

Advancing Knowledge on the Health Consequences of Discrimination:  
The Potential of Virtual Reality

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### Abstract

**Objectives:** Racism and discrimination drive racial and ethnic health disparities, and are robust markers for a host of health outcomes in People of Color and Indigenous Peoples (POCI). A comprehensive understanding of possible causal pathways by which racism and discrimination lead to POCI's health disadvantages is a critical step toward reducing disparities and promoting health equity. Experimental methods can help researchers delineate these causal pathways. In this manuscript, we illustrate how virtual reality (VR) can be used by researchers in experimental studies to advance discrimination science. **Method:** We summarize current findings on health effects of discrimination. We describe common methodological approaches that have been employed in discrimination science and discuss some of their limitations. Arguments for the potential benefits of using VR to advance discrimination science are provided. **Results:** VR has the potential to facilitate ecologically valid experiments that examine individuals' responses to racism and discrimination-related experiences in real-time. **Conclusions:** VR offers scientists an innovative method that can be used in experimental studies to help delineate how racism and discrimination might lead to health problems in POCI. Still, VR is new to discrimination science; thus, research is necessary to empirically delineate advantages and possible disadvantages of using VR in studies on discrimination.

*Keywords:* differential treatment; experiment; immersive virtual environment; race; validity

### Public Significance Statement

Racism and discrimination drive racial and ethnic health disparities. Virtual reality can be used in experimental studies to enhance the ecological validity of research on the health effects of racism and discrimination-related experiences. Virtual reality also has the potential of accelerating practical efforts directed at addressing the negative effects of discrimination.

## Advancing Knowledge on the Health Consequences of Discrimination:

### The Potential of Virtual Reality

Racism and discrimination contribute to poorer health outcomes among People of Color and Indigenous Peoples (POCI), relative to their more privileged counterparts (Brondolo et al., 2008; Harrell, 2000; Williams, 1999). An important step toward eliminating health disparities and promoting POCI's optimal functioning involves advancing the scientific understanding of how, when, in what contexts, and for whom racism and discrimination causally affect health outcomes (Jeffries et al., 2019). This article is being written at a time when the United States Department of Justice and other organizations report increases in hate crimes and discrimination facing POCI, and when there is a renewed and intensified societal discourse about systemic racism (Devakumar et al., 2020; FBI, 2018; Jeung & Nham, 2020). Thus, the use of innovative methods to advance knowledge concerning the negative health consequences of racism and discrimination is highly significant. Although virtual reality (VR) has been around for decades, it has not been used systematically in research on the health consequences of racism and discrimination. Yet, the use of VR in experimental research has tremendous potential for advancing discrimination science. In this article, we briefly summarize current knowledge on the effects of discrimination on health and common methodological approaches that have been used to generate this knowledge. We then discuss the potential benefits of using VR in experiments to advance scientific understanding of effects of discrimination. Finally, we provide insights about unique methodological considerations of conducting research with VR.

### **Health Disparities: Understanding the Impact of Racism and Discrimination**

In the United States, people from minoritized backgrounds experience higher disease morbidity and mortality rates associated with many mental and behavioral health problems,

compared to their nonminority counterparts (CDC, 2013; DHHS, 2001). Above and beyond biological predispositions and socioeconomic status, racism and discrimination account for racial and ethnic differences in health outcomes (Williams, 1997, 1999). Exposure to discrimination is positively associated with a host of health problems, including alcohol and substance misuse, internalizing symptoms, somatic complaints, and cardiovascular illnesses (Jones et al., 2016; Lee & Ahn, 2011, 2012; Volpe et al., 2018). Compared to Whites, POCI are exposed more frequently to interpersonal discrimination and racist treatment, microaggressions, and structural injustice (see Gilbert & Zemore, 2016; Lui & Quezada, 2019; Pascoe & Richman, 2009 for review; RWJF, 2018; West, 2019). POCI also experience higher levels of unfair treatment in the medical setting than their White peers (Benjamins & Whitman, 2014; Shavers et al., 2012).

Compounding discrimination in day-to-day lives and in the medical settings, POCI who experience greater racism are less likely to seek and use medical services to address their healthcare needs than their White counterparts (Gazard et al., 2018; Rivenbark & Ichou, 2020).

Identifying the causal mechanisms linking discrimination-related experiences to individual health is an important scientific undertaking; yet, conducting this type of research can be extremely challenging. Individual differences and contextual factors complicate the process even further. Whereas some people are adversely affected by racism- and discrimination-related events, others seemingly are unaffected by these experiences (Carter & Murphy, 2015; Plaut, 2010; Sue, 2017). Similarly, individuals' responses can be shaped by the timing, situational conditions, and people involved in racism- and discrimination-related events. It should not be unexpected to observe differences in the degree to which POCI perceive and react to racism and discrimination experiences; researchers have documented diverse responses to many negative events such as child maltreatment, intimate partner violence, and interpersonal victimization

(Cicchetti et al., 1993; Grych et al., 2000; Sapouna & Wolke, 2013). Unfortunately, differences in POCI's responses to discrimination have led some people to doubt the rigor of—and therefore conclusions drawn from—research focusing on racism and discrimination (e.g., Lilienfeld, 2017).

### **Current Approaches to Discrimination Research**

Researchers have used a number of approaches to illuminate causal processes linking discrimination-related experiences to adverse health outcomes; at the same time, researchers have attempted to balance the internal and ecological validity of their approaches. Internal validity refers to the extent to which a study rules out alternative explanations of the results, usually concerning causal effects (Kazdin, 2017). Ecological validity refers to the extent to which a study represents the real-world conditions under which the effects take place (Reis, 2012). Consider a study addressing the question: How do discrimination experiences influence substance use? To make strong conclusions about the causal effects of discrimination experiences in the everyday lives of POCI, it is important to assess discrimination in individuals' milieu, while simultaneously ruling out the confounding effects of variables associated with both discrimination experiences and substance use (e.g., Gibbons et al., 2014; Lui, 2020).

### ***Observational Research***

To understand POCI's lived experiences with discrimination, many researchers have used qualitative inquiry and self-report survey methods (Pascoe & Richman, 2009; Wong et al., 2014). Research studies using these methods have contributed substantially to the current knowledge base by examining different types of racism and discrimination experiences, describing how they are perceived, and identifying processes by which they might affect mental and behavioral health (e.g., Iwamoto et al., 2013; Ong et al., 2013; Sue et al., 2008). For

instance, data revealed that 50% to 75% of the POCI population reported experiencing some form of racial discrimination across the lifespan (Lee, Perez, et al., 2019). Experiences of racism and discrimination occur in educational, medical, and work environments; they predict stress responses such as increased cortisol output and a range of health problems such as alcohol misuse, depression and anxiety symptoms, sleep disturbances, and cardiovascular health difficulties (Berger & Sarneyai, 2015; Chavez et al., 2015; Fang & Myers, 2001; Flores et al., 2010; Hughes et al., 2016; Lui, 2020; Walls et al., 2015; Yoo & Castro, 2011; Zeiders, 2017).

Still, major limitations are inherent when drawing conclusions about the causal links between discrimination experiences and health outcomes in research that relies on qualitative inquiry or self-report surveys of past experiences. In observational research, individual differences and situational conditions are not readily ruled out as explanatory factors in the documented relations linking racism and discrimination to negative health consequences. These potentially confounding factors include racial identity and parental racial socialization, prior exposure to unfair treatment, vigilance, and personality characteristics (Lewis et al., 2015). For example, links between racial discrimination and a number of psychological adjustment outcomes among African Americans were no longer statistically significant once neuroticism was included in multivariate analyses (Lui, 2020). The centrality of race to people's self-concept also had been shown to intensify the negative psychological impact of vicarious racism in African Americans and Asian Americans (Mason et al., 2017; Yip et al., 2008). People who were more vigilant and vulnerable to stress tended to report higher levels of discrimination and become more sensitive to the deleterious health consequences (Alvarez et al., 2006; Sellers et al., 2003). These individual differences in the perception and negative health effects of discrimination likely are particularly pronounced when racism events are ambiguous (Lilienfeld,

2017; Sue, Capodilupo, et al., 2007).

A problem inherent in the use of self-reported discrimination-related experiences are that they are likely to include systematic measurement error. People do not always report accurately on things that they have experienced, and what they have done in response to these experiences (Baumeister et al., 2007). Hence, measurement error may be byproducts of recall bias, social desirability biases, and issues of question interpretation (i.e., participants understand the question in a way that is different from what the researcher intended). Issues of interpretation may be compounded by the fact that many current questionnaires assessing racism and discrimination contain items that are ambiguous or capture broadband experiences. For example, an item from a commonly used measure, the Brief Racism Scale from the Racism and Life Experiences Scales-Revised (Harrell, 1994), asks, “*How much have you personally experienced racism, racial discrimination, or racial prejudice?*” This item leaves much room for research participants to define what they consider to be an experience of racism, racial discrimination, or prejudice. Furthermore, racism and discrimination experiences are inherently interactional among individuals, institutions, and societal structure (Neblett, 2019); therefore, survey items often fail to capture the dynamic exchanges in these interactions.

### ***Experimental Research***

Experimental studies are valuable in delineating the possible causal effects of discrimination experiences for three reasons. First, experimental designs allow researchers to establish the temporal ordering of the discrimination experience and the health-related outcome. Second, relative to observational studies, experiments also permit researchers to have tighter control of potentially confounding factors. Third, researchers can possess a high level of control over the discrimination experience itself (e.g., type of experience, intensity) because the

discrimination experiences can be designed and controlled by the researchers. As a result, researchers do not need to be concerned about participants' recall of past discrimination-related experiences.

Although laboratory experiments are underutilized in discrimination science, there have been a number of cleverly designed experimental studies in which researchers manipulated participants' experiences with racism and discrimination. For example, discrimination experiences have been manipulated through: (1) imaginary or visualization experiences, (2) written information provided to participants, (3) written vignettes, and (4) interactions with research staff actors (i.e., "confederates"). We provide examples to illustrate each of these four manipulations.

First, a study by Gibbons et al. (2010) examined whether envisioning discrimination experiences elicited negative affect and urges to use alcohol and drugs. In this study, African American participants were randomly assigned to one of three visualization conditions, and then were asked to think about how they would react to the situation. The racial discrimination situation involved imagining having received racial insults and unfair treatment from a boss. One control situation involved imagining job stress that was unrelated to racial discrimination, whereas a second control situation involved imagining a non-stressful work experience.

Second, a study by Sawyer et al. (2012) examined how anticipating prejudicial reactions from a work partner influenced Latina participants' stress reactions. In this study, Sawyer and colleagues manipulated the written information that was given to the Latina participants. In the prejudicial condition, participants read that their work partner (portrayed by a research actor) strongly agreed with four statements that reflected racial biases (e.g., "*Ethnic minorities often do not have to work as hard as Whites do to get ahead*"). By contrast, participants in the control



condition read that their work partner strongly disagreed with the same four statements.

Third, a study by Yoo and Lee (2008) examined the extent to which single versus multiple discrimination incidents influenced the emotional responses among Asian American college students. In this study, researchers presented participants with a written vignette, and asked participants to imagine themselves in similar situations. In the single incident condition, participants read that they and their friends were denied entry to one club, but had no problem entering other clubs on the same night (i.e., they were admitted into four of five clubs). In the multiple incidents condition, participants read that they and their friends were denied entry into five of five clubs that night. In both conditions, participants read that groups of White students were allowed into the clubs on the same night that they were denied entry.

Fourth, a study by Torres et al. (2020) examined how witnessing others respond to major discrimination and microaggression incidents affected research participants' emotional and physiological reactions. In this study, participants were exposed to seeing a POCI research actor interacting with a research assistant. In the major discrimination condition, participants heard the experimenter say to another "participant" portrayed by the research actor, "*Wow, you're really far back [in completing the survey questionnaires]. Shouldn't you people know how to read English? This is America.*" In the microaggression condition, participants heard the research assistant say to the actor, "*Wow, you're pretty far back [in completing the survey questionnaires]. Is English your first language?*" In the control condition, the research assistant said, "*Okay, keep working [on the survey questionnaires].*"

The manipulations used in these four studies can be categorized as imagined experiences of discrimination in which research participants were victims (as in Gibbons et al., 2010; Yoo & Lee, 2008), and vicarious (imagined or in real-life) experiences of discrimination in which

research participants witnessed discriminatory acts (as in Sawyer et al., 2012; Torres et al., 2020). The researchers who conducted these four studies should be commended for their efforts at attempting to advance knowledge on effects of discrimination. To further advance experimental research on discrimination, however, there remain critical considerations about the manipulations. For example, it is unclear how well imagined discrimination experiences—and research participants' reactions to them—generalize to actual discrimination experiences. Indeed, research suggests that African Americans display less intense emotions when imagining interracial contact than when experiencing actual interracial contact (Vrana & Rollock, 2002). In addition, researchers who are interested in having participants directly experience or witness discrimination (i.e., not imagine the discrimination experience) are limited in what they can manipulate in a psychology laboratory setting. The extent to which research participants' responses to discrimination in laboratory settings generalize to other naturalistic environments is unclear.

### **Using Virtual Reality in Experimental Research**

We believe that VR offers potential advantages over other commonly used methods for manipulating discrimination experiences in experimental research. Advantages include the ability to have research participants actually experience or witness discrimination in a variety of settings, potentially enhancing the ecological validity of manipulated discrimination experiences. Additionally, researchers can design studies in which discrimination experiences are manipulated using VR, and then conduct real-time assessments of many health-related outcome variables (e.g., emotions, distress symptoms, and behavioral intentions), during and shortly after the discrimination experience. Below we offer a brief description of VR and illustrate possible research applications. We also elaborate upon the aforementioned advantages and offer

suggestions on incorporating VR in studies designed to examine health consequences of racism and discrimination.

### **Immersive Virtual Environments and Illustrations of Their Use**

Modern VR is made possible by a head-mounted display (i.e., VR headset or goggles) that tracks and measures the user's—research participant's—position and orientation. The VR headset communicates with a rendering computer in which the virtual simulation software programs are stored and operated (Loomis et al., 1999). VR uses these stereoscopic displays, tracking, and other digital technologies to create an immersive, computer-generated environment. This computer-generated environment, often referred to as a virtual environment, is an alternative spatial world that is seen from the research participant's point of view. Virtual environments can be designed to resemble almost any real-world setting. For example, there are empirical studies using virtual environments to resemble underground trains, wine bars, casinos, auditoriums with a large audience, airplane interiors, and inner-city neighborhoods (Anderson et al., 2005; Bouchard et al., 2017; Herrera et al., 2018; James et al., 2003; Rothbaum et al., 2006). Immersive virtual environments can also be designed with avatars, with whom research participants interact directly. The avatars are three-dimensional digital representations of real-life humans and are controlled by research staff, thereby allowing researchers to expose participants to social situations and dynamic interactions (Jouriles et al., 2016; Kassner et al., 2012; Powers et al., 2013).

In using VR, the researchers' goal is to help participants temporarily suspend “normal” perceptions of their real-world reality and experience a “new” reality. Importantly, the effectiveness of a study that uses VR does not typically depend on the immersive virtual environment being highly realistic visual representations of the actual environment (Kassner et

al., 2012). Rather, it depends on the extent to which research participants are able to feel a sense of presence within the immersive virtual environment to elicit realistic responses to the experimental conditions. Presence has been defined as the “experience of being in an environment, even when one is physically situated in another” (Witmer & Singer, 1998, p. 225). There is a large body of research on VR and presence, which yields compelling evidence indicating that presence and realism can be achieved in immersive virtual environments. Specifically, virtually simulated situations have been shown to elicit self-reported stress, feelings, and physiological responses in human participants that are similar to those elicited in natural environments (Martens et al., 2019; Zimmer et al., 2019).

Still, virtual environments are only one of several variables that influence presence. For example, presence can be affected by both the experimenter’s instructions that set up the simulation contexts (i.e., the research participant’s interaction within the virtual environment) and the avatar’s dialogue with the research participants. The avatar’s dialogue is often scripted and controlled by a research staff member (i.e., the actor) via the rendering computer. Additional social cues such as the avatar’s facial expressions, nonverbal and vocal signals, and eye gaze can enhance the feelings of immersion and presence (Blascovich et al., 2002).

To help illustrate, we describe a study examining women’s responses to unwanted sexual advances (Jouriles et al., 2009). In this study, the virtual environment was the interior of a car, in which the research participant would sit in the passenger seat. A male avatar was seated behind the steering wheel. The car was parked by a lake on a rainy day. The instructions to set up the simulation were: *You were at a party where you met this guy. He offered to give you a ride home. He seemed nice enough so you agreed. On the way home, it started to pour, so he pulled over to let the rain subside.* During the simulation, the avatar started by making small talk with the

research participant (“*What are you studying?*”). The avatar then began to flirt (“*You’re gorgeous*”) and escalated (“*Let me kiss you*”). Controlling the avatar’s speech and responses, male research actors were trained to follow the script while keeping the interaction feeling natural. In this study, Jouriles and colleagues consulted with college women to develop the opening instructions for the simulations and the scripts for the avatar, select male research actors, and design the virtual environment (2009). During each simulation, data on several health outcomes were collected in real-time (e.g., self-reported affect and measured heart rate).

By placing participants in a virtual environment, researchers can use a similar paradigm to investigate how different types of discrimination experiences influence POCI participants’ health. During VR simulations, researchers can have avatars act in a discriminatory way toward research participants (e.g., deliver subtle slights, use racial slurs), and researchers can measure in real-time participants’ emotional, behavioral, cognitive, and physiological responses to various forms of unfair treatment delivered by the avatar. To provide a more concrete example, we will use the question addressed in the experimental study by Gibbons et al. (2010): How do discrimination experiences influence negative affect and urges to use alcohol and drugs? In the Gibbons study, research participants were randomly assigned to an experimental discrimination condition in which they visualized being in a situation where their boss made racial insults to them. Using VR, this same question can be addressed by exposing research participants to first-hand experiences of racial insults and unfair treatment in an immersive virtual environment simulating an office. An avatar representing the boss can directly yell racial slurs at the research participants. Assets in the virtual environments (e.g., office chairs, computers) can be customized and programmed into the environments. To assess the causal effects of the experimentation, researchers can measure participants’ negative affect and urges to engage in alcohol and drug use

during and immediately after simulations.

## **Potential Advantages of Virtual Reality in Discrimination Research**

### ***Experimenter Control Coupled with Ecological Validity***

VR offers researchers a lot of flexibility in the types of discriminatory acts that can be manipulated, and the context in which they are manipulated (i.e., the virtual environment). For example, it may be difficult, costly, and unrealistic to investigate in a typical university research laboratory how POCI respond to discriminatory acts that take place at restaurants and bars (e.g., a slight by a waiter, a racist picture on the restaurant wall). VR makes it easier for researchers to experimentally manipulate different types of discrimination experiences across a wide range of possible contexts. In fact, VR offers researchers the ability to expose participants to multiple virtual environments and/or stimuli even within the same experimental session.

The flexibility that VR affords researchers in designing environments can enhance ecological validity, which is an important consideration for evaluating the generalizability of a causal effect (Brewer, 2000). How individuals respond to racism often depend on contexts (e.g., Benner & Graham, 2013); thus, it is vital to examine systematically the roles of social or environmental settings surrounding discrimination. Research participants' responses to stressful encounters in virtual environments have been shown to be similar to those elicited in natural environments (Martens et al., 2019; Zimmer et al., 2019), providing some evidence that ecologically valid studies can be designed with the use of VR.

We use some of our own work to illustrate further. In a series of pilot studies, we exposed individuals to interpersonal racial discrimination exchanges and assessed their immediate reactions (Lui et al., 2020). In a virtual environment that simulated a house party, participants received racist comments from an avatar. The avatar was controlled by a research actor in real-

time via the rendering computer and software, and avatars were programmed to display a variety of emotions. To convey dismissiveness and frustration, for example, avatars were programmed to be able to throw their hands up in the air, smirk, frown or raise the eyebrows at, and look away from, the research participants. In our pilot studies, research participants judged the avatar's verbal and nonverbal communications and the overall interactions to be very realistic. Not only did they report that they felt immersed in the conversations and virtual environments, but also that they responded to the discrimination experiences as they would in real life.

### ***Real-Time Assessments***

Most observational research on how discrimination-related experiences relate to minority health has relied on retrospective reporting. Commonly, participants are asked to recall their lifetime experiences with racism and discrimination, and sometimes their appraisals of these personal experiences. This type of retrospective reporting provides information about the experiences from the reporter's current vantage point. Yet, memory and motivational biases have been shown to affect the accuracy of these assessments; biases may include the tendency to recall and report on recent experiences (*recency effect*), personally relevant experiences (*personal heuristics effect*), significant experiences (*salience effect*), and demand characteristics of the situation (Schwarz, 2012; Trull & Ebner-Priemer, 2009). In contrast to approaches that rely on retrospective reporting, VR offers the opportunity to present research participants with discriminatory experiences in real-time. Researchers can observe and record directly participants' physiological, affective, and behavioral reactions before, during, and after VR experimentation. The assessment of participants' cognitive reactions also can be conducted shortly after the VR simulation, which helps mitigate the possibility of forgetting and other potential reporting biases.

### **Recommending Virtual Reality as An Approach to Discrimination Research: Further Considerations**

The use of VR to manipulate discrimination experiences differs from what has been done in prior experimental research on discrimination. We do not suggest that assessing individuals' responses to racist acts performed by an avatar in a virtual environment is the best or most accurate way of evaluating the effects of discrimination. We do believe that the use of VR can contribute to a more complete and methodologically sophisticated understanding of how discrimination experiences might influence the health of POCI over and above existing research. A multimethod approach to discrimination science can help researchers enhance the real-world relevance of documented experimental effects and contribute to a greater understanding of boundary conditions of the effects (i.e., when the effects occur), and in turn refine psychological theories. For example, researchers may conduct VR experimental studies to directly expose participants to discrimination experiences in virtual environments and examine some hypothesized causal pathways by which discrimination experiences lead to health outcomes. Researchers also may attempt to replicate and extend VR experimental findings in other investigations that use different methods of manipulating discrimination experiences (e.g., imagining discrimination experiences, viewing video clips of discrimination experiences). To further validate the generalizability of findings from experimental studies, researchers can collect real-world, real-time data using daily diary or ecological momentary assessment methods (Livingston et al., 2017; Torres & Ong, 2010). A convergence of findings across different methods strengthens the conclusions that can be made about the effects of racism and discrimination on health, whereas a divergence of findings across methods implies a need to further understanding the study heterogeneity.



Additionally, we acknowledge that qualitative inquiry can be especially valuable in identifying salient aspects of the discrimination experiences among POCI, which in turn can be used in VR research (Iwamoto et al., 2013; Robinson-Wood et al., 2020; Sue, Bucci, et al., 2007; Sue et al., 2008). In-depth interviews have yielded rich insight about how individuals and groups respond to racism and different types of discrimination across systemic, institutional, and interpersonal levels. Findings from qualitative and naturalistic survey research can inform the empirical questions that are addressed in VR studies and guide the design of VR simulations. In some of our own research, focus group participants deemed a set of written vignettes to be representative of real-life discrimination-related experiences, and we turned these scenarios into scripts and interactions within an immersive virtual environment (Lui et al., 2020).

### **Insights on Unique Methodological Considerations for Using Virtual Reality**

#### ***Design and Technical Requirements***

The design of a VR project may involve the creation and customization of a virtual environment or the selection of an already-existing virtual environment. The former requires close multidisciplinary collaborations that may involve content experts as well as computer scientists, production artists, and level designers (i.e., technicians who assemble digital assets together into the immersive virtual environment). VR research also requires hardware and software systems, rendering computers and head-mounted displays, and user interfaces.

Commercialized equipment used for operating a virtual environment makes it possible to conduct VR studies in a small laboratory, which may be located in a university or community setting (see Figure 1 for illustration). The wide availability of wireless headsets and accessories to transform handheld mobile devices into head-mounted displays have enhanced the portability of VR research. This portability can be particularly important because POCI remain

underrepresented in psychological science and are less inclined to participate in research than Whites (George et al., 2014). The ability to transport VR “laboratories” to the community may enhance the feasibility of participant recruitment and reduce the burden on POCI individuals to engage in research.

### *Costs*

Despite the use of innovative technology, the financial costs associated with VR research can be quite manageable. If existing and off-the-shelf virtual environments are used, direct costs unique to the use of the technology may be limited to basic equipment purchases. At the time of the writing of this manuscript, head-mounted devices can cost as low as US\$300 whereas VR-compatible computers can cost as low as US\$1500.<sup>1</sup> Other general research expenses such as compensating research personnel for their efforts and time and participant reimbursements are not different than what may be typical in conventional experimental studies. Based on our experience of conducting game design research in VR and designing VR-related psychological research, modifications to existing virtual environments can be completed with \$10,000 and within one month of full-time professional assistance (or one academic semester with part-time technical support; e.g., course buyout by an art faculty member).

The use of VR becomes more expensive when researchers design customized virtual environments and simulations from scratch. For example, in our experience, it may cost \$30,000 to \$50,000 depending on the features (e.g., avatars, assets in the environments, animations). Such high-level customizations can be completed within three months with full-time professional assistance or one academic year with part-time support (e.g., salary/course buyout for programmer and production and art faculty members).

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<sup>1</sup> See vendors such as Oculus (<https://www.oculus.com>) and Dell (<https://www.dell.com/en-us/shop/dell-laptops/sr/laptops/vr-ready?appliedRefinements=9903>).

### ***Participant Engagement***

It is possible that there are higher levels of participant attentional focus and motivation in research that uses VR compared to more conventional research methods (Rockstroh et al., 2019). Because enhanced mundane realism can increase people's participation in the experiments (Blascovich et al., 2002), it would be important to anticipate this possibility. Similarly, there may be individuals who have no prior experiences with VR and/or are at high risk for anxiety about being immersed in a novel virtual environment. To address these possibilities, researchers may consider an acclimation period prior to starting the study. We suggest that researchers provide their participants an opportunity to explore the virtual environments and become comfortable with the technology prior to being exposed to experimental stimuli (Lee, Eden, et al., 2019). These steps can reduce possible novelty effects and increase fidelity of the method (Chirico & Gaggioli, 2019). Furthermore, it would be helpful to conduct semi-structured interviews at the end of the study to obtain an understanding of participants' perceptions and reactions to the VR technology (Alghamdi et al., 2017).

Researchers incorporating VR in their studies also should consider the possibility that participants experience unique negative side effects from the technology. For example, it is possible that participants may feel that they do not have free will to interrupt the interactions in the computer-generated environments because of the separation of their virtual reality and physical reality. Additionally, VR simulations may generate more intense visual and audio experiences than conventional stimulus presentations (Behr et al., 2005). There is also the possibility that some participants have difficulty reentering into the "real" world should they become used to the virtual environments. This reentry can be particularly challenging when individuals have engaged in behaviors that they deem to be inappropriate (e.g., yelling at the

avatar) and when they experience high levels of negative affect. VR use may also cause aversive reactions in some individuals (Saredakis et al., 2020). The most common aversive effects of VR include visually induced cybersickness (also known as simulator sickness or motion sickness); symptoms include nausea, disorientation, and blurred vision (Kim et al., 2018).

Each of these VR-specific issues can be addressed with careful planning, implementation of safety protocols, and participant informed consent. For example, we recommend researchers to incorporate procedures that screen and warn potential participants about the possibility of cybersickness prior to enrollment. Similarly, potential participants should be informed of the nature of their immersive virtual interactions, and what to do when they are in physical or emotional distress during the simulations. In short, safeguards should be put in place, similar to other types of research that exposes participants to stressors and/or adverse experiences (e.g., research using stress induction). We also recommend that researchers conduct post-simulation debriefing to assess participants' experiences throughout the study. In the unlikely event that participants report aversive experiences, researchers should provide clinical or support resources and consult with their ethics board.

### ***Reporting of Methods***

In study preregistrations and manuscript method sections, certain details about the VR technology should be reported. These include the make and model of head-mounted displays, whether the immersive virtual environments were off-the-shelf or customized for the research study, features in the virtual environments, and instructions provided to research participants before and during the VR experimentation.

### **Future Research Examining the Potential Benefits of Virtual Reality**

Methodological studies are needed to evaluate the actual utility of VR as a tool in

discrimination research. For example, it would be valuable to know how participants experience different manipulations of discriminatory acts. Are racial slurs delivered by an avatar in a virtual environment experienced as more realistic than those delivered by a research actor in a laboratory setting? Do VR simulations result in more intense emotions than imagined discrimination exchanges? Given that a potential advantage of VR is the opportunity for researchers to manipulate different types of discrimination experiences, and observe research participants' reactions across contexts, it would be important to know if this "advantage" extends theory and empirical knowledge on how discrimination affects health outcomes. In what settings—a restaurant versus a university laboratory—might POCI experience more intense reactions in response to racism and discrimination-related exchanges?

### **Practical Implications**

Although the present article is not focused on clinical or applied uses of VR, we would be remiss to not discuss briefly the potential of VR in this context. There already is research showing the efficacy of using VR to deliver cognitive-behavioral therapy, particularly targeting anxiety-related disorders, and training for empathy and assertiveness in interpersonal situations (Donker et al., 2019; Oprea et al., 2012; Parrish et al., 2016). VR-based methods are being used successfully in training medical providers to master complex surgical procedures and teaching rehabilitation patients to regain motor control, balance, and strength (Bing et al., 2019; Haque & Srinivasan, 2006; Howard, 2017). By the same token, VR can be useful in bolstering training efforts directed at preventing racist and discriminatory behaviors directed at POCI and helping individuals practice various adaptive responses to racism-related situations.

Being able to understand POCI's lived experiences can help reduce and prevent discrimination; thus, racial and cultural sensitivity training that is aimed to enhance empathy may

reduce the perpetration of discriminatory behaviors (Finlay & Stephan, 2000). VR has been shown to be effective in efforts to promote empathy. Specifically, research showed greater changes in perspective taking when participants experienced homelessness in an immersive virtual environment than when they imagined what it was like to be homeless (Herrera et al., 2018). Additionally, VR can be valuable in helping individuals hone skills in responding effectively to discrimination-related situations—either as recipients of racism or as bystanders. For example, research showed that VR facilitated the learning and practicing of assertive resistance in response to unwanted sexual advances (Rowe et al., 2015). Similar strategies can be used in promoting individuals’ mastery of skills to confront discriminatory behaviors, including calling out the unintended slights, educating the deliverers of racist behaviors, seeking support from allies, and engaging in prosocial bystander behaviors (Palmer et al., 2017; Sue et al., 2019).

### **Conclusion**

In this article, we have described VR and our thoughts of the potential benefits of using VR in efforts to advance knowledge on causal effects of racism and discrimination. The present overview can help researchers consider an innovative way to potentially explain how, when, in what contexts, and for whom racism and discrimination impact health outcomes. VR can be added to the toolkit currently available to researchers in not only advancing theories and empirical evidence concerning health disparities, but also potentially informing practical ways to mitigate the negative effects of racism and discrimination on POCI health.

## References

- Alghamdi, M., Regenbrecht, H., Hoermann, S., & Swain, N. (2017). Mild stress stimuli built into a non-immersive virtual environment can elicit actual stress responses. *Behaviour & Information Technology*, 36(9), 913-934.  
<https://doi.org/10.1080/0144929X.2017.1311374>
- Alvarez, A. N., Juang, L., & Liang, C. T. H. (2006). Asian Americans and racism: When bad things happen to 'model minorities.'. *Cultural Diversity and Ethnic Minority Psychology*, 12(3), 477-492. <https://doi.org/10.1037/1099-9809.12.3.477>
- Anderson, P. L., Zimand, E., Hodges, L. F., & Rothbaum, B. O. (2005). Cognitive behavioral therapy for public-speaking anxiety using virtual reality for exposure. *Depression & Anxiety*, 22(3), 156-158. <https://doi.org/10.1002/da.20090>
- Baumeister, R. F., Vohs, K. D., & Funder, D. C. (2007, 2007/12/01). Psychology as the science of self-reports and finger movements: Whatever happened to actual behavior? *Perspectives on Psychological Science*, 2(4), 396-403. <https://doi.org/10.1111/j.1745-6916.2007.00051.x>
- Behr, K.-M., Nosper, A., Klimmt, C., & Hartmann, T. (2005). Some practical considerations of ethical issues in VR research. *Presence: Teleoperators & Virtual Environments*, 14(6), 668-676. <https://doi.org/10.1162/105474605775196535>
- Benjamins, M. R., & Whitman, S. (2014, 2014/06/01). Relationships between discrimination in health care and health care outcomes among four race/ethnic groups. *Journal of Behavioral Medicine*, 37(3), 402-413. <https://doi.org/10.1007/s10865-013-9496-7>

- Benner, A. D., & Graham, S. (2013). The antecedents and consequences of racial/ethnic discrimination during adolescence: Does the source of discrimination matter? *Developmental Psychology*, 49(8), 1602-1613. <https://doi.org/10.1037/a0030557>
- Berger, M., & Sarnyai, Z. (2015). 'More than skin deep': Stress neurobiology and mental health consequences of racial discrimination. *Stress*, 18(1), 1-10. <https://doi.org/10.3109/10253890.2014.989204>
- Bing, E. G., Parham, G. P., Cuevas, A., Fisher, B., Skinner, J., Mwanahamuntu, M., & Sullivan, R. (2019). Using low-cost virtual reality simulation to build surgical capacity for cervical cancer treatment. *Journal of Global Oncology*(5), 1-7. <https://doi.org/10.1200/jgo.18.00263>
- 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. <http://www.jstor.org/stable/1449167>
- Bouchard, S., Robillard, G., Giroux, I., Jacques, C., Loranger, C., St-Pierre, M., Chrétien, M., & Goulet, A. (2017). Using virtual reality in the treatment of gambling disorder: The development of a new tool for cognitive behavior therapy. *Frontiers in psychiatry*, 8, 27-27. <https://doi.org/10.3389/fpsy.2017.00027>
- Brewer, M. B. (2000). Research design and issues of validity. In *Handbook of research methods in social and personality psychology*. (pp. 3-16). Cambridge University Press.
- Brondolo, E., Gallo, L. C., & Myers, H. F. (2008). Race, racism and health: Disparities, mechanisms, and interventions. *Journal of Behavioral Medicine*, 32(1), 1. <https://doi.org/10.1007/s10865-008-9190-3>



- Carter, E. R., & Murphy, M. C. (2015). Group-based differences in perceptions of racism: What counts, to whom, and why? *Social and Personality Psychology Compass*, 9(6), 269-280. <https://doi.org/10.1111/spc3.12181>
- CDC. (2013). CDC health disparities and inequalities report—United States, 2013. [https://www.cdc.gov/mmwr/preview/ind2013\\_su.html#HealthDisparities2013](https://www.cdc.gov/mmwr/preview/ind2013_su.html#HealthDisparities2013)
- Chavez, L. J., Ornelas, I. J., Lyles, C. R., & Williams, E. C. (2015). Racial/ethnic workplace discrimination: Association with tobacco and alcohol use. *American Journal of Preventive Medicine*, 48(1), 42-49. <https://doi.org/10.1016/j.amepre.2014.08.013>
- Chirico, A., & Gaggioli, A. (2019). When virtual feels real: Comparing emotional responses and presence in virtual and natural environments. *Cyberpsychology, Behavior, and Social Networking*, 22(3), 220-226. <https://doi.org/10.1089/cyber.2018.0393>
- Cicchetti, D., Rogosch, F. A., Lynch, M., & Holt, K. D. (1993). Resilience in maltreated children: Processes leading to adaptive outcome. *Development and Psychopathology*, 5(4), 629-647. <https://doi.org/10.1017/S0954579400006209>
- Devakumar, D., Selvarajah, S., Shannon, G., Muraya, K., Lasoye, S., Corona, S., Paradies, Y., Abubakar, I., & Achiume, E. T. (2020). Racism, the public health crisis we can no longer ignore. *Lancet*, 395(10242), e112-e113. [https://doi.org/10.1016/S0140-6736\(20\)31371-4](https://doi.org/10.1016/S0140-6736(20)31371-4)
- DHHS. (2001). *Mental health: Culture, race, and ethnicity—a supplement to mental health: A report of the surgeon general*. U.S. Department of Health and Human Services. <http://health-equity.lib.umd.edu/866/>
- Donker, T., Cornelisz, I., van Klaveren, C., van Straten, A., Carlbring, P., Cuijpers, P., & van Gelder, J.-L. (2019). Effectiveness of self-guided app-based virtual reality cognitive

- behavior therapy for acrophobia: A randomized clinical trial. *JAMA Psychiatry*, 76(7), 682-690. <https://doi.org/10.1001/jamapsychiatry.2019.0219>
- Fang, C. Y., & Myers, H. F. (2001). The effects of racial stressors and hostility on cardiovascular reactivity in African American and Caucasian men. *Health Psychology*, 20(1), 64-70. <https://doi.org/10.1037/0278-6133.20.1.64>
- FBI. (2018). *Hate crime statistics, 2017*. <https://ucr.fbi.gov/hate-crime/2017>
- Finlay, K. A., & Stephan, W. G. (2000). Improving intergroup relations: The effects of empathy on racial attitudes. *Journal of Applied Social Psychology*, 30(8), 1720-1737. <https://doi.org/10.1111/j.1559-1816.2000.tb02464.x>
- Flores, E., Tschann, J. M., Dimas, J. M., Pasch, L. A., & de Groat, C. L. (2010). Perceived racial/ethnic discrimination, posttraumatic stress symptoms, and health risk behaviors among Mexican American adolescents. *Journal of Counseling Psychology*, 57(3), 264-273. <https://doi.org/10.1037/a0020026>
- Gazard, B., Chui, Z., Harber-Aschan, L., MacCrimmon, S., Bakolis, I., Rimes, K., Hotopf, M., & Hatch, S. L. (2018). Barrier or stressor? The role of discrimination experiences in health service use. *BMC Public Health*, 18(1), 1354. <https://doi.org/10.1186/s12889-018-6267-y>
- George, S., Duran, N., & Norris, K. (2014). A systematic review of barriers and facilitators to minority research participation among African Americans, Latinos, Asian Americans, and Pacific Islanders. *American Journal of Public Health*, 104(2), e16-e31. <https://doi.org/10.2105/AJPH.2013.301706>
- Gibbons, F. X., Etcheverry, P. E., Stock, M. L., Gerrard, M., Weng, C.-Y., Kiviniemi, M., & O'Hara, R. E. (2010). Exploring the link between racial discrimination and substance use:

- What mediates? What buffers? *Journal of Personality and Social Psychology*, 99(5), 785-801. <https://doi.org/10.1037/a0019880>
- Gibbons, F. X., Kingsbury, J. H., Weng, C.-Y., Gerrard, M., Cutrona, C., Wills, T. A., & Stock, M. (2014). Effects of perceived racial discrimination on health status and health behavior: A differential mediation hypothesis. *Health Psychology*, 33(1), 11-19. <https://doi.org/10.1037/a0033857>
- Gilbert, P. A., & Zemore, S. E. (2016). Discrimination and drinking: A systematic review of the evidence. *Social Science & Medicine*, 161, 178-194. <https://doi.org/10.1016/j.socscimed.2016.06.009>
- Grych, J. H., Jouriles, E. N., Swank, P. R., McDonald, R., & Norwood, W. D. (2000). Patterns of adjustment among children of battered women. *Journal of Consulting and Clinical Psychology*, 68(1), 84-94. <https://doi.org/10.1037/0022-006X.68.1.84>
- Haque, S., & Srinivasan, S. (2006, Jan). A meta-analysis of the training effectiveness of virtual reality surgical simulators. *IEEE Trans Inf Technol Biomed*, 10(1), 51-58. <https://doi.org/10.1109/titb.2005.855529>
- Harrell, S. P. (1994). *The racism and life experience scales*. Unpublished manuscript.
- Harrell, S. P. (2000). A multidimensional conceptualization of racism-related stress: Implications for the well-being of people of color. *American Journal of Orthopsychiatry*, 70(1), 42-57. <https://doi.org/10.1037/h0087722>
- Herrera, F., Bailenson, J., Weisz, E., Ogle, E., & Zaki, J. (2018). Building long-term empathy: A large-scale comparison of traditional and virtual reality perspective-taking. *PLoS ONE*, 13(10), e0204494. <https://doi.org/10.1371/journal.pone.0204494>

- Howard, M. C. (2017). A meta-analysis and systematic literature review of virtual reality rehabilitation programs. *Computers in Human Behavior*, 70, 317-327.  
<https://doi.org/10.1016/j.chb.2017.01.013>
- Hughes, D., Del Toro, J., Harding, J. F., Way, N., & Rarick, J. R. D. (2016). Trajectories of discrimination across adolescence: Associations with academic, psychological, and behavioral outcomes. *Child Development*, 87(5), 1337-1351.  
<https://doi.org/10.1111/cdev.12591>
- Iwamoto, D. K., Negi, N. J., Partiali, R. N., & Creswell, J. W. (2013). The racial and ethnic identity formation process of second-generation Asian Indian Americans: A phenomenological study. *Journal of Multicultural Counseling and Development*, 41(4), 224-239. <https://doi.org/10.1002/j.2161-1912.2013.00038.x>
- James, L. K., Lin, C.-Y., Steed, A., Swapp, D., & Slater, M. (2003). Social anxiety in virtual environments: Results of a pilot study. *CyberPsychology & Behavior*, 6(3), 237-243.  
<https://doi.org/10.1089/109493103322011515>
- Jeffries, N., Zaslavsky, A. M., Diez Roux, A. V., Creswell, J. W., Palmer, R. C., Gregorich, S. E., Reschovsky, J. D., Graubard, B. I., Choi, K., Pfeiffer, R. M., Zhang, X., & Breen, N. (2019). Methodological approaches to understanding causes of health disparities. *American Journal of Public Health*, 109(S1), S28-S33.  
<https://doi.org/10.2105/AJPH.2018.304843>
- Jeung, R., & Nham, K. (2020). *Incidents of coronavirus-related discrimination*.  
<https://www.asianpacificpolicyandplanningcouncil.org/stop-aapi-hate/>

- Jones, K. P., Peddie, C. I., Gilrane, V. L., King, E. B., & Gray, A. L. (2016). Not so subtle: A meta-analytic investigation of the correlates of subtle and overt discrimination. *Journal of Management*, 42(6), 1588-1613. <https://doi.org/10.1177/0149206313506466>
- Jouriles, E. N., Kleinsasser, A., Rosenfield, D., & McDonald, R. (2016). Measuring bystander behavior to prevent sexual violence: Moving beyond self reports. *Psychology of Violence*, 6(1), 73-81. <https://doi.org/10.1037/a0038230>
- Jouriles, E. N., McDonald, R., Kullowatz, A., Rosenfield, D., Gomez, G. S., & Cuevas, A. (2009). Can virtual reality increase the realism of role plays used to teach college women sexual coercion and rape-resistance skills? *Behavior Therapy*, 40(4), 337-345. <https://doi.org/https://doi.org/10.1016/j.beth.2008.09.002>
- Kassner, M. P., Wesselmann, E. D., Law, A. T., & Williams, K. D. (2012, 08//). Virtually ostracized: Studying ostracism in immersive virtual environments. *CyberPsychology, Behavior & Social Networking*, 15(8), 399-403. <https://doi.org/10.1089/cyber.2012.0113>
- Kazdin, A. E. (2017). *Research design in clinical psychology*. Pearson.
- Kim, H. K., Park, J., Choi, Y., & Choe, M. (2018). Virtual reality sickness questionnaire (VRSQ): Motion sickness measurement index in a virtual reality environment. *Applied Ergonomics*, 69, 66-73. <https://doi.org/10.1016/j.apergo.2017.12.016>
- Lee, D. L., & Ahn, S. (2011). Racial discrimination and Asian mental health: A meta-analysis. *The Counseling Psychologist*, 39(3), 463-489. <https://doi.org/10.1177/0011000010381791>
- Lee, D. L., & Ahn, S. (2012). Discrimination against Latina/os: A meta-analysis of individual-level resources and outcomes. *The Counseling Psychologist*, 40(1), 28-65. <https://doi.org/10.1177/0011000011403326>

- Lee, J., Eden, A., Ewoldsen, D. R., Beyea, D., & Lee, S. (2019). Seeing possibilities for action: Orienting and exploratory behaviors in VR. *Computers in Human Behavior*, 98, 158-165. <https://doi.org/10.1016/j.chb.2019.03.040>
- Lee, R. T., Perez, A. D., Boykin, C. M., & Mendoza-Denton, R. (2019). On the prevalence of racial discrimination in the United States. *PLoS ONE*, 14(1), e0210698. <https://doi.org/10.1371/journal.pone.0210698>
- Lewis, T. T., Cogburn, C. D., & Williams, D. R. (2015). Self-reported experiences of discrimination and health: Scientific advances, ongoing controversies, and emerging issues. *Annual review of clinical psychology*, 11, 407-440. <https://doi.org/10.1146/annurev-clinpsy-032814-112728>
- Lilienfeld, S. O. (2017). Microaggressions: Strong claims, inadequate evidence. *Perspectives on Psychological Science*, 12(1), 138-169. <https://doi.org/10.1177/1745691616659391>
- Livingston, N. A., Flentje, A., Heck, N. C., Szalda-Petree, A., & Cochran, B. N. (2017). Ecological momentary assessment of daily discrimination experiences and nicotine, alcohol, and drug use among sexual and gender minority individuals. *Journal of Consulting and Clinical Psychology*, 85(12), 1131-1143. <https://doi.org/10.1037/ccp0000252>
- Loomis, J. M., Blascovich, J. J., & Beall, A. C. (1999). Immersive virtual environment technology as a basic research tool in psychology. *Behavior Research Methods, Instruments, & Computers*, 31(4), 557-564. <https://doi.org/10.3758/BF03200735>
- Lui, P. P. (2020). Racial microaggression, overt discrimination, and distress: (In)Direct associations with psychological adjustment. *The Counseling Psychologist*, 48(4), 551-582. <https://doi.org/10.1177/0011000020901714>

- Lui, P. P., & Quezada, L. (2019). Associations between microaggression and adjustment outcomes: A meta-analytic and narrative review. *Psychological Bulletin*, 145(1), 45-78. <https://doi.org/10.1037/bul0000172>
- Lui, P. P., Pham, S., Stringer, E., & Jouriles, E. N. (2020). Effects of racial discrimination on stress, negative emotions, and alcohol craving: A registered report of a virtual reality experiment. *Cultural Diversity and Ethnic Minority Psychology*. In Principle Acceptance.
- Martens, M. A. G., Antley, A., Freeman, D., Slater, M., Harrison, P. J., & Tunbridge, E. M. (2019). It feels real: Physiological responses to a stressful virtual reality environment and its impact on working memory. *Journal of Psychopharmacology*, 33(10), 1264-1273. <https://doi.org/10.1177/0269881119860156>
- Mason, T. B., Maduro, R. S., Derlega, V. J., Hacker, D. S., Winstead, B. A., & Haywood, J. E. (2017). Individual differences in the impact of vicarious racism: African American students react to the george zimmerman trial. *Cultural Diversity and Ethnic Minority Psychology*, 23(2), 174-184. <https://doi.org/10.1037/cdp0000099>
- Neblett, E. W., Jr. (2019). Racism and health: Challenges and future directions in behavioral and psychological research. *Cultural Diversity and Ethnic Minority Psychology*, 25(1), 12-20. <https://doi.org/10.1037/cdp0000253>
- Ong, A. D., Burrow, A. L., Fuller-Rowell, T. E., Ja, N. M., & Sue, D. W. (2013). Racial microaggressions and daily well-being among Asian Americans. *Journal of Counseling Psychology*, 60(2), 188-199. <https://doi.org/10.1037/a0031736>
- Opriş, D., Pinteă, S., García-Palacios, A., Botella, C., Szamosközi, Ş., & David, D. (2012). Virtual reality exposure therapy in anxiety disorders: A quantitative meta-analysis. *Depression & Anxiety*, 29(2), 85-93. <https://doi.org/10.1002/da.20910>

- Palmer, S. B., Cameron, L., Rutland, A., & Blake, B. (2017). Majority and minority ethnic status adolescents' bystander responses to racism in school. *Journal of Community & Applied Social Psychology*, 27(5), 374-380. <https://doi.org/10.1002/casp.2313>
- Parrish, D. E., Oxhandler, H. K., Duron, J. F., Swank, P., & Bordnick, P. (2016). Feasibility of virtual reality environments for adolescent social anxiety disorder. *Research on Social Work Practice*, 26(7), 825-835. <https://doi.org/10.1177/1049731514568897>
- Pascoe, E. A., & Richman, L. S. (2009). Perceived discrimination and health: A meta-analytic review. *Psychological Bulletin*, 135(4), 531-554. <https://doi.org/10.1037/a0016059>
- Plaut, V. C. (2010). Diversity science: Why and how difference makes a difference. *Psychological Inquiry*, 21(2), 77-99. <https://doi.org/10.1080/10478401003676501>
- Powers, M. B., Briceno, N. F., Gresham, R., Jouriles, E. N., Emmelkamp, P. M. G., & Smits, J. A. J. (2013). Do conversations with virtual avatars increase feelings of social anxiety? *Journal of Anxiety Disorders*, 27(4), 398-403. <https://doi.org/https://doi.org/10.1016/j.janxdis.2013.03.003>
- Reis, H. T. (2012). Why researchers should think "real-world": A conceptual rationale. In M. R. Mehl & T. S. Conner (Eds.), *Handbook of research methods for studying daily life* (pp. 3-21). The Guilford Press.
- Rivenbark, J. G., & Ichou, M. (2020, 2020/01/09). Discrimination in healthcare as a barrier to care: Experiences of socially disadvantaged populations in france from a nationally representative survey. *BMC Public Health*, 20(1), 31. <https://doi.org/10.1186/s12889-019-8124-z>
- Robinson-Wood, T., Balogun-Mwangi, O., Weber, A., Zeko-Underwood, E., Rawle, S.-A. C., Popat-Jain, A., Matsumoto, A., & Cook, E. (2020). 'What is it going to be like?': A



- phenomenological investigation of racial, gendered, and sexual microaggressions among highly educated individuals. *Qualitative Psychology*, 7(1), 43-58.  
<https://doi.org/10.1037/qup0000113>
- Rockstroh, C., Blum, J., & Göritz, A. S. (2019). Virtual reality in the application of heart rate variability biofeedback. *International Journal of Human-Computer Studies*, 130, 209-220. <https://doi.org/10.1016/j.ijhcs.2019.06.011>
- Rothbaum, B. O., Anderson, P., Zimand, E., Hodges, L., Lang, D., & Wilson, J. (2006). Virtual reality exposure therapy and standard (in vivo) exposure therapy in the treatment of fear of flying. *Behavior Therapy*, 37(1), 80-90.  
<https://doi.org/https://doi.org/10.1016/j.beth.2005.04.004>
- Rowe, L. S., Jouriles, E. N., & McDonald, R. (2015). Reducing sexual victimization among adolescent girls: A randomized controlled pilot trial of My Voice, My Choice. *Behavior Therapy*, 46(3), 315-327. <https://doi.org/https://doi.org/10.1016/j.beth.2014.11.003>
- RWJF. (2018). *Discrimination in america: Final summary*. Robert Wood Johnson Foundation.  
<https://www.rwjf.org/en/library/research/2017/10/discrimination-in-america--experiences-and-views.html>
- Sapouna, M., & Wolke, D. (2013, 2013/11/01/). Resilience to bullying victimization: The role of individual, family and peer characteristics. *Child Abuse & Neglect*, 37(11), 997-1006.  
<https://doi.org/https://doi.org/10.1016/j.chiabu.2013.05.009>
- Saredakis, D., Szpak, A., Birckhead, B., Keage, H. A. D., Rizzo, A., & Loetscher, T. (2020). Factors associated with virtual reality sickness in head-mounted displays: A systematic review and meta-analysis. *Frontiers in Human Neuroscience*, 14.  
<https://doi.org/10.3389/fnhum.2020.00096>

Sawyer, P. J., Major, B., Casad, B. J., Townsend, S. S. M., & Mendes, W. B. (2012).

Discrimination and the stress response: Psychological and physiological consequences of anticipating prejudice in interethnic interactions. *American Journal of Public Health*, 102(5), 1020-1026. <https://doi.org/10.2105/ajph.2011.300620>

Schwarz, N. (2012). Why researchers should think "real-time": A cognitive rationale. In M. R. Mehl & T. S. Conner (Eds.), *Handbook of research methods for studying daily life*. (pp. 22-42). The Guilford Press.

Sellers, R. M., Caldwell, C. H., Schmeelk-Cone, K. H., & Zimmerman, M. A. (2003). Racial identity, racial discrimination, perceived stress, and psychological distress among African American young adults. *Journal of Health and Social Behavior*, 44(3), 302-317. <https://doi.org/10.2307/1519781>

Shavers, V. L., Fagan, P., Jones, D., Klein, W. M. P., Boyington, J., Moten, C., & Rorie, E. (2012). The state of research on racial/ethnic discrimination in the receipt of health care. *American Journal of Public Health*, 102(5), 953-966. <https://doi.org/10.2105/AJPH.2012.300773>

Sue, D. W. (2017). Microaggressions and "evidence": Empirical or experiential reality? *Perspectives on Psychological Science*, 12(1), 170-172. <https://doi.org/10.1177/1745691616664437>

Sue, D. W., Alsaidi, S., Awad, M. N., Glaeser, E., Calle, C. Z., & Mendez, N. (2019). Disarming racial microaggressions: Microintervention strategies for targets, White allies, and bystanders. *American Psychologist*, 74(1), 128-142. <https://doi.org/10.1037/amp0000296>

- Sue, D. W., Bucceri, J., Lin, A. I., Nadal, K. L., & Torino, G. C. (2007). Racial microaggressions and the Asian American experience. *Cultural Diversity and Ethnic Minority Psychology, 13*(1), 72-81. <https://doi.org/10.1037/1099-9809.13.1.72>
- Sue, D. W., Capodilupo, C. M., & Holder, A. M. B. (2008). Racial microaggressions in the life experience of Black Americans. *Professional Psychology: Research and Practice, 39*(3), 329-336. <https://doi.org/10.1037/0735-7028.39.3.329>
- Sue, D. W., Capodilupo, C. M., Torino, G. C., Bucceri, J. M., Holder, A. M. B., Nadal, K. L., & Esquilin, M. (2007). Racial microaggressions in everyday life: Implications for clinical practice. *American Psychologist, 62*(4), 271-286. <https://doi.org/10.1037/0003-066X.62.4.271>
- Torres, L., & Ong, A. D. (2010). A daily diary investigation of Latino ethnic identity, discrimination, and depression. *Cultural Diversity and Ethnic Minority Psychology, 16*(4), 561-568. <https://doi.org/10.1037/a0020652>
- Torres, L., Reveles, A. K., Mata-Greve, F., Schwartz, S., & Domenech Rodriguez, M. M. (2020, 2020/02/01). Reactions to witnessing ethnic microaggressions: An experimental study. *Journal of Social and Clinical Psychology, 39*(2), 141-164. <https://doi.org/10.1521/jscp.2020.39.02.141>
- Trull, T. J., & Ebner-Priemer, U. W. (2009, Dec). Using experience sampling methods/ecological momentary assessment (ESM/EMA) in clinical assessment and clinical research: Introduction to the special section. *Psychological Assessment, 21*(4), 457-462. <https://doi.org/10.1037/a0017653>

- Volpe, V. V., Lee, D. B., Hoggard, L. S., & Rahal, D. (2018). Racial discrimination and acute physiological responses among Black young adults: The role of racial identity. *Journal of Adolescent Health*. <https://doi.org/10.1016/j.jadohealth.2018.09.004>
- Vrana, S. R., & Rollock, D. (2002). The role of ethnicity, gender, emotional content, and contextual differences in physiological, expressive, and self-reported emotional responses to imagery. *Cognition and Emotion*, 16(1), 165-192.  
<https://doi.org/10.1080/02699930143000185>
- Walls, M. L., Gonzalez, J., Gladney, T., & Onello, E. (2015). Unconscious biases: Racial microaggressions in American Indian health care. *Journal of the American Board of Family Medicine : JABFM*, 28(2), 231-239.  
<https://doi.org/10.3122/jabfm.2015.02.140194>
- West, K. (2019). Testing hypersensitive responses: Ethnic minorities are not more sensitive to microaggressions, they just experience them more frequently. *Personality and Social Psychology Bulletin*, 0146167219838790. <https://doi.org/10.1177/0146167219838790>
- Williams, D. R. (1997). Race and health: Basic questions, emerging directions. *Annals of Epidemiology*, 7(5), 322-333. [https://doi.org/https://doi.org/10.1016/S1047-2797\(97\)00051-3](https://doi.org/https://doi.org/10.1016/S1047-2797(97)00051-3)
- Williams, D. R. (1999). Race, socioeconomic status, and health the added effects of racism and discrimination. *Annals of the New York Academy of Sciences*, 896(1), 173-188.  
<https://doi.org/10.1111/j.1749-6632.1999.tb08114.x>
- Witmer, B. G., & Singer, M. J. (1998). Measuring presence in virtual environments: A presence questionnaire. *Presence: Teleoperators and Virtual Environments*, 7(3), 225-240.  
<https://doi.org/10.1162/105474698565686>

- Wong, G., Derthick, A. O., David, E. J. R., Saw, A., & Okazaki, S. (2014). The what, the why, and the how: A review of racial microaggressions research in psychology. *Race and Social Problems*, 6(2), 181-200. <https://doi.org/10.1007/s12552-013-9107-9>
- Yip, T., Gee, G. C., & Takeuchi, D. T. (2008). Racial discrimination and psychological distress: The impact of ethnic identity and age among immigrant and united states-born Asian adults. *Developmental Psychology*, 44(3), 787-800. <https://doi.org/10.1037/0012-1649.44.3.787>
- Yoo, H. C., & Castro, K. S. (2011). Does nativity status matter in the relationship between perceived racism and academic performance of Asian American college students? *Journal of College Student Development*, 52(2), 234-245. <https://doi.org/10.1353/csd.2011.0031>
- Yoo, H. C., & Lee, R. M. (2008). Does ethnic identity buffer or exacerbate the effects of frequent racial discrimination on situational well-being of Asian Americans? *Journal of Counseling Psychology*, 55(1), 63-74. <https://doi.org/10.1037/0022-0167.55.1.63>
- Zeiders, K. H. (2017). Discrimination, daily stress, sleep, and Mexican-origin adolescents' internalizing symptoms. *Cultural Diversity and Ethnic Minority Psychology*, 23(4), 570-575. <https://doi.org/10.1037/cdp0000159>
- Zimmer, P., Buttlar, B., Halbeisen, G., Walther, E., & Domes, G. (2019). Virtually stressed? A refined virtual reality adaptation of the trier social stress test (TSST) induces robust endocrine responses. *Psychoneuroendocrinology*, 101, 186-192. <https://doi.org/10.1016/j.psyneuen.2018.11.010>

**Figure 1**

*Illustration of Experimental Setup using Virtual Reality Technology*



*Note.* Left panel: A research staff actor using the rendering computer to expose a research participant (not shown) to discrimination conditions in an immersive virtual environment. The actor controls the avatar's verbal and nonverbal signals and follows a script to interact with the research participant in real-time. Right panel: A research participant wearing a head-mounted display interacts in real-time with the avatar in the virtual reality simulations of discrimination experiences.