (2023). A diary study in social virtual reality: Impact of avatars with disability signifiers on the social experiences of people with disabilities. In *The 25th international ACM SIGACCESS conference on computers and accessibility* (pp. 1–17). <https://doi.org/10.1145/3597638.3608388>