ABSTRACT

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Digital communication methods such as social media, texting, Skype, etc. account for a significant amount of social interaction traffic; however, in the coming decade, virtual reality (VR) is likely to appropriate much of this space from traditional 2D computer-mediated applications. While VR is not new, its price point has dramatically decreased in the last couple years making mass consumer use of VR a likely event in the near future (Bailenson, 2018), and although VR has the potential to fundamentally change the way humans interact in virtual spaces, research is still needed to understand the psychological impact on communication conducted via this medium (Bailenson, 2018; Rubin, 2018). The current series of studies first compared how different digital communication mediums (i.e., voice only, video chat, and VR) affect self-disclosure and then, looking specifically at VR, evaluated how avatar appearance affects self-disclosure and social presence (i.e., feeling like you are there with another person). Overall, study one indicated that VR users are more likely to reveal highly personal facts, attitudes, opinions, and emotions than video chat or voice only communication users. Looking only at VR communication, study two demonstrated that individuals with a human avatar are more likely to reveal emotional experiences and highly personal facts, attitudes, and emotions about themselves and their experiences compared to individuals using a robot avatar.

How Does Virtual Reality Compare? The Effects of Digital Communication Medium and Avatar Appearance on Self-Disclosure

by
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DEDICATION

I dedicate this dissertation to my granny, Nancy Bradbury. I love you and miss you.

BIOGRAPHY

Amanda (Mandy) Bradbury is from Richmond, Va. She attended Christopher Newport University from 2011 to 2015 to pursue a Bachelor's degree in Psychology. After graduating, she worked as a research assistant at the VCU school of medicine. There she assisted in several studies including curriculum assessments, personal protective equipment evaluations, high fidelity simulation and training, and the evaluation of adverse event reporting. As a graduate student at North Carolina State University, her research focused on two areas: advanced learning technologies (ALTs) and digital communication. While focused on ALTs, she worked with two interdisciplinary teams of computer scientists, psychologists, designers, and educators, 1) to evaluate and improve a game-based learning environment designed to teach microbiology (work published and presented at CogSci 2017), and 2) to improve the interface design of an intelligent tutoring system designed to teach programming skills to elementary-aged students. This work was published and presented at the Human Factors and Ergonomics Conference where it won the Education Technical Group Young Researcher Award. In terms of digital communication research, this dissertation focuses on how feelings of connection change depending on the digital medium and how one represents their digital self via an avatar. During graduate school, she also worked extensively as a user experience researcher in various domains and companies such as banking, medical devices, tech, Lenovo, Google, and is currently a Senior User Research at Veracity Consulting based in Richmond, VA. Outside of work and research, she has two sweet cats named Binx and Sokka, trains in the martial art aikido, and plays on a recreational volleyball team.

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Introduction

Digital communication methods such as social media, texting, Skype, etc. account for a significant amount of social interaction traffic; however, in the coming decade, virtual reality (VR) is likely to appropriate much of this space from traditional 2D computer-mediated applications. While VR is not new, its price point has dramatically decreased in the last couple years making mass consumer use of VR a likely event in the near future (Bailenson, 2018), and although VR has the potential to fundamentally change the way humans interact in virtual spaces, research is still needed to understand the psychological impact on communication conducted via this medium (Bailenson, 2018; Rubin, 2018). The current series of studies will first compare how different digital communication mediums (i.e., voice only, video chat, and VR) affect self-disclosure and then, looking specifically at VR, evaluate how avatar appearance affects self-disclosure and social presence (i.e., feeling like you are there with another person).

The term virtual reality has seen many disparate definitions in the literature, and as such, a concrete definition of VR would be helpful. Immersive VR is defined as a computer-generated simulation of a three-dimensional environment in which a person is 'transported' to a virtual environment via the use of a head mounted display (HMD) (Bombari, Schmid Mast, Canadas, & Bachmann, 2015). VR HMDs create synthetic sensory experiences via the use of computer-generated 3D visual displays, auditory output, and haptics which create perceptions of digital environments as if they were not synthetic (Blascovich et al., 2002; Huang & Bailenson, 2019). This means the user is fully immersed in an artificial/virtual world and can look around as if in the real world, and in the most advanced versions, can also walk around and interact with objects in the environment (Bombari et al., 2015). For instance, room-scale VR allows the user to walk around the VR environment by tracking head and body movements within the real-world and

then maps these movements into the VR world. VR game controllers allow for precise tracking of hand movements and provide some haptic feedback, allowing users to pick up and manipulate objects in the environment while providing subtle vibrations to mimic the feel of an object in the hand (Bailenson, 2018). While immersed in VR environments, users report feeling psychologically present and as if the fully synthetic world around them is the actual world they currently inhabit (Huang & Bailenson, 2019). This illusion is further enhanced with the addition of new technologies which accurately track head orientation, body position, and increase interactivity within VR environments, all of which lead to increased perceptions of presence and immersion (Cummings & Bailenson, 2016).

Thus, virtual reality is an entirely new medium for everyday consumers and the psychological effects of its use may prove to be vastly different from other mediums (Bailenson, 2018). For instance, virtual reality makes the user feel like they are actually there with another human being, inducing a greater sense of presence than if they were interacting with another person through a screen (Bailenson, 2018; Bombari et al., 2015; Oh, Bailenson, & Welch, 2018). This sense of 'being there' in virtual reality is the first example of a medium to even come close to real-world social interactions. However, as we have seen from research on the negative impacts of social media use on mental health (Turkle, 2013; Twenge, 2013; Twenge, Joiner, Rogers, & Martin, 2018) —a technology many thought would only lead to connection—research is necessary to fully understand both the positive and negative effects of social interactions in VR (Bailenson, 2018; Rubin, 2018).

Theoretical Framework

Media Ecology

Media Ecology can be broadly defined as the study of complex communication systems using the framing of ecology (Scolari, 2012). Media ecologists examine how media has evolved over time and how new technologies impact individuals, communities, and society. In his 2012 paper on media ecology, Scolari stated that, "media ecology tries to find out what roles media force us to play, how media structures what we are seeing or thinking, and why media make us feel and act as we do," (pp. 205). For instance, the invention of communicative technologies such as the printing press, radio, television, computers and the internet, each had a massive impact on individuals, communities, societies, and the world as a whole. What will be the effects of VR?

Medium Theory

Medium theory posits that the medium in which a message is presented can affect the meaning of the message (McLuhan & Fiore, 1967). This means that the medium, regardless of the content of the message, also influences individuals and society and that communication will differ depending on the medium used. Thus, the affordances of some technologies lead to certain types of communication patterns which in turn shape perspectives, relationships, and communities (Meyrowitz, 2001). VR is a relatively new medium and its affordances are yet unclear and even still being developed and adapted, thus the communication patterns it elicits are of great interest.

Social Presence Theory

One of the most captivating aspects of virtual reality is the feeling of actually being there. That feeling of 'being there' is called *presence* (Cummings & Bailenson, 2016). *Social presence*

is the feeling of being there with another ‘real’ person (de Kort, Poels, & Ijsselsteijn, 2007; Oh et al., 2018). Social presence is critical to social interactions in online environments as it enables users to better connect with the other person, and as such, it is essential for virtual reality to provide high levels of social presence (Oh et al., 2018). In real world face-to-face conversations, people communicate via body language, words, tone of voice, eye contact, touch, facial expressions, and gestures (de Kort et al., 2007; Oh et al., 2018). Traditional technologies for remote communication only employ verbal or text-based communication which miss a large amount of the nuances found in real-world communication, and these nuances are what drive connection (de Kort et al., 2007; Oh et al., 2018). The more virtual reality can mirror real-world communication, the more social presence, and thus, the greater the social connection (Oh et al., 2018; Riva et al., 2007).

Conceptual Framework

In generalizing how the affordances of non-VR online communication are beneficial, it is critical to understand that the effects found in these environments may not always translate to VR. However, understanding how these affordances might translate, using a media ecology viewpoint, is useful since VR has ‘evolved’ out of online communication technologies and many of the behaviors, norms, and standards created in older screen-based communication platforms may very well have transferred to VR, a new ‘species’ of communicative technologies (Scolari, 2012). Conversely, medium theory holds that communication will differ depending on the medium (Poster, 1995). For instance, the affordances of VR do differ in important ways from online screen-based communication, which may lead to different communication patterns compared to other online mechanisms. These different communication patterns will then shape the interactions and relationships formed and maintained in the VR world (Poster, 1995). Thus,

while it is likely that some of the communication patterns and psychological effects found in screen-based online communication will also hold true in VR environments, it is also possible that the affordances of VR are different enough that interaction patterns may differ in significant ways. For instance, a major affordance of VR over traditional computer-mediated communication is in its ability to make users feel physically present in the digital environment (e.g., presence and social presence), and past studies have demonstrated that the higher the social presence, the more effective the communication (Oh et al., 2018).

Literature Review

Social Media, Gaming, and Mental Health

As VR is still relatively new, there is significantly less research in VR contexts; however, research on other forms of computer-mediated communication technologies can be useful in understanding the consequences of forming and maintaining relationships in VR (Huang & Bailenson, 2019). Social media sites have dramatically changed the norms surrounding how people interact. For instance, a defining feature of most social media sites (e.g., Facebook, Instagram, Twitter, LinkedIn) is that they enable the creation and distribution of user-generated content (Verduyn, Ybarra, Résibois, Jonides, & Kross, 2017). These sites are highly engaging, leading individuals to spend significant amounts of time on these platforms. In 2016, Facebook revealed that the average user spent 50 minutes a day using both Facebook and Instagram (Stewart, 2016). This is critically important as a large percentage of the population use social networking sites. Specifically, the Pew Internet and American Life Project, which tracks internet usage over time, found that in 2015 65% of American adults used social networking sites (Perrin, 2015). As is clear from above, many adults use social networking sites and although these sites are designed to connect people, they may also be contributing to the rise in mental health issues.

A study involving 93 university counseling centers found that these centers experienced a 30% increase in cases between the 2009-2010 and 2014-2015 school years, especially for mood disorders, anxiety disorders, and suicidal ideation (Pennsylvania State University, 2015). This time frame coincides with the rise of social media sites, and in addition to universities, there are also reports of increased mental health issues for high schools (Twenge et al., 2018). So, what is causing this uptake in mental health issues? Maybe it is not that more people are experiencing mental health issues than before, but that more people are now seeking help as the stigma surrounding mental illness has decreased (Twenge et al., 2018). It could also be that more students with mental health issues are able to cope with college life, counseling centers are getting better with outreach, and students are just more willing to seek help than before (Twenge et al., 2018). However, others have speculated that mental health issues have become more prevalent in adolescents due an array of factors including: increased homework loads and academic pressures (Galloway, Conner, & Pope, 2013), increased rates of obesity (Ogden, Carroll, Kit, & Flegal, 2014), increased rates of divorce among parents (Brown, Stykes, & Manning, 2016), and reduced physical activity as adolescents replace physical activity with time online (Wu, Tao, Zhang, Zhang, & Tao, 2015). While the link between social media usage and mental health is only correlational, this information is still critically important to the design of VR social experiences. For instance, what about social media use leads to mental health issues, and how can VR developers use this information to design their own social media platforms to guard against similar problems?

A growing body of literature has linked increased screen time, specifically social media use, with decreased subjective well-being (Huang, 2017; Turkle, 2013; Twenge et al., 2018; Wu et al., 2015). Subjective well-being measures how “people feel moment to moment and how

satisfied they are with their lives" (Verduyn et al., 2017, pp. 274). Individuals with high subjective well-being experience significantly more positive emotions, infrequent negative emotions, and a high degree of life satisfaction (Verduyn et al., 2017). Subjective well-being is influenced by genetics (50%), life circumstances (10%), and intentional activities (40%), suggesting that subjective well-being can be positively influenced by encouraging and teaching people to interact with social networking sites in the most healthy and adaptive manner (Verduyn et al., 2017). For instance, a longitudinal 2-week study asked participants to report several times a day how much they used Facebook and how they felt at that time (Kross et al., 2013). They found that increased use of Facebook was associated with decreased subjective well-being (Kross et al., 2013). Specifically, participants felt 8% worse when they engaged in Facebook usage 'a lot' compared to when they did not use Facebook at all (Kross et al., 2013). Additionally, a large-scale study (n = 1095) conducted by the Happiness Research Institute in Denmark evaluated the effects of Facebook use on subjective well-being (Tromholt, Lundby, Andsbjerg, & Wiking, 2015). The researchers implemented an experimental design where half the participants agreed not to use Facebook for a week (treatment group) and the other half served as the control group (e.g., continued using Facebook as usual) (Tromholt et al., 2015). The researchers found that individuals in the treatment group reported significantly higher levels of subjective well-being (Tromholt et al., 2015).

Conversely, other studies have linked social media use to positive well-being (Pittman & Reich, 2016; Valenzuela, Park, & Kee, 2009; Verduyn et al., 2017). For instance, a study comparing communication via social networking sites, instant messaging, and face-to-face communication found that social networking site communication increased both face-to-face interactions and instant messaging communication six months later and that communication via

social networking sites actually increased life satisfaction (Dienlin, Masur, & Trepte, 2017). This aligns with a study that found that Facebook users who used the platform to keep in touch with current friends exhibited higher levels of subjective well-being than users who accessed Facebook to try and make new friends (Rae & Lonborg, 2015). Many studies have linked social media use to subjective well-being depending on how individuals interact with these sites, arguing that the relationship between social media use and subjective well-being is more nuanced (Verduyn et al., 2017).

For instance, many of the studies finding negative effects of social media use look subjectively at time spent on social media sites, paying little attention to the actual activities people engage in when interacting with social media (Verduyn et al., 2017). In their 2017 review of the literature, Verduyn and colleagues examined the relationship between different types of social networking activities (e.g., active usage vs passive usage) and subjective well-being. Active use encompassed direct one-to-one exchanges with others (e.g., direct messaging, sharing links, tagging people to posts, etc.) as well as non-targeted broadcasting (e.g., status updates, uploading photos, sharing an article to your wall, etc.). Passive usage refers to monitoring other people's content without engaging in direct conversations with others on the site. Several studies have linked passive usage to reduced subjective well-being (Krasnova, Wenninger, Widjaja, & Buxmann, 2013; Krasnova, Widjaja, Buxmann, Wenninger, & Benbasat, 2015; Shaw, Timpano, Tran, & Joormann, 2015; Tandoc, Ferrucci, & Duffy, 2015; Verduyn et al., 2017). Passive usage is likely detrimental to subjective well-being due to negative social comparisons; as most people only show their best selves on these sites, passive viewers self-critically see themselves as not measuring up to those who are posting positive experiences and accomplishments. When passive users scroll through their friends' feeds, they are typically

bombarded with vacation photos, the newly engaged, lofty achievements, well behaved kids, etc. and will then engage in upward social comparisons viewing their lives as less enjoyable, productive, and fulfilling than others (Krasnova et al., 2015). Conversely, active Facebook usage in terms of self-disclosure has been correlated with increased subjective well-being (Kim & Lee, 2010; Kim, Chung, & Ahn, 2014; Lee, Lee, & Kwon, 2010; Wang, 2013), this effect is especially true for female users (Frison & Eggermont, 2016).

These findings indicate that VR social networking platforms should be designed to encourage active (i.e., self-disclosure) use over passive use, which the affordances of the VR medium may already encourage. For instance, social VR platforms such as AltspaceVR and RecRoom make passive usage very unlikely because the environments are built to encourage active conversations rather than passive observation. When users enter these environments, they can talk to strangers' avatars as if face-to-face; if they do not want to talk to strangers, users can also create private chat rooms to hangout or even play a game with just their friends. However, research is necessary to confirm these design inclinations, thus the current study will compare communication between traditional 2D computer, and VR mediums.

In addition to traditional social media use, many people also engage in social interactions via online video games. Most early adopters of virtual reality are gamers as the gaming industry was one of the first industries to commit large amounts of time, money, and resources to the development of VR content (Bailenson, 2018). Hence, most social VR experiences include some element of gaming. Social interactions during video game play have already been extensively studied (e.g., Granic, Lobel, & Engels, 2014); however, these findings may differ in significant ways for the virtual reality medium (Oh, Bailenson, & Welch, 2018).

News media often portrays digital gaming as socially isolating and detrimental to social growth; however, the scientific community has shown both positive and negative effects of gaming (Granic et al., 2014). On the negative side, research exploring gaming has primarily looked at potential harm related to violence, addiction, and depression, and while this research is important, it is also important to explore the benefits of gaming to gain a balanced understanding of their effects (Granic et al., 2014). For instance, challenging the idea of video games leading to social isolation, one study found that 56% of the most frequent gamers play multiplayer games with friends at least once a week, averaging seven hours a week playing with others online (Entertainment Software Association, 2016). Further, 55% of frequent gamers reported that video games help them connect with their friends (Entertainment Software Association, 2016). Modern video games have changed drastically in the last decade, with many console and game developers using advances in processing speeds to enable players to play with their friends remotely. This uptake in the social capabilities of gaming has led to a demand for more games with online multiplayer options. Further, past research has demonstrated many benefits of social gaming such as increasing collaboration skills, attention, resilience, emotion regulation, and prosocial behavior (Granic et al., 2014).

Research on video games has also demonstrated clear benefits for youth social development as games provide an opportunity to develop online relationships, gain social support (Desjarlais & Willoughby, 2010; McHale, Dotterer, & Kim, 2009), and feel included in a digital community (Carras et al., 2017; Livingstone, 2013). Although this cited research does highlight some positive effects of online social interactions, are they able to replace real-world social relationships? In his book, Bowling Alone¸ Robert Putnam (2000) suggested a direct link between the decline of community groups and organizations to the invention of the television.

No longer were people spending their leisure time interacting with their neighbors, but instead were sitting in their living rooms quietly watching television programs. This comparison seems in-analogous to online social interactions as, at least in video game and other online social interactions, the users are still connected to another human being; however, other researchers have found that interactions mediated through screens diminishes one's ability to relate with the other person (Turkle, 2012; Twenge, 2013). Ongoing research is attempting to uncover the degree to which computer-based mediums for communication contributes to internet trolling behaviors and the toxic social interactions sometimes seen in video game chats (Kwak, Doha, Blackburn, & Han, 2015; Twenge, 2013). Clearly there are both positive and negative effects of video game use but, in short, it's complicated.

Avatar Design and Communication

An important emerging issue in computer-mediated communication research is the use of avatars as a social representation of human users (Gunkel, 2010). The word 'avatar' comes from Sanskrit and means incarnation or the embodiment of a deity on earth. However, the designation of 'avatar' as a digital representation of oneself in a virtual world was first coined in Neal Stephenson's 1992 science fiction novel Snow Crash. While this term caught on, the academic definition varies across studies. For instance, some use the term avatar for simple static images while others believe avatars have to look like the user, while still others have yet other definitions (Bailenson et al., 2006). Interestingly, users usually prefer to customize their avatar's appearance by creating it in their own image or more often creating an idealized version of themselves and representing their own identity via that avatar (Gunkel, 2010). For this study, we define avatars simply as "computer-generated characters driven by real life humans," (Bailenson et al., 2006, pp. 359).

Creating and customizing an avatar is a form of identity creation within a virtual world and can directly influence others' perceptions and interactions with you in an online environment (Behm-Morawitz & Schipper, 2016). Rak (2019) argues that avatar appearance in online communities is a form of social currency and in-game identity. Depending on the level of customization available, an avatar's appearance may also be a good indication of its creator's characteristics (Behrend, Toaddy, Thompson, & Sharek, 2012). For instance, women who are introverts prefer avatars that are similar to themselves in appearance while extroverted women are more likely to choose avatars that do not match their appearance (Diemer, Pauli, & Mühlberger, 2015). Additionally, avatar choice can affect users' behaviors within a VR environment (Yee & Bailenson, 2007).

For instance, there are countless activities (e.g., acting, dancing, etc.) people would like to try in the real world but never start due to the possibility of embarrassment. Avatars offer some degree of anonymity through altered appearance which likely reduces discomfort and thus leads to a greater willingness to open oneself up (Huang & Bailenson, 2019). Additionally, avatar design can affect a user's own characteristics (Yee & Bailenson, 2007). The Proteus Effect describes the phenomenon of individuals changing their behaviors in a virtual world due to the characteristics of their avatars (Yee, Bailenson, & Ducheneaut, 2009). This effect may be explained by behavioral confirmation, or the self-fulfilling prophecy which states that the expectations of one person can cause the behavior of the other (Snyder, Tanke, & Berscheid, 1977). Thus, the person is not acting a certain way because of the characteristics of their avatar, but instead because of the way others interact with them when using that avatar. However, there is also compelling evidence that a user's behavior conforms to their digital self-representation (e.g., their avatar) regardless of how others interact with them, demonstrating that people are not

changing their behavior due to interactions, but are changing their behavior due to their digital appearance (Yee & Bailenson, 2007).

Yee and Bailenson (2007) examined how self-disclosure, interpersonal distance, and confidence were affected by the attractiveness and height of avatars in a VR environment. Attractiveness is linked to perceptions of numerous positive traits (Dion, Berscheid, & Walster, 1972), and previous research demonstrates that most people usually select attractive avatars (Principe & Langlois, 2013). In the first study, participants were assigned to one of three conditions which varied the level of attractiveness of their avatar and then asked participants to engage in conversation with another person in the VR space. Participants with attractive avatars engaged in significantly more self-disclosure and were more willing to approach opposite-gendered avatars than participants assigned to unattractive avatars. Thus, attractiveness affected the level of intimacy a person was willing to reach with a stranger. The second study modified avatar height because height has been linked to increased self-esteem but not friendliness (Young & French, 1996). Participants participated in a negotiation task in which two individuals took turns dividing up a 100-dollar cash pool. One individual would make a split and then the other person would decide whether or not to accept it. Yee and Bailenson (2007) predicted that participants with taller avatars would be more confident and therefore more willing to offer unfair splits. Their hypothesis was supported because participants in the tall avatar condition more often split the money in their favor than participants in the short condition, and participants in the short condition were more likely to accept unfair splits (72%) than participants in both the normal (31%) and tall conditions (38%). A 2009 finding further supports these results, finding that both height and attractiveness of player avatars in an online game predicted player performance (Yee, Bailenson, & Ducheneaut, 2009). Further, the proteus effect seemed to

transfer to the real-world as participants who were given a taller avatar negotiated more aggressively in both the VR environment and a subsequent face-to-face interaction than participants who were given a shorter avatar (Yee et al., 2009).

Avatar choice can also affect the behavior and perceptions of others (Bailenson et al., 2005). There is clear evidence that physical appearance significantly affects individual perceptions. The "what is beautiful is good" stereotype demonstrates a compelling link between a person's level of physical attractiveness and others' perceptions of desirable traits (Dion et al., 1972; Eagly, Ashmore, Makhijani, & Longo, 1991). For instance, attractive job applicants are viewed as more competent, qualified, and likeable than less attractive applicants and are therefore more likely to get the job (Eagly et al., 1991). This effect also transfers to online avatars. For example, as smiling has been linked to attraction (Swami, 2011) and likability (Reysen, 2006), a 2016 study was interested in the effects of smiling avatars on positive emotions, social presence, and attraction (Oh et al., 2016). They were also interested in whether an enhanced smile (e.g., more prominent smile than what the user actually expressed) led to improved communication. Participant dyads whose smiles were enhanced experienced greater positive emotions and social presence than participants in the normal smiling condition (e.g., smiles reflected their true expression); however, there were no significant differences in attraction between smile groups. This study offers strong evidence that enhancing true facial expressions can influence online communication via avatars, and that enhancing smiles can significantly improve communication (Oh et al., 2016). While this study is insightful to designers, it is important to consider whether this result is replicable in different cultures. For instance, a recent cross-cultural study involving 44 distinct cultures found substantial variation in the perception of smiles (Krys et al., 2016). Some cultures rated a smiling person as more

intelligent (e.g., Germany, Switzerland, China, UK, Denmark, etc.) while others rated a smiling person as unintelligent (e.g., Japan, India, Iran, South Korea, etc.). Additionally, some cultures tended to mistrust smiling people—judging them as dishonest (e.g., India, Argentina, etc.) while in other cultures, smiling was a sign of honesty (e.g., Switzerland, Australia, UK, etc.). Thus, enhancing a smile may be appropriate for some user interactions (e.g., Swiss or British) while inappropriate and even problematic in other interactions (e.g., Indian, Japanese). This point illustrates the dangers of using primarily WEIRD societies (western, educated, industrialized, rich, and democratic) to make design decisions and, while studying cultural differences in avatar perception is beyond the scope of the current study, it is important to acknowledge that the results of this study may not generalize to all cultural backgrounds.

In response to these findings in the literature, this dissertation conducted two studies to evaluate self-disclosure and therefore feelings of connection while interacting via digital environments. Study one compares differences in self-disclosure between communication mediums (i.e., video chat, Voice Chat, and VR) while study two looks at how avatar design in a VR environment affects self-disclosure. Medium theory holds that communication patterns will change depending on the communication method. For instance, VR communication offers very different affordances than video chat and voice only communication which may have contributed to differences in levels of self-disclosure. Similarly, while study two is conducted in VR alone, avatar appearance is altered with one group interacting via human avatars and the second group interacting via robot avatars. So, while the medium is the same, alterations within that medium (i.e., changes in avatar appearance) can still have major impacts on communication patterns. Study one demonstrates that medium can have a great impact on communication patterns leading

to self-disclosure and feelings of connection while study two shows that alterations within a single medium, such as avatar appearance, can also have a significant impact.

Study One

Literature Review

Text-only computer-mediated interactions are missing fundamental aspects of communication such as voice nuances, facial expressions, and body language, and thus, according to the reduced social cues theory, make interactions impersonal and stunt the development of intimacy (Ling et al., 2018). The social presence theory theorizes that there is a positive correlation between the number of communicative cues a medium can produce and the development of close relationships (Walther & Parks, 2002). However, it is evident that the lack of communication cues does not inherently prevent the development of close relationships online. Lea and Spears (1995) suggest relationships can form online; however, they take significantly longer to develop than relationships formed via real-world interactions (Lea & Spears, 1995). This is interesting because there is substantial evidence that people self-disclose more during online interactions than during face-to-face interactions (Gibbs, Ellison, & Heino, 2006; Jiang, Bazarova, & Hancock, 2011; Joinson, 2001; Valkenburg & Peter, 2009), and there is a strong link between self-disclosure and the formation and maintenance of relationships (Baccon, Chiarovano, & Macdougall, 2019; Ruppel et al., 2017).

Self-disclosure has also been linked to friendship development (Baccon et al., 2019), liking (Antheunis, Valkenburg, & Peter, 2007), and trust (Wheeles, 1978), but why are people more likely to self-disclose online than during face-to-face interactions? One hypothesis suggests users feel safe presenting their ‘true self’ in online environments due to the anonymity granted in online platforms (Jiang et al., 2011). Another hypothesis suggests that the absence of nonverbal

cues facilitates increased self-disclosure because users no longer have to waste cognitive resources regulating their nonverbal behaviors (Jiang et al., 2011; Joinson, 2001). If this hypothesis is correct, adding more nonverbal cues to avatars may actually stunt online communication and thus be unnecessary or even harmful to communication and relationship formation (Baccon et al., 2019). Conversely, both the reduced social cues and the social presence theory suggest that adding more communicative cues to VR avatars would improve communication. This begs the question of whether communicative cues are important for VR communication or not? In fact, this question has been explored by a recent study comparing self-disclosure between online text-based, VR, and face-to-face communication (Baccon et al., 2019).

Baccon and colleagues (2019) were interested in VR's function as a new communication medium, and similar to medium theory, posited that the "communication methods influence communication content," (Baccon et al., 2019, pp. 158; Littlejohn et al., 2016). Their study examined the effects of medium type on self-disclosure. One hundred and sixty-eight college students participated in this study. All participants were female to avoid possible gender differences and were paired with another participant they did not know. Dyads were randomly assigned to one of three conditions—face-to-face, VR, or online texted-based communication—and spent 20 minutes answering a closeness generating prompt. Participants in the face-to-face and VR conditions exhibited greater self-disclosure than participants in the online text-based condition, indicating that VR is a better communication tool than simple text-based communication. This may be because the VR condition had a greater number of communicative cues (i.e., voice, head movements, mouth movements) while the online text-based condition only communicated via text and were provided with no other communicative cues. Additionally, the face-to-face condition exhibited significantly more cognitive and emotional self-disclosure than

the VR condition, thus not supporting the protection hypothesis of anonymity. While the difference in self-disclosure between the VR and face-to-face conditions was significant, the VR condition was significantly closer to matching the face-to-face condition than the text-based condition. This study gives preliminary evidence that VR may someday rival face-to-face interactions in terms of self-disclosure and also supports both the social presence and the reduced social cues theory, suggesting that more communicative cues lead to better communication (Baccon et al., 2019; Parks & Floyd, 1996; Walther & Parks, 2002). However, a counterfactual explanation may be that the time constraints of the text-based conversation condition of the Baccon study contributed a significant confound. Specifically, the researchers stated that if participants completed the prompts early, they were instructed to keep talking. Did participants in the text-based conditions have time to complete all prompts, as the level of self-disclosure would have increased in these later prompts and text-based communication is usually slower? For example, it is clear that self-disclosure and relationship development does happen in text-based environments, but these relationships take significantly longer to develop (Lea & Spears, 1995). Maybe they take a longer amount of time to develop simply because writing typically takes longer than speaking (Walther et al., 1994), and not because of reduced communicative cues.

Another study, which manipulated self-disclosure during texted-based communication versus face-to-face communication, compensated for this discrepancy by giving the face-to-face condition 10 minutes to complete a prompted conversation while the text-based condition was given 30 minutes (Jiang et al., 2011). On average, the face-to-face participants' discussions lasted just under 10 minutes while the text-based participants' discussions lasted a little over 20 minutes. The researchers also demonstrated that both conditions produced equivalent word

counts, suggesting that the same amount of information was exchanged but that the text-based condition needed double the amount of time than the face-to-face condition to complete the task (Jiang et al., 2011). Overall, participants self-reported higher levels of intimacy after text-based communication than after face-to-face communication; however, this was only the case in the high self-disclosure condition. There were no significant differences in reported intimacy for the low self-disclosure condition. A possible explanation for why individuals self-disclosed more in the text-based condition could be that text-based communication offers more anonymity than face-to-face communication. However, a secondary explanation may lay in how self-disclosure was measured. For instance, in Jiang et al's (2011), self-disclosure was measured via self-report while in Baccon and colleagues (2019), a less subjective method was employed by directly coding each instance of self-disclosure.

And finally, both Baccon and Jiang shared the same limitation with their computer condition (Baccon et al., 2019; Jiang et al., 2011). Specifically, they used a text-based computer condition instead of matching the voice-based face-to-face and VR conditions. Text-based communication is typically done over a longer period of time and is not as instantaneous as other forms of communication (e.g., face-to-face, video chat, phone call, etc.). Text-based communication allows people to carefully formulate their questions and answers before sending their responses which leads to different communication patterns and conversation paths. Thus, the reason behind a text-based medium leading to more self-disclosure could be a third variable (e.g., the ability to think out a carefully considered response before responding), rather than the fact that it is conducted on a 2D screen. Thus, differences between a text-based computer condition and a VR and face-to-face condition may be explained by communication type (i.e., voice vs text) and not the medium (i.e., VR vs face-to-face vs 2D computer).

The current study addresses both studies' limitations to determine which medium leads to the highest level of self-disclosure. Specifically, we address the time constraints of using a text-based condition (Baccon et al., 2019) and the confound of comparing a text-based communication method with a voice-based communication method (Baccon et al., 2019; Jiang et al., 2011). Additionally, we address the limitation of measuring self-disclosure via self-report (Jiang et al., 2011).

Statement of Purpose

Specifically, study one compares three digital communication mediums' (i.e., video chat, Voice Chat, and VR) effects on communication and connection by specifically focusing on self-disclosure. Our conditions differ from both Baccon (Baccon et al., 2019) and Jiang (Jiang et al., 2011) because, contrary to Jiang, we have a VR condition and contrary to both Jiang and Baccon, the face-to-face condition was replaced with a video chat condition and the text only condition with voice-only communication, thus our focus is on comparing the most common digital communication methods without the confound of mixing communication methods (e.g., voice vs text). This will better mimic the communication mediums VR is likely to challenge (e.g., social gaming, business conferencing), thus improving ecological validity, and removing the need to give any condition extra time as participants will not be communicating via text but will be directly talking to each other.

Secondly, the current study will allow us to further parse the effects of anonymity and communicative cues. Specifically, research has demonstrated that people self-disclose more when anonymity is higher (Jiang et al., 2011). If this is true, then the VR and voice only Conditions should elicit more self-disclosure than the video chat Condition. Conversely, the reduced social cues and social presence theory suggest that more communicative cues lead to the

development of close relationships which is associated with higher self-disclosure (Baccon et al., 2019; Parks & Floyd, 1996; Walther & Parks, 2002). If this hypothesis is correct, then video chat, followed by the VR condition will have the highest level of self-disclosure. And lastly, a third hypothesis suggests that self-disclosure can be stunted because individuals waste cognitive resources regulating their nonverbal behaviors (Joinson, 2001). If this is true, then the video chat condition will elicit significantly less self-disclosure than the VR and voice only condition. In Baccon's study (Baccon et al., 2019), the VR and face-to-face conditions both self-disclosed more than the text-based condition and there were no significant differences in self-disclosure between VR and face-to-face, thus supporting the reduced social cues and social presences theory while not supporting the anonymity and waste of cognitive resources hypothesis. Conversely, Jiang's study (Jiang et al., 2011), found significantly more self-disclosure for a text-based condition compared to a face-to-face condition thus supporting the anonymity and waste of cognitive resources hypotheses and not supporting the reduced social cues and social presence theory. The removal of several study confounds--time constraints of using a text-based condition, comparing a text-based communication method with a voice-based communication method, and measuring self-disclosure via self-report--will help elluminate these questions.

Research Question and Hypotheses

Research Question

How does communication medium (e.g., VR, video chat, and voice only) affect self-disclosure during a closeness-generating conversation between dyads?

Hypothesis: Self-Disclosure—Communicative Cues and Anonymity.

Overall, we expected the VR condition to have the highest level of self-disclosure followed by the video chat condition, followed finally by the voice only condition. We expected

communicative cues and anonymity to both play a part in this finding. For instance, past research indicates that higher anonymity (e.g., feeling less likely to be identified later) leads to more self-disclosure (Jiang et al., 2011; Ling et al., 2018). Because the VR and voice only conditions do not show their faces, it is likely that the VR and voice only conditions would experience greater feelings of anonymity than the video chat condition which may contribute to great self-disclosure. However, past research also indicates that having more communicative cues leads to higher self-disclosure (Baccon et al., 2019, Walther & Parks, 2002). We believe the video chat condition has the most communicative cues followed by the VR condition. For instance, past research has shown that lower photo-realistic avatars elicited higher social presence when behavioral realism was low, while higher photo-realistic avatars elicited greater social presence when behavioral realism was also high (Garau & Colleagues, 2003). The photo realism of the VR condition's avatar was relatively low with the avatars being cartoon-like rather than photo-realistic. Additionally, the behavioral realism matches the avatar's appearance as speakers are limited to hand and head movements, thus lacking other communicative cues such as facial expressions, thus behavioral realism and photo-realism match. Lastly, the voice only condition has only voice communicative cues. Overall, we hypothesized that the VR condition would outperform the video chat condition because it has reached a threshold of needed communicative cues (e.g., hand and head movements, vocal cues) while also offering anonymity. For instance, we expected the VR condition to self-disclose significantly more than both the video chat and voice only conditions because VR represents mixing the best of both worlds, providing significantly more communicative cues than voice only communication while also offering the anonymity a video chat conversation does not. We expected the video chat condition to elicit the second highest level of self-disclosure because we expected that communicative cues are a more

powerful driver of self-disclosure than anonymity (Walther & Parks, 2002), and while the voice only condition offers a high degree of anonymity, it does not offer any visual communicative cues. Thus, the VR condition represents both anonymity and communicative cues, the video chat condition represents communicative cues, and the voice only condition represents anonymity. Succinctly, we expected the VR condition to elicit the highest self-disclosure because it offers both anonymity and at least some threshold of communicative cues. We expected the video chat condition to elicit the second highest self-disclosure because although it offers no anonymity, it has the most communicative cues; and lastly, we expected the voice only condition to elicit the least self-disclosure because while it offers anonymity, we expect communicative cues to be more important.

Method

Participants

106 participants (49% female; age *M* = 27.71 years old, *SD* = 10.73; Range = 18-67 years old) were recruited from both online message boards (i.e., Facebook, Reddit) and psychology courses in a large Mid-Atlantic University. Specifically, we targeted VR related Facebook groups such as Oculus Virtual Reality, Women in VR, Altspace VR Pals, Oculus Quest Community, Women in VR/AR, HTC VIVE (+PRO) Owners, Oculus Quest Ladies, HTC Vive (+pro), community Facebook groups, VR related Reddit channels such as r/virtualreality, r/AltspaceVR, r/OculusQuest, r/Oculus, and community Reddit channels. See Appendix A for an example of our recruitment flyer. Participants recruited from online message boards were volunteers while student participants received course credit. Participants were all fluent English speakers and self-reported 20/20 corrected/natural vision. Participants were located all over the world with 80.2% residing in the United States, 9.4% in Europe, 4.7% in Canada, 3.8% in

Australia, 0.9% in Mexico, 0.9% in Africa, and represented several ethnicities with 68.9% identifying as White, 10.4% Black, 7.5%, Asian, 5.7% mixed race, 4.7% South Asian/Indian, 1.9% Hispanic, and 0.9% Middle Eastern.

Materials and Apparatus

Data was collected remotely between April and August 2020. The informed consent and all self-report measures were completed electronically using the online survey platform Qualtrics. The demographics questionnaire asked participants' age, race, gender, and level of experience with VR (see Appendix B). Participant discussions followed a closeness generating prompt modified from Aron and colleagues (1997; see Appendix C). This prompt has been used in previous self-disclosure studies (e.g., Baccon et al., 2019) and is designed to elicit closeness and self-disclosure (Aron et al., 1997). All quantitative data analyses were completed using the statistical analysis software SPSS.

Video Chat and Voice Only Materials

Participants in the video chat and voice only conditions completed the study from their home using the web conferencing service Zoom. Participants were required to login in using either a laptop or desktop computer. The video chat participants were instructed to turn their video on for the closeness generating conversions while the voice only participants were instructed to leave their video off. Conversions were recorded using the Zoom recording feature.

VR Materials

Participants in the VR condition used their personal VR headsets and completed the study from their home; however, they were required to have one of the following headsets to participate--Oculus Quest, Oculus Rift, Oculus Rift S, HTC Vive, HTC Vive Pro, Microsoft Mixed Reality, Valve Index. VR participants were also required to download the free social VR

app, AltspaceVR (study ran April 2020 - August 2020), to their headset and to log into the app during their study time. AltspaceVR is a social VR environment where users can meetup with other VR users in different social rooms such as at a campfire, a club, conference room, etc. and can also attend various events, and classes. For this study, a private room within AltspaceVR was created. Conversations were recorded via the experimenter's Oculus Quest Headset's recording function. The VR avatar is a cartoon human avatar that is low on both photo-realism and behavioral realism while the video chat condition will be high on both. Specifically, the VR condition had participants communicate via human avatars (see Figure 1) which allowed for hand and head movements as well as vocal cues while the video chat condition allowed for facial expressions in addition to vocal cues and hand and head movements. The voice only condition only allowed for vocal cues.

Figure 1. Image of the AltspaceVR environment.

Conditions

Study one had three conditions: VR (*n* = 18 pairs), video chat (*n* = 16 pairs), and voice only (*n* = 19 pairs). In the VR condition, participants interacted in a computer-generated three-dimensional environment (i.e., AltspaceVR) via the use of a head mounted display. Participants interacted through human avatars that they created to look like themselves and saw their partner's avatar and gestures (e.g., head movements, hand movements) as well as heard their voice during the interaction. Participants in the video chat and voice only conditions completed the study via Zoom. The video chat condition communicated via both video and voice while the voice only condition communicated via voice only.

Procedure

VR Condition

Participants were paired with a conversation partner of the same gender. Prior to the session, participants were sent an email with instructions to download AltspaceVR, create a human avatar that looked similar to their real-world appearance, and fill out the pre-study questionnaire and consent form. The pre-study questionnaire (see Appendix B) asked basic demographic info such as age, current location, gender, and race. It also probed participants' level of experience with VR, and level of experience with AltspaceVR. Participants were also instructed to email their AltspaceVR username and to friend request the AltspaceVR account used for the study. Participants completed these steps any time prior to the study and then logged into AltspaceVR at their designated study time. Participants then participated in a 20 minute, 12-question long prompted conversation with their partner (Appendix C). If participants completed the questions before the 20 minutes were up, they were instructed to continue getting to know

each other. After 20 minutes, participants were instructed to stop and told to take the electronic post-study questionnaire directly after logging off (see Appendix D).

Video Chat and Voice Only Conditions

Participants were paired with a conversation partner of the same gender or in one case, with a participant who identified as non-binary (i.e., voice only condition). Prior to the session, participants were sent an email with instructions to download Zoom and fill out the pre-study questionnaire and consent form (see Appendix B). Participants then participated in a 20 minute, 12-question long prompted conversation with their partner (Appendix C) via a video chat conversation (i.e., video chat condition) or via voice only/no video (i.e., voice only condition). If participants completed the questions before the 20 minutes were up, they were instructed to continue getting to know each other. After 20 minutes, participants were instructed to stop and told to take the electronic post-study questionnaire directly after logging off (see Appendix D).

Analyses

Hypothesis: Self-Disclosure—Anonymity and Communicative Cues

The current study employed the self-disclosure coding paradigm used in Baccon and colleagues (2019) which was adapted from Mitchell and colleagues' couples intimate behavior rating system (Mitchell et al., 2008). Using this paradigm, instances of self-disclosure were coded by frequency as either factual, cognitive, or emotional. Utterances that simply described facts about oneself such as, "last time I went to the zoo was in January'' were coded as factual self-disclosure (Baccon et al., 2019, pp. 160). Utterances that described one's opinions, attitudes, and beliefs were coded as cognitive self-disclosure, and utterances that revealed any emotional experiences were coded as emotional self-disclosure (Baccon et al., 2019). Further, each instance of factual, cognitive, and emotional self-disclosure was given a score between 1 and 3 to

describe how personal the utterance was. This scale was adapted from Mitchell and colleagues (2008) who scored each utterance from 1 to 5. Please see Appendix E to view our full coding scheme. Lastly, a second coder randomly coded 22% of the conversations. Interrater reliability was then calculated using Cohen's kappa (McHugh, 2012). There was substantive agreement between the two raters, $k = .86$.

Each experimental session was video and audio recorded. Each video was then transcribed and coded. Using the frequency scores for each measure, a MANOVA was used with the three conditions (VR, video chat, and voice only) as the independent variable and factual self-disclosure, cognitive self-disclosure, emotional self-disclosure as the three dependent variables. Next, we qualitatively evaluated level of disclosure by comparing mean scores of level one, level two and level three disclosure.

Results

Research Question: How does communication medium (e.g., VR, video chat, and voice only) affect self-disclosure during a (closeness-generating) conversation between dyads?

To investigate the effects of communication medium on self-disclosure during a closeness generating conversation, a MANOVA was conducted using the three communication medium conditions (VR, video chat, and voice only) as the independent variable and factual self-disclosure, cognitive self-disclosure, and emotional self-disclosure as the three dependent variables. These scores for individuals ranged from 16-76 total instances of factual self-disclosure, 47-105 total instances of cognitive self-disclosure, and 2-25 total instances of emotional self-disclosure. Each condition had the potential to obtain the same score. Factual self-disclosure was normally distributed as determined by skewness and kurtosis. However, cognitive and emotional self-disclosure scores were not normally distributed. The cognitive self-disclosure

and emotional self-disclosure variables were transformed to achieve a normal distribution. Specifically, the cognitive self-disclosure variable was extremely positively skewed, and therefore, a reciprocal or "inverse" transformation was used (i.e., 1/cognitive self-disclosure). The emotional self-disclosure variable was only moderately positively skewed and therefore, a square root transformation was used.

There was a statistically significant difference between communication mediums on the combined dependent variables, $F(6, 202) = 6.43$, $p < .001$; Wilks' $\Lambda = .71$; partial $\eta 2 = .16$. Univariate results found that factual self-disclosure exhibited no significant differences between conditions, $F(2, 106) = 2.44$, $p = .09$, partial $\eta 2 = .05$. Conversely, cognitive self-disclosure, $F(2, 106) = 7.52$, $p < .001$, partial $\eta 2 = .13$, and emotional self-disclosure, $F(2, 106) = 4.85$, $p = .10$, partial $\eta 2 = .07$ exhibited statistically significant differences between communication mediums (VR vs video chat vs voice only). Post hoc LSD analyses indicated that the VR condition ($M = .017$, $SD = .003$) elicited significantly more cognitive self-disclosure than both the video chat ($M = .014$, $SD = .002$) and voice only conditions ($M = .016$, $SD = .003$). There was no significant difference between the video chat and voice only conditions. Post hoc LSD analyses for total emotional self-disclosure indicated that the VR condition ($M = 3.12$, $SD = .80$) elicited significantly more emotional self-disclosure that both the video chat ($M = 2.65$, $SD = .60$) and voice only conditions ($M = 2.79$, $SD = .48$). There was no significant difference between the video chat and voice only conditions.

Table 1. *Mean self-disclosure frequency scores and comparisons between digital communication mediums.*

	Experimental Conditions			F-test Results	
Self-Disclosure	VR	Video Chat	Voice Only	F-Stat	Post hoc LSD Comparisons
	M (*SD*)	*M* (*SD*)	*M* (*SD*)	*F* (*p*)	
Factual Self-Disclosure	47.06 (12.16)	51.38 (12.10)	44.42 (14.84)	2.44 (.09)	VR = VC = VO
Cognitive Self-Disclosure	.017 (.003)	.014 (.002)	.016 (.003)	7.52 (<.001)	VR > VC & VO; VC = VO
Emotional Self-Disclosure	3.11 (.80)	2.65 (.56)	2.79 (.49)	4.85 (.01)	VR > VC & VO; VC = VO

Note: VR = virtual reality condition, VO = voice only condition, VC = video chat condition; Greater than (>) and less than (<) symbols indicate a significant difference between conditions.

[a]Cognitive self-disclosure and emotional self-disclosure variables were transformed; cognitive self-disclosure was transformed using a reciprocal or "inverse" transformation; Emotional self-disclosure was transformed using a square root transformation.

Each instance of factual, cognitive, and emotional self-disclosure was coded on a scale of one to three based on how personal the disclosure. Specifically, self-disclosures marked as a level one were the least personal while level threes were highly personal disclosures. Because level of disclosure is a permutation of factual, cognitive, and emotional self-disclosure data, we did not include level of self-disclosure in the above MANOVA and will evaluate these findings qualitatively. Overall, the VR condition (M = 43.28, SD = 11.07) exhibited less level one self-disclosure than both the video chat (M = 55.56, SD = 15.73) and voice only conditions (M = 54.79, SD = 20.69) while the video chat and voice only conditions exhibited a similar number of level one disclosure. In terms of level two self-disclosure, the VR condition (M = 69.33, SD = 15.08) and the video chat condition (M = 72.25, SD = 12.85) had similar numbers of self-

disclosure while the voice only Condition (*M* = 63.05; *SD* = 11.92) exhibited slightly less level two self-disclosure. Lastly, the VR condition (*M* = 5.94, *SD* = 6.43) exhibited more level three self-disclosure than both the video chat (*M* = 2.44, *SD* = 3.82) and voice only (*M* = 2.68, *SD* = 4.07) conditions while the video chat and voice only conditions exhibited a similar number of level one disclosure. Note that, overall, there were very low levels of level three disclosure relative to the other levels. See Figure 2. for a visualization of this data.

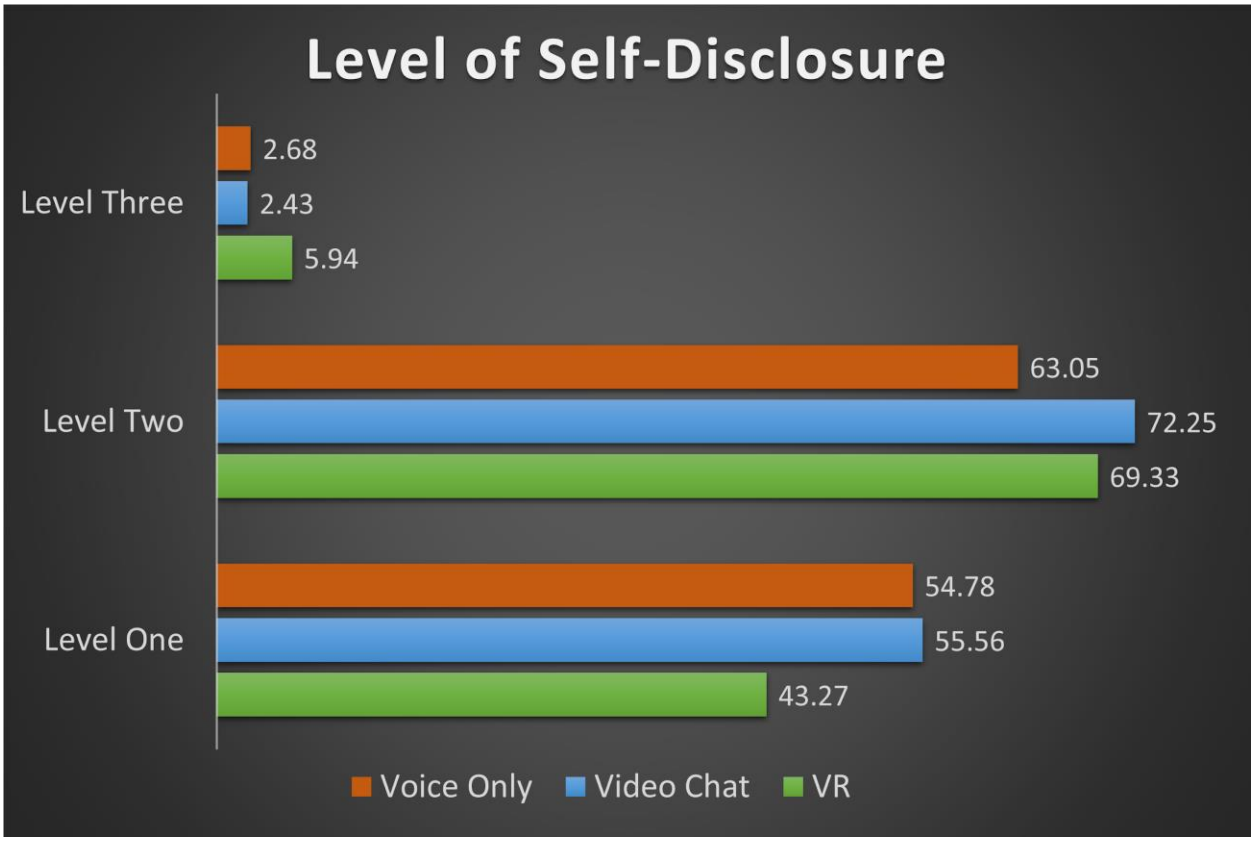

Figure 2. Comparing Level of Self-Disclosure by Digital Communication Medium.

Study Two

Literature Review

While study one explored how communication medium (VR being one of them) affects self-disclosure, study two focused exclusively on VR communication. Specifically, study two

explored how differences within a VR environment such as avatar appearance affects self-disclosure and social presence, thus providing valuable information for designers to improve both communication and connection in their VR platforms. Avatar fidelity can be divided into three categories: realism, avatar-user match, and anthropomorphism, (Gorisse, Christmann, Houzangbe, & Richir, 2019). Realism deals with whether the avatar is photo-realistic versus non-photorealistic (Gorisse et al., 2019). Garau and colleagues (2003) investigated photo-realistic avatars and behavioral realism in a VR CAVE-like system. They demonstrated that photo-realistic avatars engendered no more social presence than did less photo-realistic avatars; however, there was a significant interaction between behavioral realism and photo-realism. For instance, lower photo-realistic avatars elicited higher social presence when behavioral realism (e.g., eye gaze) was low, while higher photo-realistic avatars elicited greater social presence when behavioral realism was also high. Thus, a high degree of behavioral realism can be beneficial to communication; however, the degree of behavioral realism needs to match the photo-realism of the avatar. Supporting this finding, previous research indicates that people hold higher expectations for more realistic looking avatars, thus, the more realistic-looking an avatar appears, the more behaviorally realistic behaviors such as facial expressions, eye gaze, body movements, etc. need to be (Slater & Steed, 2002). Next, avatar-user match which is the visual similarity between a user and their avatar or simply, having one's avatar looks like them in real life (Gorisse et al., 2019). Past work has demonstrated that users experience higher engagement and a higher sense of ownership of their avatar when avatar-user match is high (Lucas et al., 2016; Waltemate et al., 2018). Additionally, users tend to self-disclose more when avatar-user match is high (Hooi, & Cho, 2014). The last factor being considered is anthropomorphism; that is, whether an avatar is humanoid versus non-humanoid (Gorisse et al., 2019). Bailenson and his

team (2005) studied the impact of using humanoid vs. non-humanoid avatars on social presence and found that participants in a human condition reported significantly higher social presence than participants in a teddy bear and blockhead (avatar) condition, demonstrating that human avatars lead to higher social presence.

Overall, the current study aimed to identify which avatar design (human or robot) leads to greater self-disclosure and therefore feelings of connection. The robot, a common form of avatar representation, will be our non-human avatar condition. Secondarily, we compared how avatar appearance affects social presence. While past research has shown that avatars rated higher in anthropomorphism exhibit higher social presence (Bailenson et al., 2005), to our knowledge, there have been no studies evaluating the effects of avatar appearance, specifically robot avatars vs human avatars, on self-disclosure and social presence. Such a comparison is important because it is also known that behavioral realism, where the robot avatar can come close to matching a human avatar, is also an important factor in social presence (Gorisse et al., 2019). Since multiplayer VR games/experiences typically have either a robot avatar or a human avatar, such a study would also have high ecological validity.

Statement of Purpose

Study two will evaluate how avatar appearance affects social presence and self-disclosure. This study consists of two conditions: human avatar and robot avatar. The human avatar condition will allow users the agency to create their own avatar with the only stipulation being that they make their avatar look like themselves, thus increasing avatar-user match along the visual dimension. Past research has demonstrated that when visual avatar-user match is high, self-disclosure and identification with one's avatar is also higher (Hooi, & Cho, 2014), and higher identification with one's avatar is linked with greater social presence (Christy & Fox,

2016; Teng, 2017). Additionally, human avatars rate higher than robot avatars in anthropomorphism and are therefore likely to outperform robot avatars in social presence (Bailenson et al., 2005). Study two will test these hypotheses.

Research Question and Hypotheses

Research Question

How does avatar appearance affect self-disclosure and social presence during a closeness-generating conversation between dyads?

Hypothesis One: Self-Disclosure

We expected the Human avatar condition to elicit significantly more self-disclosure than the Robot avatar condition because past research has demonstrated that the higher the visual avatar-user match, the higher the self-disclosure (Hooi, & Cho, 2014).

Hypothesis Two: Social Presence

We expected the human avatar condition to elicit significantly more social presence than the robot avatar condition because having a human avatar has been linked to higher social presence scores (Bailenson et al., 2005). Additionally, we expected participants to rate avatar-user match as higher in the Human avatar condition. Past research has demonstrated that when visual avatar-user match is high, self-disclosure and identification with one's avatar is also higher (Hooi, & Cho, 2014), and higher identification with one's avatar is linked with greater social presence (Christy & Fox, 2016; Teng, 2017).

Method

Participants

66 participants (46% female; *M* = 34.97 years old, *SD* = 11.20; Range = 19 - 67 years old) were recruited from both online message boards (i.e., Facebook, Reddit, Discord) and

psychology courses in a large Mid-Atlantic University. Specifically, we targeted VR related facebook groups such as Oculus Virtual Reality, Women in VR, Altspace VR Pals, Oculus Quest Community, Women in VR/AR, HTC VIVE (+PRO) Owners, Oculus Quest Ladies, HTC Vive (+pro), community facebook groups, VR related Reddit channels such as r/virtualreality, r/AltspaceVR, r/OculusQuest, r/Oculus, and community Reddit channels. See Appendix A for an example of our recruitment flyer. Participants recruited from online message boards were volunteers while student participants received course credit. Participants were all fluent English speakers and self-reported 20/20 corrected/natural vision. Participants were located all over the world with 63.6% residing in the United States, 18.2% in Europe, 10.6% in Canada, 6.1% in Australia, 1.5% in Mexico, and represented many ethnicities with 77.3% identifying as White, 1.5% Black, 9.1%, Asian, 6.1% mixed race, and 4.5% Hispanic.

Materials and Apparatus

Data was collected between April and August 2020. The informed consent and all self-report measures were completed electronically using the online survey platform Qualtrics. The demographics questionnaire asked participants' age, race, gender, and level of experience with VR (see Appendix B). Participant discussions followed a closeness generating prompt modified from Aron and colleagues (1997; see Appendix C). This prompt has been used in previous self-disclosure studies (Baccon et al., 2019) and is designed to elicit closeness and self-disclosure (Aron et al., 1997). All quantitative data analyses were completed using the statistical analysis software SPSS.

Participants used their personal VR headsets and completed the study from their home; however, they were required to have one of the following headsets to participate--Oculus Quest, Oculus Rift, Oculus Rift S, HTC Vive, HTC Vive Pro, Microsoft Mixed Reality, or Valve Index.

These headsets were selected for inclusion because they all had similar resolutions (1080 × 1200 - 1440 × 1600), field of view (86 - 130hz), and refresh rates (75 - 144hz). All participants were also required to download the free social VR app, AltspaceVR (study ran April 2020 - August 2020), to their headset and to log into the app during their study time. AltspaceVR is a social VR environment where users can meetup with other VR users in different social rooms such as at a campfire, a club, conference room, etc. and can also attend various events, and classes. For this study, a private room within AltspaceVR was created. Conversations were recorded via the experimenter's Oculus Quest Headset's recording function.

Procedure

Participants were paired with a conversation partner of the same gender. Prior to the session, participants were sent an email with instructions to download AltspaceVR, create a human avatar that looked similar to their real-world appearance (Human avatar condition [*n*=18 pairs]) or to create a robot avatar (Robot avatar condition [*n* = 15 pairs]) (see Figure 3). They were also instructed to fill out the pre-study questionnaire and consent form. The pre-study questionnaire (see Appendix B) asked basic demographic info such as age, current location, gender, and race. It also probed participants' level of experience with VR, and level of experience with AltspaceVR. Participants were also instructed to email their AltspaceVR username and to friend request the AltspaceVR account used for the study. Participants completed these steps any time prior to the study and then logged into AltspaceVR at their designated study time. Participants then participated in a 20 minute, 12-question long prompted conversation with their partner (Appendix C). If participants completed the questions before the 20 minutes were up, they were instructed to continue getting to know each other. After 20 minutes, participants were

instructed to stop and told to take the electronic post-study questionnaire directly after logging off (see Appendix D).

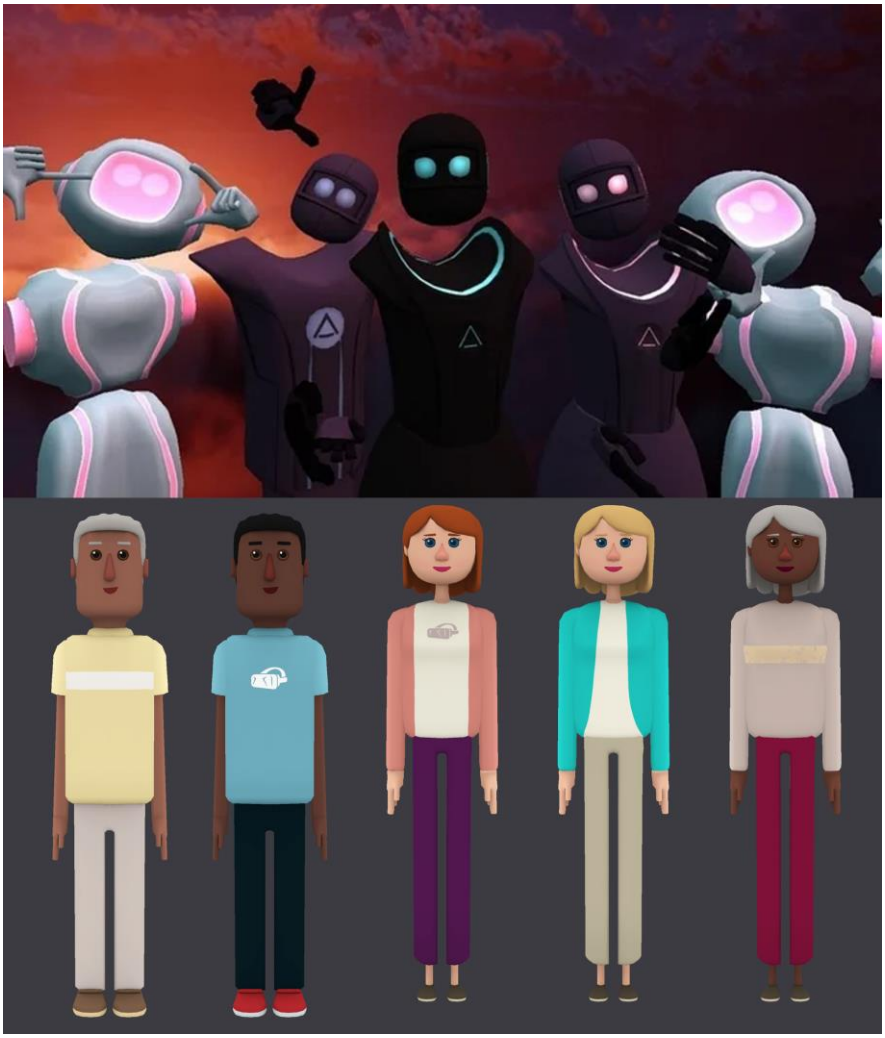

Figure 3. AltspaceVR Robot and Human Avatars.

Analyses

Study two employed the same self-disclosure coding paradigm (Appendix E) and procedure described in study one. Additionally, a second coder randomly coded 27% of the conversations. Interrater reliability was calculated using Cohen's kappa (McHugh, 2012). There was substantive agreement between the two raters, k = .85. To determine the impact of condition on self-disclosure, a MANOVA was used with avatar appearance (Human avatar or Robot

avatar) as the independent variable and factual self-disclosure, cognitive self-disclosure, and emotional self-disclosure as the three dependent variables. Next, we qualitatively evaluated level of disclosure by comparing mean scores of level one, level two and level three disclosure. To evaluate the post-study questionnaire data, a second MANOVA was conducted with avatar appearance (Human avatar or Robot avatar) as the independent variable and social presence, anonymity, and avatar liking as the dependent variables. Because the avatar-user match data could not be normalized for the purposes of using a parametric statistical test, we evaluated that variable using a non-parametric Mann-Whitney U test.

Results

Research Questions: How does avatar appearance affect self-disclosure and social presence during a (closeness-generating) conversation between dyads?

To investigate the effects of avatar appearance on self-disclosure during a closeness generating conversation, a MANOVA was conducted using the two conditions (Human avatar vs Robot avatar) as the independent variable and factual self-disclosure, cognitive self-disclosure, and emotional self-disclosure as the three dependent variables. Factual self-disclosure was normally distributed as determined by skewness and kurtosis. However, like in study one, cognitive and emotional self-disclosure scores were not normally distributed. The cognitive self-disclosure and emotional self-disclosure variables were transformed to achieve a normal distribution. Specifically, the cognitive self-disclosure variable was extremely positively skewed, and therefore, a reciprocal or “inverse” transformation was used (i.e., 1/cognitive self-disclosure). The emotional self-disclosure variable was strongly positively skewed and therefore, a logarithmic transformation was used.

There was a statistically significant difference between communication mediums on the combined dependent variables, $F(6, 64) = 5.33$, $p = .002$; Wilks' $\Lambda = .80$; partial $\eta 2 = .21$. Univariate results found that factual self-disclosure, $F(1, 64) = 2.95$, $p = .09$, partial $\eta 2 = .04$ and cognitive self-disclosure, $F(1, 64) = .08$, $p = .78$, partial $\eta 2 = .001$, exhibited no significant differences between conditions. Conversely, emotional self-disclosure, $F(1, 64) = 9.71$, $p = .003$, partial $\eta 2 = .13$, exhibited statistically significant differences between conditions. Overall, the Human avatar condition ($M = 3.11$, $SD = .80$) elicited significantly more emotional self-disclosure than the Robot avatar condition *(*$M = 2.54$, $SD = .64$*)*. See Table 2 for a more condensed view of this information.

Table 2. *Mean self-disclosure frequency scores and comparisons between robot versus human avatars*

	Experimental Conditions		F-test Results	
Self-Disclosure	Human avatar	Robot avatar	F-Stat	Comparison
	M (*SD*)	*M* (*SD*)	*F* (*p*)	
Factual Self-Disclosure	47.06 (12.16)	52.40 (13.08)	2.95 (.09)	Human = Robot
Cognitive Self-Disclosure	.017 (.003)	.017 (.003)	.08 (.78)	Human = Robot
Emotional Self-Disclosure	3.11 (.80)	2.54 (.64)	9.71 (.003)	Human > Robot

Note: Greater than (>) and less than (<) symbols indicate a significant difference between conditions.
[a]Cognitive self-disclosure and emotional self-disclosure variables were transformed; cognitive self-disclosure was transformed using a reciprocal or "inverse" transformation; Emotional self-disclosure was transformed using a logarithmic transformation.

Each instance of factual, cognitive, and emotional self-disclosure was coded on a scale of one to three based on how personal the disclosure. Specifically, self-disclosures marked as level

one were the least personal while level threes were highly personal disclosures. Because level of disclosure is a permutation of factual, cognitive, and emotional self-disclosure data, we did not include level of self-disclosure in the above MANOVA and will evaluate these findings qualitatively. Overall, the Human avatar condition (M = 43.28, SD = 11.07) exhibited less level one self-disclosure than the Robot avatar condition (M = 56.53, SD = 18.24). In terms of level two self-disclosure, the Human avatar condition (M = 69.33, SD = 15.08) had approximately equivalent level two self-disclosure than the Robot avatar condition (M = 63.80; SD = 9.88). Lastly, the Human avatar condition (M = 5.94, SD = 6.43) exhibited more level three self-disclosure than the Robot avatar condition (M = 1.73, SD = 2.21). As with study one, participants had substantively lower instances of level three self-disclosure. See Figure 4 for a visualization of this data.

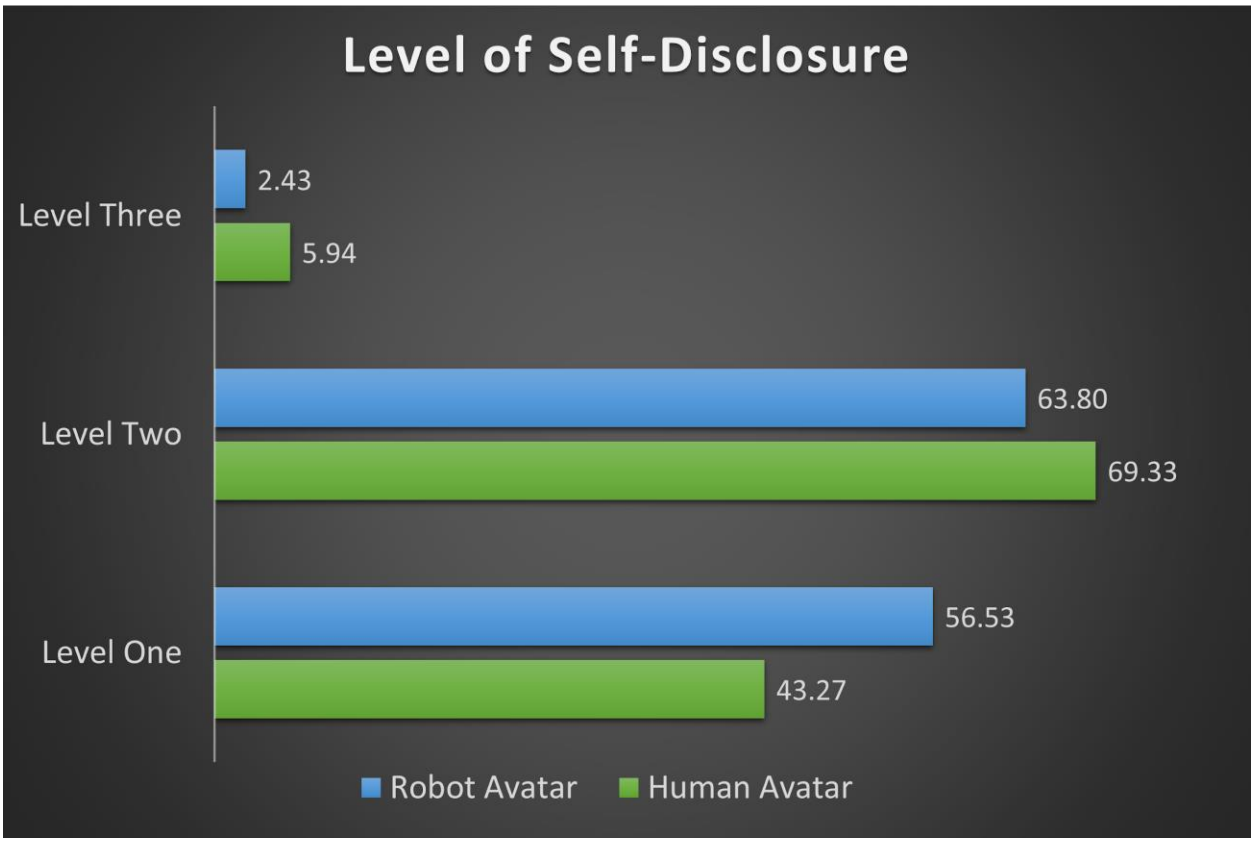

Figure 4. Comparing Level of Self-Disclosure by Robot Versus Human Avatars.

Avatar-user match was heavily skewed with the majority of the human avatar condition (M = 5.28, SD = 1.28) reporting their avatar looked like them and the majority of the robot avatar condition (M = 1.83, SD = 1.39) reporting that their avatar did not look like them; therefore, a non-parametric Mann-Whitney U test was run. We used the Mann-Whitney test because it provides a robust test for skewed data. There was a statistically significant difference in avatar-user match between the Robot and Human avatar conditions, U = 68.50, z = -6.11, p < .001, using an exact sampling distribution for U (Dineen & Blakesley, 1973). Looking at the other self-reported post-study questionnaire data, a second MANOVA was conducted with avatar appearance (Human avatar or Robot avatar) as the independent variable and social presence, anonymity, and avatar liking as the three dependent variables. Anonymity was normally distributed as determined by skewness and kurtosis. However, social presence and avatar liking were not normally distributed. Social presence and avatar liking were transformed to achieve a normal distribution. Specifically, they were transformed using a reflect and inverse transformation (i.e., 1/(8 - variable) because both were extremely negatively skewed. The resulting transformed data indicated there was a statistically significant difference between communication mediums on the combined dependent variables, F(3, 61) = 11.56, p < .001; Wilks' Λ = .64; partial $\eta 2$ = .36. Univariate results found no significant difference in social presence between avatar appearance (Human vs Robot), F(1, 63) = .88, p = .35, partial $\eta 2$ = .01. Conversely, there was a significant difference between conditions (human vs robot avatar) in reported feelings of anonymity, F(1, 63) = 4.16, p = .05, partial $\eta 2$ = .062 and avatar liking, F(1, 63) = 30.71, p < .001, partial $\eta 2$ = .33. Overall, the Human avatar condition (M = 4.02, SD = 1.76) self-reported feeling significantly less anonymous than the Robot avatar condition *(*M = 4.96, SD = 1.93*)*. In addition, participants in the Human avatar condition (M = .58, SD = .28)

liked their avatar significantly more than participants in the Robot avatar condition (*M* = .28, *SD* = .10). See Table 3 for a more condensed view of this information.

Table 3. Mean self-report scores and comparisons between robot and human avatars.

	Experimental Conditions		*F*-test Results	
Self-Report	Human avatar	Robot avatar	*F*-Stat	Comparison
	M (*SD*)	*M* (*SD*)	*F*(*p*)	
Social Presence	.68 (.27)	.74 (.25)	.88 (.35)	Human = Robot
Anonymity	4.03 (1.77)	4.97 (1.94)	4.16 (.05)	Human < Robot
Avatar Liking	.58 (.28)	.28 (.10)	30.71 (<.001)	Human > Robot

Note: Greater than (>) and less than (<) symbols indicate a significant difference between conditions.
[a]Social presence and avatar liking data was transformed; Both were transformed using a reflect and inverse transformation.

Discussion

This dissertation sought to determine which digital communication method leads to deeper feelings of connection between individuals in computer-mediated environments. Overall, study one indicates that VR users are more likely to reveal highly personal facts, attitudes, opinions, and emotions than video chat or voice only communication users. Looking only at VR communication, study two demonstrates that individuals with a human avatar are more likely to reveal emotional experiences and highly personal facts, attitudes, and emotions about themselves and their experiences compared to individuals using a robot avatar. Past research indicates that self-disclosure is critical to the formation and maintenance of relationships (Baccon, Chiarovano, & Macdougall, 2019; Ruppel et al., 2017) and subjective liking (Antheunis, Valkenburg, &

Peter, 2007). Additionally, past research indicates that self-disclosure of highly personal information as well as cognitive and emotional experiences, attitudes, and feelings predict greater intimacy (Lippert & Prager, 2001; Mitchel et al., 2008). This aligns with Reis and Shaver's (1988) interpersonal process model of intimacy which posits that disclosure of personal desires, anxieties, and emotions result in greater levels of intimacy than merely disclosing facts about oneself.

Digital Communication Medium Attributes

Study one indicates that VR communication outperforms other digital communication methods such as video chat and voice only in terms of cognitive, emotional, and highly personal self-disclosure, which based on past research, indicates a greater likelihood of forming meaningful relationships and developing intimacy/closeness with another person (Baccon, Chiarovano, & Macdougall, 2019; Mitchell et al., 2008; Ruppel et al., 2017). One explanation, and possible limitation, for the quality of the VR conversations could be the novelty of the experience. For instance, VR is still relatively new and the experience may be more exciting and interesting for participants than more traditional digital communication such as video chat and voice only. In fact, Baccon and colleagues (2019) listed VR's novelty as a limitation for their own study and suggested that researchers control for VR exposure in future studies. The current study only used participants who owned their own VR headset, making VR use less of a novelty. To ensure participants had at least some experience with VR, we asked them to rate their past VR experience ranging from (1) not at all experienced to (5) very experienced. The average experience rating was 4.58/5 for all VR participants in study one and two, thus the novelty of the experience was likely reduced.

It is interesting to note that past research has indicated VR rates higher in social presence than most other digital communication mediums (Oh et al., 2018; Riva et al., 2007). Perhaps certain attributes of VR encourage deeper connection through more personal self-disclosures? For instance, the feeling of 'being there' is critical to online interactions as it is helpful when building connections with other people (Oh et al., 2018). Unfortunately, the current study did not measure social presence for the video chat and voice only conditions, leaving us unable to make a more definitive statement about this. Future research should include these measures. While we cannot directly compare social presence between these three conditions, we can hypothesize that the VR condition experienced significantly more social presences than the other two conditions—video chat and voice only—based on previous research (Oh et al., 2018; Riva et al., 2007). So, while VR's ability to elicit social presence is one attribute likely contributing to deeper conversations/more personal self-disclosures, anonymity and communicative cues are likely two other contributing factors. This line of reasoning matches closely to Medium Theory which again holds that each communication medium has its own affordances/features which in turn affect communication patterns (McLuhan & Fiore, 1967). For instance, based on the current study's results, it is likely that the attributes of VR diverge enough from video chat and voice only communication that even when communication pairs are given the same conversation prompt, the VR pairs are much more likely to engage in deeper conversations by disclosing more personal details about themselves. While VR differs from video chat and voice only communication in myriad ways, we will focus on these three areas: social presence, anonymity, and communicative cues.

Social presence theory posits a positive correlation between the number of communicative cues a medium can produce and the development of close relationships (Walther

& Parks, 2002). VR allows for some body language cues such as hand and head movements. It also allows for vocal cues. However, video chat likely offers a greater number of communicative cues as facial expressions are now visible along with head and hand movements and vocal cues. Voice only communication only offers vocal cues. While voice-only communication does not offer body language cues, it does have voice nuances that both the Jiang and colleagues' (2011) and Baccon and colleagues' (2019) computer-based conditions did not have because both these studies used text-based communication. This was a limitation of both studies because the differences between a text-based computer condition and either a VR and face-to-face condition may be explained by the communicative cues afforded via the voice rather than text. The current study eliminated this confound by having all conditions to use voice-based communication. However, Baccon and colleagues and Jiang and colleagues offered very different hypotheses on the outcome of their studies, which will be expanded on here.

Baccon and Colleagues (2019) hypothesized that the VR and face-to-face conditions outperformed a text-based computer condition in self-disclosure because both had greater social presence and communicative cues compared to text-based communication (Parks & Floyd, 1996; Walther & Parks, 2002). Conversely, Jiang and Colleagues (2011) hypothesized that their text-based computer condition outperformed their face-to-face condition in self-disclosure because the text-based computer condition offered greater anonymity and reduced the cognitive load of the conversation by allowing participants extra cognitive resources to focus on the conversation rather than regulating their own body language and reading their partner's body language (Joinson, 2001). Both the Baccon and Jiang included a face-to-face and a text-based computer condition. Unfortunately, the current study did not include a face-to-face condition or a text-based condition as we focused on the modes of communication most likely to compete with VR.

However, it would be beneficial for future research to include face-to-face and text-based conditions. While we did not include these conditions, our video chat condition is the closest to the face-to-face condition as participants actually see the other person along with their communicative cues. However, video chat participants are likely lacking the level of social presence that face-to-face communication offers (Baccon et al., 2019). Lastly, our voice only condition is the closest to the text-based computer condition. However, we acknowledge that text communication is significantly different from voice-based communication. For instance, text-based communication only receives the speech while voice communication receives both speech and vocal cues.

Overall, our study most closely matches the results of Baccon's study (Baccon et al., 2019). For instance, our VR condition exhibited significantly more cognitive and emotional self-disclosure than our voice only condition just as Baccon's VR condition exhibited significantly more cognitive and emotional self-disclosure than their text-based computer condition, thus supporting the communicative cues and social presence hypothesis. While our results align with the Baccon study, they diverge from Jiang's self-disclosure results (text-based > face-to-face), thus not supporting the anonymity and waste of cognitive resources hypothesis. Again, this difference may be explained by voice vs text-based communication rather than anonymity, waste of cognitive resources, social presence, or other communicative cues such as facial expressions or body language. Future research should include a text-based condition to better explore the question whether vocal cues are a powerful predictor of self-disclosure by itself. Additionally, the trade-offs of communicative cues and social presence vs anonymity and waste of cognitive resources may be more nuanced rather than a binary interpretation. For instance, while our video chat condition is not the same as Baccon's face-to-face condition, it certainly offers significantly

more communicative cues than the VR condition. However, our VR condition exhibited significantly more cognitive and emotional self-disclosure than our video chat condition, thus weakening the communicative cues hypothesis and giving the anonymity and waste of cognitive resources hypothesis some ground. Additionally, the current findings strengthen the social presence hypothesis as VR likely elicits significantly more social presences than the video chat condition; however, future research should include a social presence measure to empirically test this assumption.

The difference in findings between the current study, the Baccon study and the Jiang study may also lie in how self-disclosure was measured (Baccon et al., 2019; Jiang et al., 2011). For instance, Jiang relied on self-reported measures of self-disclosure which were not as objective as the method both Baccon and the current study used—hand coding each conversation for self-disclosure by the researcher. Lastly, the current study went further than the Baccon study by coding how personal each utterance of self-disclosure was on a scale of 1 (not very personal) to 3 (highly personal). By further delineating self-disclosure into how personal the disclosure, we were able to better gauge the quality of the conversation rather than just looking at quantity. For instance, the video chat and voice only conditions both exhibit more level one self-disclosure than the VR condition. Past research has shown that the disclosure of highly personal emotions, attitudes, and opinions are a much better predictor of intimacy/connection than general small talk (Mitchell et al., 2008). The video chat and voice only conditions likely disclosed more level one information about themselves than the VR condition because level one disclosure requires less vulnerability and is the main substance of general small talk, get to know you type conversations: My name is Harry Potter, I like the color red, I play Quidditch, etc. The video chat and VR conditions exhibited more level two self-disclosure than the voice only condition while the VR

condition exhibited more level 3 self-disclosure than the video chat and voice only conditions. Just as with exhibiting great cognitive and emotional self-disclosure, VR induced more highly personal self-disclosures. This is likely due to a combination of factors supported by all four hypotheses—communicative cues, social presence, anonymity, and waste of cognitive resources.

An alternative explanation for why VR users were more likely to reveal highly personal information simply could be their shared interest in VR which makes them more likely to start off with a favorable impression of the other person because they already share a hobby or interest. However, a substantial difference between the VR, video chat and voice only conditions is that VR has a level of immersion that video chat and voice only does not. For instance, VR users are immersed environments very different from prior to putting on the headset. Thus, general presence, feeling like they are there in the digital environment co-located with their partner, is much higher than traditional digital communication. While video chat, likely has the most communicative cues, it does not have that feeling of being co-located in the same 'place' with the other person. This feeling of 'being there' may make up for the lack of some communicative cues such as facial expressions. Additionally, while VR users cannot physically see their conversation partner's face, their partner is still embodied in the visible environment which can mimic a real-world environment. For instance, in this study, participants stood in front of each other's avatars and talked similar to how they might mingle at a party.

One positive of a completely digital environment is the anonymity it offers. Users do not need to dress nice to create a good impression, they just need to outfit their avatar. Some research even suggests that users may feel a little more comfortable in digital environments over the real world because they feel safe presenting their 'true self' due to the anonymity granted in an online platform (Jiang et al., 2011). For the current study, participants did not know their

conversation partner and were not expected to reconnect after the study, thus anonymity was likely high because they felt they could not be recognized in the real world by their avatar. However, self-reported anonymity was only conducted for study two. Future research should include self-reported anonymity, the degree to which they believe their avatar looks like their true selves, to better parse out its effects on self-disclosure. Anonymity is expected to be higher in the VR and voice only conditions because participants could not see each other, meaning they do not see the other person's facial expressions. One hypothesis suggests that the absence of nonverbal cues such as facial expressions facilitates self-disclosure because users no longer need to waste cognitive resources regulating their nonverbal behaviors (Jiang et al., 2011; Joinson, 2001). However, our results do not completely align with this explanation; although the VR condition does exhibit more cognitive, emotional, and level three self-disclosure, the voice only condition never outperforms the video chat condition. Thus, if reducing cognitive load by not needing to regulate nonverbal body language increased self-disclosure, the voice only condition should have significantly more self-disclosure. While we still believe anonymity and waste of cognitive resources play a role in self-disclosure, these may not be as strong of predictors as communicative cues and social presence.

Cognitive resource utilization during conversation has gained increased interest, during the Covid 19 pandemic, when much more business and social communication became computer-mediated. This led many to experience what has since been dubbed 'Zoom Fatigue'—the exhaustion following a video conference (Fauville, Luo, Muller Queiroz, Bailenson, & Hancock, 2021; Nadler, 2020). One contributing cause to Zoom Fatigue is the cognitive load associated with controlling one's own nonverbal cues along with interpreting others' cues (Fauville et al., 2021). Zoom Fatigue is a new area of research and has not been explored in alternative digital

meeting platforms such as VR. It is typically only associated with video chat conversations. Future research should explore if the same fatigue/exhaustion associated with video conferencing also happens with alternative digital communication methods such as VR or voice only. Such research will have important implications for the future of work as a pre-covid workforce will likely take a hybrid approach with many companies already opting to become fully remote. As such, a main area of interest will focus on reducing Zoom Fatigue. VR may be the answer to reducing fatigue. For instance, a contributing reason for why VR led to more personal disclosure than the video chat condition could be because the conversation was less fatiguing due to not having to regulate your own body language while also having to interpret your conversation partners' body language. Thus, further exploration of using VR for video conferencing would be useful, and in fact, Facebook has already devoted significant resources to developing their own video conferencing/collaboration space—Horizon Workrooms—which was recently released in August 2021 (Del Rio, 2021).

Overall, study one demonstrated that VR leads to more personal discussions than video chat and voice only communication. In general, video chat and voice only communication does not appear to lead to highly personal self-disclosures compared to VR or video chat communication. Thus, all four hypotheses (i.e., communicative cues, social presence, anonymity, and the waste of cognitive resources) likely play a significant role in self-disclosure and feelings of connection and VR is the only digital communication medium which allows, to some extent, for all four. For instance, while VR does not offer a full range of communicative cues, it does allow for hand and head movements as well as vocal cues. It does not tax a speaker's cognitive load with the regulation and interpretation of paraverbal cues such as facial expressions compared to voice only; it offers a high degree of social presence compared to video chat and

voice only; and lastly, it allows for anonymity as speakers do not need to show their face, thus they don't need to worry about how they visually appear to others. Future research should empirically explore the degree to which each variable (i.e., social presence, anonymity, communicative cues, and waste of cognitive resources) predicts self-disclosure and feelings of connection.

Avatar Appearance

Study two explored how avatar appearance (human vs robot) in a VR environment would affect self-disclosure. Our hypothesis that the human avatar condition would elicit greater self-disclosure compared to the robot avatar condition was supported. This result was likely due to avatar-user match being greater for the human avatar condition. Participants in the human avatar condition were instructed to make their avatars look like themselves. The human avatar condition also self-reported avatar-user match as higher than the robot avatar condition, which was expected. Past research has shown that the higher the avatar-user match, the higher the self-disclosure (Hooi, & Cho, 2014). Study two adds more evidence in support of this hypothesis. Additionally, this result is important because mainstream VR games and environments seem to opt for either human avatars or robot avatars and to our knowledge, there are no studies evaluating how avatar appearance—specifically human vs robot—affect self-disclosure and connection. VR environments aimed at building communities and connections between users, such as AltspaceVR or Facebook Horizon, might be better served relying on human avatars rather than robot avatars. In fact, AltspaceVR has since discontinued its use of robot avatars in favor of human avatars and has vastly expanded users' ability to customize their avatars. This points to another factor that may also affect self-disclosure in VR environments: avatar choice.

Most games or experiences that use avatars allow users to obtain their avatar in one of two ways: create your own avatar or pre-made defaults. Avatar customization has been extensively studied and is a major component of creating an online identity (Ducheneaut, Wen, Yee, & Wadley, 2009; Kafai, Fields, & Cook, 2010; McArthur, Teather, & Jenson, 2015, Neustaedter & Fedorovskaya, 2009). Study two allowed users to create their own avatar rather than provide them with a premade avatar. However, participants were given some limitations to their creations: told whether it was to be a robot or human and told to make any human avatar look like themselves. So, while they had the experience of creating the avatar themselves, they did not have the full range of creative expression. This is important because avatars are a social representation of their human user in computer-mediated communication (Gunkel, 2010). Creating and customizing an avatar is a form of identity creation within a virtual world and can directly influence how others perceive and interact with the user in an online environment (Behm-Morawitz & Schipper, 2016). Further, Rak (2019) argues that avatar appearance in online communities is a form of social currency and in-game identity. Depending on the level of customization available, an avatar's appearance may also be a good indication of its creator's characteristics (Behrend, Toaddy, Thompson, & Sharek, 2012). For instance, women who are introverts prefer avatars that are similar to themselves in appearance while extroverted women are more likely to choose avatars that do not match their appearance (Diemer, Pauli, & Mühlberger, 2015). At the time of the current study, AltspaceVR had relatively limited avatar choices in that there were few choices in body type, facial structure, clothing, and accessories. For instance, there may have been a mismatch between demographic features (e.g., age, race/ethnicity, gender expression, etc.) of the real-life person and the avatar they created due to limited customization choices. Further, the current study did not explore how differences in

avatar demographic representations such as age and race may impact self-disclosure and social presence. Future research should explore these questions. Further on the question of choice, it is possible participants in the human condition would have preferred a robot avatar and vice versa thus their avatars may not have been exactly how they would have preferred to represent their digital self. In fact, users typically prefer to customize their avatar's appearance by creating it in their own image or more often creating an idealized version of themselves and representing their own identity via that avatar (Gunkel, 2010). It is likely that most in the robot avatar condition would have preferred a human avatar and thus it is possible that the lower level of self-disclosure in the robot avatar condition was due to a lack of choice (told to create a robot avatar rather than a preferred human avatar) rather than avatar-user match or how humanoid the robot appeared because avatar choice can affect users' behaviors within a VR environment (Yee & Bailenson, 2007).

The Proteus Effect describes the phenomenon of individuals changing their behaviors in a virtual world due to the characteristics of their avatars (Yee, Bailenson, & Ducheneaut, 2009). Study two offered either robot or human avatars. Were human avatar users more likely to open up due to how they presented their digital selves, or was their conversation partner more likely to open up and build a connection because they were talking to a human rather than a robot? For instance, past research shows that that amount of information disclosed is reciprocal, that is we share a similar amount to what our conversation partner shares (Sprecher, Treger, Wondra, Hilaire, & Wallpe, 2013). So, was the cause of increased self-disclosure in the human avatar condition due to individuals acting differently because they were using a human avatar or was it due to their conversation partners behaving differently when talking to a human avatar vs a robot avatar? Future research should further explore this idea. For instance, the Proteus Effect may be

explained by behavioral confirmation or the self-fulfilling prophecy which states that the expectations of one person can cause the behavior of another person (Snyder, Tanke, & Berscheid, 1977). It follows that the person is not acting a certain way because of the characteristics of their avatar, but instead because of the way others interact with them when using that avatar (e.g., a person interacting with a partner using a human avatar may be more likely to open up than with a partner using a robot avatar). However, there is compelling evidence that a user's behavior conforms to their digital self-representation (e.g., their avatar) regardless of how others interact with them, demonstrating that people are not changing their behavior due to interactions, but are changing their behavior due to their digital appearance (Yee & Bailenson, 2007). For instance, Yee and Bailenson's 2007 study found that participants given an attractive avatar engaged in significantly more self-disclosure and were more willing to approach opposite-gendered avatars than participants given an unattractive avatar. Thus, avatar attractiveness affected the level of intimacy a person with that avatar was willing to reach with a stranger. Participants with attractive avatars were also likely feeling more confident than participants with unattractive avatars as confidence and attractiveness have been linked (Messinger et al., 2008) and participants who feel confident are more likely to engage in greater levels of self-disclosure (Sprecher & Hendrick, 2004). Unfortunately, study two did not ask participants to rate the perceived attractiveness of their avatar or their partner's avatar. However, they did rate how much they liked their avatar which likely relates to attractiveness. Overall, the human avatar condition liked their avatar significantly more than the robot avatar condition liked their avatar. Thus, the human avatar condition likely found their avatars more attractive compared to the non-human robot avatars. Because participants in the human avatar condition

liked their avatars, they likely felt more comfortable ‘in their own skin’ and thus more confident during the closeness generating conversation, leading to more self-disclosure.

Conversely, there is evidence that physical appearance significantly affects individual perceptions and behaviors based on what the other person looks like. The “what is beautiful is good” stereotype demonstrates a compelling link between a person’s level of physical attractiveness and others’ perceptions of desirable traits (Dion et al., 1972; Eagly, Ashmore, Makhijani, & Longo, 1991). Again, while study two did not measure attractiveness, it did measure liking. Human avatar participants overwhelmingly reported liking their avatars; however, would they have rated their partner’s avatar similarly? Thus, were people more likely to open up when they perceived their partner’s avatar as attractive? While it is likely that both play a role, future research is necessary to understand the degree to which each affect self-disclosure and feelings of connection.

In addition to general attractiveness, what about when someone’s choice in digital self-representation is limited? For instance, would the results of study two have differed if we had asked participants which type of avatar they preferred (human or robot) and then put them into the robot or human avatar condition based on their own choice? For instance, higher identification with one’s avatar is likely linked to self-disclosure and while avatar-user match may have been low for the robot avatar condition, maybe choice is more important than avatar-user match when it comes to self-disclosure. While the current study did not directly manipulate choice, it was a confounding variable as we had some limiting requirements on our participants—specified human or robot and instructed participants to make their human avatar look as close to themselves as possible. Future research should parse out the effects of choice versus appearance.

Anthropomorphism is whether an avatar is humanoid versus non-humanoid (Gorisse et al., 2019). Bailenson and his team (2005) studied the impact of using humanoid vs. non-humanoid avatars on social presence. Specifically, participants in a human condition reported significantly higher social presence than participants in a teddy bear and abstract blockhead condition, demonstrating that human avatars lead to higher social presence. However, contrary to our hypothesis, study two did not find any significant differences in social presence between the human avatar and robot avatar conditions. This could be due to the robot avatar reaching some threshold of humanoid-like characteristics. For instance, the robot avatar would likely rate higher in humanoid characteristics than the teddy bear and blockhead avatars in Bailenson's study. However, future research should explore this assumption by comparing different avatars' effects on social presence.

Conclusion

Study one explored how VR compared to traditional video chat and voice only online communication in terms of feelings of connection as measured by self-disclosure. VR communication led to deeper conversations with more personal self-disclosure compared to both video chat and voice only communication which has been linked to greater intimacy and feelings of connection (Mitchell et al., 2008). This has implications in multiple domains, such as education and training systems, business conferencing, social media use, and more, as the results could influence the decision to use a VR versus 2D screen-based method for online communication. For instance, COVID 19 has led many companies to adopt hybrid working models where employees are allowed to work from home either fully or several days out of the week. However, several remote workers report exhaustion after back-to-back meetings being conducted via video conferencing (i.e., 'Zoom Fatigue'). VR might alleviate this issue while

even leading to greater feelings of connection and comradery between remote coworkers than can be achieved with video chat. And finally, the results of study two can help designers decide between robot and human avatars. For instance, there is significant research demonstrating that user's behaviors change depending on how their avatar looks (i.e., the proteus effect). This study adds to this body of research showing that human avatars lead to deeper self-disclosure than robot avatars, thus designers of a primarily social VR application may want to employ human avatars over robot avatars.

VR offers an enticing new medium to conduct online communication; however, research is needed to fully explore the psychological effects of using VR. Studies have demonstrated that online communication can lead to both positive and negative effects on mental wellbeing; however, it depends on how users interact with these environments. Media ecology suggests that VR has ‘evolved’ out of older forms of online communication (Scolari, 2012), and therefore, these effects may transfer to VR environments. Conversely, medium theory holds that communication will differ depending on the medium (Littlejohn et al., 2016). For instance, the affordances of VR are very different from online screen-based communication, and thus, while it is likely that some of the communication patterns and psychological effects found in screen-based online communication will also propagate in VR environments, it is also possible that the affordances of VR are different enough that interaction patterns may differ in significant ways. VR specific research is necessary to fully understand the psychological effects of VR and how different aspects of VR (e.g., avatar appearance, avatar choice) can be altered to improve psychological outcomes. The current study seeks to add insight into this area.

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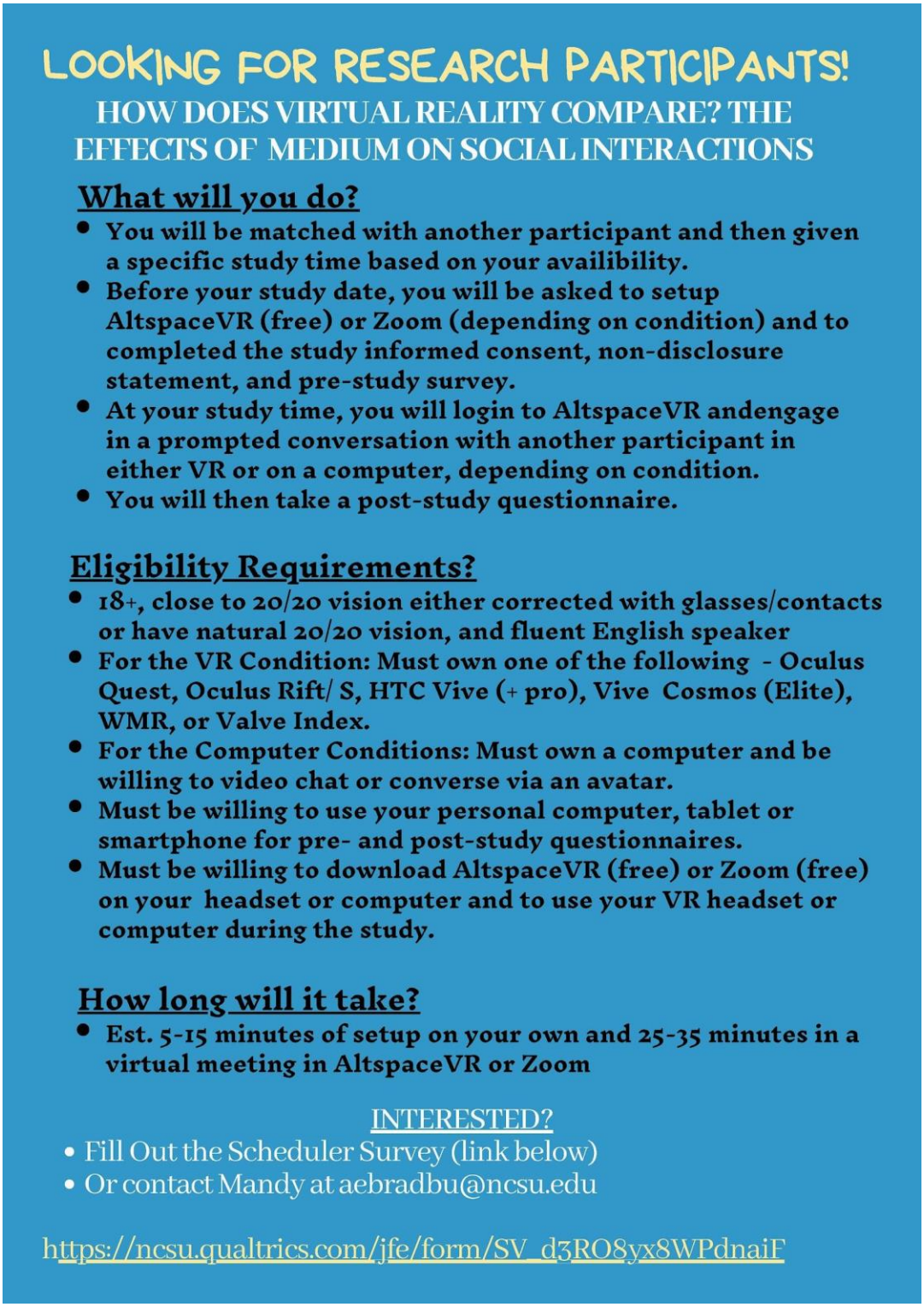
APPENDICES

Appendix A

Recruitment Flyer



Appendix B

Pre-Study Questionnaires

Study One_Pre-Study Questionnaire_video chat and voice only

1. Participant ID: _____

2. How old are you? _____

3. What is your gender?
    a. Male
    b. Female
    c. Other: _____

4. What is your race/ethnicity?
    a. Caucasian/European
    b. African American/African
    c. Hispanic/Latino
    d. American Indian/Native Alaskan
    e. Native Hawaiian/Other Pacific Islander
    f. Middle Eastern
    g. South Asian/Indian
    h. East Asian
    i. Prefer not to answer
    j. Other: Please describe _____

Study One_Pre-Study Questionnaire_VR Condition and Study Two Pre-Study Questionnaire: All Conditions

1. Participant ID: _____

2. How old are you? _____

3. What is your gender?
    a. Male
    b. Female
    c. Other: _____

4. What is your race/ethnicity?
    a. Caucasian/European
    b. African American/African

   c. Hispanic/Latino
   d. American Indian/Native Alaskan
   e. Native Hawaiian/Other Pacific Islander
   f. Middle Eastern
   g. South Asian/Indian
   h. East Asian
   i. Prefer not to answer
   j. Other: Please describe _____

5. What is your level of experience with virtual reality (VR)?
   a. Likert Scale (1 = not at all experienced; 5 = extremely experienced)

Appendix C

Closeness Generating Prompt

1. Would you like to be famous? In what way?
2. If you were able to live to the age of 90 and retain either the mind or body of a 30-year old for the last 60 years of your life, which would you choose?
3. For what in your life do you feel most grateful?
4. Take two minutes each and tell your partner your life story.
5. If you could change anything about the way you were raised, what would it be?
6. If you could wake up tomorrow having gained one quality or ability, what would it be?
7. Is there something that you've dreamt of doing for a long time? Why haven't you done it?
8. How close and warm is your family? Do you feel your childhood was happier than most other people's?
9. How do you feel about your relationship with your mother?
10. Tell your partner something that you like about them already.
11. What, if anything, is too serious to be joked about?
12. Of all the people in your family, whose death would you find most disturbing? Why?

Appendix D

Post-Study Questionnaires

Study One_Post-Questionnaire_video chat and voice only Conditions

2. How well did you know your partner prior to this study?
    a. Likert Scale (1 = do not know partner at all; 7 = know my partner extremely well)

Study One_Post-Questionnaire_VR and Computer Condition; And Study Two_Post Questionnaire_All Conditions

Post-Questionnaire

1. How well did you know your partner prior to this study?
    a. Likert Scale (1 = do not know partner at all; 7 = know my partner extremely well)
2. Do you think your avatar looks like you?
    a. Likert Scale (1 = does not look anything like you; 7 = looks exactly like you)
3. Do you like your avatar? _____
    a. Likert Scale (1 = strongly dislike; 7 = strongly like),
4. How anonymous (unlikely to be identified later by your partner) did you feel during the conversation with your partner?
    a. Likert Scale (1=Extremely likely to be identified later; 7 = Extremely unlikely to be identified later)
5. What gender did you perceive your avatar to be?
    a. Male
    b. Female
    c. Other: _____
6. What race did you perceive your avatar to be?
    a. Caucasian/European
    b. African American/African
    c. Hispanic/Latino
    d. American Indian/Native Alaskan
    e. Native Hawaiian/Other Pacific Islander
    f. Middle Eastern
    g. South Asian/Indian
    h. East Asian
    i. Prefer not to answer
    j. Other: Please describe

Social Presence Questions

Please rate on a scale from 1 to 7 (1 = strongly disagree, 5 = strongly agree) how much you agree with each of the below statements with regard to how you currently feel. For each item, please answer by filling in the blank area using the following scale:

Strongly Disagree (1)
Disagree (2)
Somewhat Disagree (3)
Neither Agree nor Disagree (4)
Somewhat Agree (5)
Agree (6)
Strongly Agree (7)

1. Even when the “other” was present, I still felt alone in the virtual room. _____

2. I felt like there was someone else in the room with me. _____

3. I felt like the “other” was aware of my presence in the room. _____

Appendix E

Self-Disclosure Coding Scheme

Before coding each piece of info ask these four questions:

1) Correct code? (Cognitive, Factual, Emotional)
2) Correct level? (1, 2, 3)
3) Correct split? (Should this be coded as one piece of info or split into multiples?)
4) Repeat? (Has this information been said elsewhere already?)

Factual

- Describe Events (e.g., I got married at 24, I was in a car crash) or facts about oneself (e.g., I am a doctor, I live in Denver, etc.)
- Is **not** describing characteristics about oneself or another person (e.g. I am a happy person, My mom is not a nice person, etc.)
- Code actions they say they are taking as factual and code characteristics they describe about themselves as cognitive
- Revealing something they know or have learned or experienced.
- Information/ knowledge they reveal.

Cognitive

- One's thoughts (e.g., " I think I would like…")
- Opinions (describing characteristics of people or themselves)
- Attitudes (e.g., I do not like large crowds)
- Code actions they say they are taking as factual and code characteristics they describe about themselves as cognitive

Emotional

- Reveal **any** emotion (e.g., sad, annoyed, happy, grateful, etc.) toward an event, person, experience. Only about their own experiences.
- Talk about self-esteem
- I'm grateful statements

General Notes

- Will not count repeated information more than once.
- Each piece of new information gets its own code
- Mutually exclusive. If it fits into more than one category, pick the most suitable category

Code Level of Personal Disclosure

1 to 3 Scale of How Personal the Info Is.

- Rate each on a scale of 1 to 3 "For example, individuals who revealed a few highly personal facts received a higher rating of factual disclosure than did individuals who revealed a greater number of impersonal facts. Similarly, individuals who disclosed highly personal emotions and thoughts received higher ratings of emotional and cognitive disclosure than did individuals who revealed more superficial emotions or thoughts" (Mitchell et al., 2008).

Overall: (1 = Information people would easily give during small talk; 2 = Information given to friends/ acquaintances; 3 = Info given to close friends and family)

Detailed Coding Scale:

1-Information people would easily give during a small talk with a stranger

Factual:

- Basic information including age, current area in which they live, current career or degree, where they are from, positive marriage/dating status, where they went to college and major
- Discussing current events
- Basic info about family such as how many children, siblings, etc.
- Any type of innocuous info that is not expanded on such as short or one word answers.
- Revealing knowledge/ information they know.
- Factual stories about someone they know. (Code whole story as one piece of info)
- Innocuous descriptions/stories that don't really reveal a lot about the person.
- Past hobbies they did as a kid.
- Basic travel description without significant explanation or story. (e.g., I've been to England)
- Basic career details (what they do, how long, etc.)

Cognitive:

- Going off of what the other participant said (agreeing or disagreeing with partner statement)
- Basic opinions without much explanation, "I'm glad" statements
- Simple likes and dislikes without much background information as to why
- Any response to a question that has little to no further development or explanation
- General advice
- A question that reveals something about them/their life/ their knowledge.
- Disclosing whether a prompt is easy or hard for them
- Asking a question that reveals something about their attitude or beliefs

- Any type of suggestions
- Small talk with opinions about celebrities, the weather, sports, VR, etc.,
- Minor jokes with an opinion attached
- Simple sentences which express general opinions about an event/experience such as, “I really enjoy it, that was a great experience” etc. These typically come after a factual or emotional sentence.

Emotional:

- Emotional response to an answer or question by the other participant.(e.g., I’m so sorry.. Oh my god!)
- “I’m grateful” sentences that do not go into detail as to why.

2- Information given to a friend/acquaintance, go further than small talk

Factual:

- Non-recent divorce
- Extra details about family: names of kids, death of a family member, etc.
- Past physical health problems: Survived cancer, etc.
- Going into personal history beyond basic facts.
- Disclosing sexuality
- Discussing religion
- Disclosing anything that might induce shame
- Past financial status
- Current interests or hobbies
- Explaining past decisions and past reasoning.

Cognitive:

- Opinions, thought, attitudes with extra explanation
- Answering questions with extra details
- Likes and dislikes that go into more background information as to why
- Life dreams (“I’ve always wanted to…”).
- Explanation of why they are grateful for something

Emotional:

- Emotional response going above superficial responses to the other participant.
- Emotional response is centered on themselves rather than sympathetic to the other participant.
- All “I’m grateful” sentences that go into further detail.
- I’m happy, sad, satisfied, worried, etc. statements (Past, present, or future)
- Answer to whose death would you find most upsetting.

3- Information only given to very close friends and family

Factual:

- Family secrets
- Disclosure of childhood trauma/abuse
- Current familial or personal physical health including weight issues.
- Current or past personal or familial mental health issues
- Marital problems: currently going through divorce, separation, etc,
- Current financial status and any mention of going bankrupt in the past.

Cognitive:

- Discussing the effects of past negative experiences, e.g., "It was horrible but made me who I am today"
- Negative opinions about oneself that are not spoken in a joking way.
- Politically incorrect views on hot button topics, beliefs, attitudes, and opinions.
- Very dark jokes like suicide.

Emotional:

- Emotional responses to negative past events/experiences
- Discussion of emotional trauma.

General Notes:

- Each new piece of factual evidence gets its own code while cognitive is a little more lenient where stories are coded together. So for cognitive, think **each new subject change has its own code.**
- Code "I'm grateful" sentences that are in response to the grateful question as level one emotional if they don't go into further detail.
    - When they go further into details, code the whole sentence ("I'm grateful" statement and the "because") as level two emotional.
- Ambiguous cognitive information and suggestions should be coded as level one cognitive
- Sometimes a level 2 cognitive/ factual story gets broken up with a factual or cognitive statement in the middle. When this happens, code the back half of the statement as purple to show it goes with the statement in front.