Chapter 4
Close Relationships and Virtual Reality

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Abstract The intersection between close relationships research and virtual reality holds great promise for the advancement of both fields. In social science research laboratories and mainstream society, virtual reality is becoming an increasingly popular and viable tool and method for not only studying close relationships such as romantic relationships and friendships, but also for engaging in relational processes (e.g., social interactions, relationship formation, and relationship maintenance). Initial research at the forefront of this intersection has focused on attachment theory in adult romantic relationships, exploring (a) how attachment processes occur and (b) how they may be studied using digital, immersive spaces created via virtual reality. The current chapter first provides a general overview of both attachment theory and virtual reality before delving deeper into the intersection of adult attachment theory, neuroscience, and virtual reality. The chapter then concludes with potential future directions for research at the intersection of close relationships and virtual reality.

Introduction

From infancy to adulthood, relationships color individuals' lives. As Berscheid (1999) eloquently writes, "We are born into relationships, we live our lives in relationships with others, and when we die, the effects of our relationships survive in the lives of the living, reverberating throughout the tissue of their relationships" (p. 261). Relationships are sources of intimacy, social support, sadness when conflicts occur, and happiness when the relationship goes well. During adulthood, romantic relationships are of particular salience. The initiation, maintenance, and (for some)

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dissolutions of romantic relationships constitute notable events in the tapestry of life, and play a considerable role in shaping one's self-concept, well-being, and behavior. For these reasons, understanding the processes that underlie romantic relationships is essential for furthering our understanding of the human life experience.

This chapter will begin by giving a brief overview of attachment theory, a central framework in studying close relationships, as applied to adult romantic relationships. Next, we will discuss the increasing utilization of virtual reality for close relationships in both research laboratories and mainstream culture. Finally, we will consider the potential impacts and implications that virtual reality will have on research in relationship science, and for close relationships in society at large.

Close Relationships and Attachment Theory

How are romantic relationships initiated? Once formed, how are relationships maintained, and why do certain relationships deteriorate and dissolve, while others thrive? Why are romantic relationships important, and what are the consequences of belonging in a relationship? These questions lie at the core of the study of close relationships. For the purposes of this chapter, we will limit our overview of the literature to a brief discussion of adult attachment theory, one of the major guiding frameworks in the study of close relationships, in this section.

Attachment theory describes the process of developing affection towards close others, and the ways in which a person's system of attachment behaviors influences how they behave in and perceive their social world. The origins of attachment theory lie within the realm of developmental psychology. Bowlby (1969) was interested in understanding how infants become attached, or affectionately bonded, to their primary caregiver (usually the mother figure), and distressed when separated from the caregiver or deprived of the caregiver's attention. He believed that from birth, infants are predisposed to become attached to their primary caregiver, and actively engage in attachment behaviors such as smiling, rooting, crying, and sucking that promote physical proximity and social interaction with the caregiver (Ainsworth & Bell, 1970; Bretherton, 1992). In turn, the primary caregiver's behaviors towards the infant (e.g., reciprocating proximity-seeking behaviors, being present, responsive, and sensitive to the infant's needs) can shape the infant's expectations of and attachment towards the primary caregiver (Bell & Ainsworth, 1972). For example, an infant feels more confident in exploring her surroundings when she knows that her caregiver will be available to comfort her if she needs it (Bowlby, 1988; Sroufe & Waters, 1977).

Through the combination of the infant's own activity in proximity-seeking attachment behaviors, the primary caregiver's behaviors towards the infant, and previous attachment-related experiences, the infant develops an internal working model of the self and environment that "provides a casual-temporal prototype of the ways in which attachment-related events typically unfold" (Cassidy, Jones, & Shaver, 2013, p. 3). This internal working model of attachment can then be used by the

infant as a guide for navigating future attachment-related interactions. Continuing with the previous example, if an infant's past experiences of falling down involved seeking and successfully receiving comfort from her caregiver, she knows that the next time she falls down in the future, she can look towards her caregiver for reassurance and expect to receive it.

Further research in this area by Ainsworth and Bell (1970) identified three main patterns of attachment behavior: secure, avoidant, and ambivalent/resistant. They noted that children with a secure attachment style feel safe and confident in exploring their world, knowing that their caregiver will be available, responsive, and helpful if they experience any frightening or threatening situations. Avoidant children, on the contrary, expect little to no help (or even rebuttal) from their caregivers, and avoid proximity and interaction with their caregivers after frightening situations. Ambivalent/resistant children are unsure of their caregiver's availability or responsiveness, and as a result tend to cling to their caregivers. These three styles of attachment are internalized, and become part of the child's internal working model of attachment (Bartholomew & Horowitz, 1991).

Although the origins of the theory focused on infants and children, attachment theory is thought to be relevant across the life span (Ainsworth, 1982; Bowlby, 1980). In particular, Hazan and Shaver (1987) postulated that romantic love could be an attachment process between adults, similar to the attachment processes between an infant and her parent. They believed attachment theory could be used to explain how romantic affectional bonds between adults are formed. The authors conducted two studies, and found that not only was the prevalence of the different attachment styles similar in adults as in infants, but also that adults with different attachment styles experienced romantic love in different ways. Adults with a secure attachment style had happy, friendly, and trusting love experiences, avoidant adults experienced fear of closeness with their relationship partners, and ambivalent/resistant adults indicated a desire for reciprocation from their partner and many highs and lows in their relationships (Hazan & Shaver, 1987; Simpson, 1990). Moreover, adults with different attachment styles had different internal working models about "the course of romantic love, the availability and trustworthiness of love partners, and their own love-worthiness" (Hazan & Shaver, 1987, p. 521). In addition, the authors found that an adult's attachment style is related to his relationship as a child with his parents, due partially to a continuity of the adult's internal working model of relationships in general from childhood (see also Collins & Read, 1990; Feeney & Noller, 1990). In other words, a person who had a secure relationship with his parents as a child is more likely to experience secure romantic relationships as an adult.

Since the publication of Hazan and Shaver (1987), the adult romantic attachment theory literature has expanded and grown rapidly, becoming a major framework for the study of close romantic relationships (Fraley & Shaver, 2000). Researchers have examined various aspects of how attachment in adult romantic relationships affects both the self and the relationship, including beliefs about relationships (Feeney & Noller, 1990; Stackert & Bursik, 2003; Wang & Mallinckrodt, 2006), relationship satisfaction (Banse, 2004; Brennan & Shaver, 1995; Butzer & Campbell, 2008; Collins & Read, 1990; Pistole, 1989), relationship stability (Duemmler & Kobak,

2001; Simpson, 1990), and partner characteristics (Brennan & Shaver, 1995; Collins & Read, 1990). Other studies have also examined areas such as stability and change in attachment style across time (Lopez & Gormley, 2002; Scharfe & Bartholomew, 1994), conflict resolution (Pistole, 1989; Shi, 2003), and effects of romantic partner presence (Feeney & Kirkpatrick, 1996; Kane, McCall, Collins, & Blascovich, 2012).

Adult Attachment Theory and Neuroscience

More recently, researchers have begun to investigate the neurobiological underpinnings of adult attachment theory—how the attachment system affects and is affected by the brain. Coan (2010) notes that the neural systems which are involved in attachment processes such as pair bonding are also linked to "responses to rewards and punishments, emotion regulation, motivation, and personality" (p. 211; see also Vrtička & Vuilleumier, 2012). He proposes that encounters with potential mates (assuming they go well) activate the production of neurotransmitters such as dopamine and oxytocin, which induce pleasurable feelings. The release of these neurotransmitters then conditions and encourages the neural systems to seek further exposure to the potential mate or partner (Coan, 2008). Some research suggests that this combination of associating pleasurable feelings with the potential partner and seeking out the partner (to experience pleasurable feelings) can lead to a form of addiction, where separation from the partner can create feelings of distress (withdrawal) and attempts to reestablish connection with the partner (and therefore re-experience pleasurable feelings; Coan, 2010; Insel, 2003). Through the above process, the attachment behavioral system is developed.

Further research has attempted to understand how attachment styles are instantiated or encoded in the brain, though the number of studies conducted in this area remains scarce (Coan, 2010; Vrtička & Vuilleumier, 2012). Much more is known about the effects of attachment style on neural processing, especially when taken in conjunction with the existing vast literature of empirical behavioral studies on attachment styles. To give an example, from this substantive literature it is well known that adults with different attachment styles react to negative, threatening situations in different ways associated with their attachment style (e.g., individuals who have an anxious attachment style tend to continuously monitor for signs of their romantic partner's availability and attention when separated from their partner), and that, depending on their attachment style, adults may rely on their attachment figure (i.e., the romantic partner) to assist with affect regulation (Coan, 2010; Hazan & Shaver, 1987). Notably, these findings have been observed at the neurological level as well. In individuals with an anxious attachment style, the brain systems that activate neural networks associated with aversion, withdrawal, and defensive responses appear to be especially sensitive to negative social cues, thereby increasing the frequency of its activation (Vrticka et al., 2008). On the other hand, avoidant individuals experience a deactivation of the brain areas (anterior insula and dorsal ACC) related to social aversion. Individuals with a secure attachment style experience less activation of the threat-

related neural networks when in the presence of their romantic partner, suggesting a greater vigilance against negative or threatening stimuli (Coan, Schaefer, & Davidson, 2006; Vrtička & Vuilleumier, 2012). Other studies examining areas such as mental state representation, memory, selective attention, and emotion regulation have drawn similar parallels between behavioral outcomes and the activation of relevant brain areas in their findings with regard to attachment styles and the attachment behavioral system (Vrtička & Vuilleumier, 2012).

Virtual Reality

Throughout history, the concept of virtual reality has evolved in conjunction with improvements and innovations in technology. Broadly defined, present-day virtual reality can be thought of as "synthetic sensory information that leads to perceptions of environments and their contents as if they were not synthetic" (Blascovich et al., 2002, p. 105). In other words, users of virtual reality employ technology such as visual displays and headphones (or speakers) to replace the sensory inputs (e.g., sight, sound) that they receive from the actual, grounded reality with digital, computer-generated sensory input from a virtual environment. For example, a person could be sitting in their living room at home, yet be seeing a rainforest instead of the open backyard sliding door (through a visual display such as a computer or television screen), and hearing sounds (through headphones or speakers) of animals living in and moving throughout the forest, instead of the radio program playing music softly in the background. Although their actual reality is their living room, for the moment, the person is engrossed in the virtual reality of the rainforest.

Through the use of head-mounted visual displays, or headsets, immersive virtual environments (IVEs) become possible. In IVEs, users feel as though they are psychological present in the virtual world—that the virtual world surrounds them and becomes the world in which they, as of that moment, inhabit. With the addition of equipment that tracks information such as current head orientation (and therefore line of sight), position in physical space, and body movements (e.g., hands, arms, legs), users are able to interact with the virtual environment, which then increases their perception of psychological presence and immersion (Cummings & Bailenson, 2016). The person in the living room could stand up and look down, observing the rich, moist soil of the rainforest ground, then look up, and see the dense green canopy with trickles of light filtering through. While walking forward in the physical world, her visual display would update based on her new physical location and head orientation, and move her forward in the virtual rainforest environment as well. Bending down, she could reach forward to virtually "touch" and flip over a leaf to examine its underside, as her handheld controller registers her hand's positions and tells the virtual reality program to move her digital hand simultaneously in order to reflect her intended actions.

The potential of virtual reality—from traveling to faraway places, creating imaginative 3D art pieces, and interacting with other people in digital worlds, to name a few—has always fascinated society and captured its imagination. Only recently,

however, has VR become viable and available for mainstream access. As of the time of this writing, many of the major technology companies such as HTC, Oculus, Google, Samsung, Sony, and Microsoft now offer commercially available virtual reality headsets that the average consumer can purchase to use in their own home. Both the HTC Vive and the Oculus Rift, two of the leading options of VR headsets currently available in the market, have recently considerably decreased in price, becoming even more affordable and accessible for the general public (Kuchera, 2017a, 2017b). This increased affordability has been reflected in the sales, with over a million headsets being sold in a single business quarter in 2017, and more sales predicted for 2018 (Taylor, 2017).

Using Virtual Reality to Study Close Relationships

Recently, researchers have begun to devise new and creative ways of studying close relationships and adult romantic attachment theory. Of particular interest is the increasing utilization of virtual reality (VR) technology as a method for studying interpersonal relationship behaviors and processes. Virtual reality allows researchers to place participants into a simulated virtual environment, created by the researchers for the purpose of the experiment. When paired with a head-mounted visual display, the VR experience becomes especially immersive, and the participant feels as though they are surrounded by and almost physically present in the virtual environment. With the addition of other sensory features such as spatialized audio (via headphones or speakers) and haptic stimulation (via feedback devices such as controllers), the experience of immersion can be further augmented (Steuer, 1992). Thus, the virtual environment replaces and becomes the user's new "real" world in which they are present (Loomis, Blascovich, & Beall, 1999).

One major advantage of using VR for close relationships research is an increase in ecological validity without the tradeoff of experimental control (Loomis et al., 1999). Similar to studies conducted in laboratories, experimenters can program studies in virtual reality to precisely deliver stimuli or create specific situations of interest while minimizing the effects of external variables. However, unlike the contrived, artificial scenarios employed by laboratory studies (e.g., asking participants to read a written passage in order to induce a certain affective state, asking participants to imagine a situation before reporting how they would act in the situation), studies conducted in virtual reality can be programmed to emulate the actual real-world scenario of interest, thus increasing both ecological validity and experimental realism (Loomis et al., 1999; Rizzo, Schultheis, Kerns, & Mateer, 2004). For example, instead of asking participants to report how they believe they would act based on a written or verbal description of a specific situation, researchers can place the participants into a virtual simulation of the situation, and measure the participant's actual, real-life actions directly.

Another advantage of using virtual reality for close relationships research is the ability to create and use virtual interaction partners instead of human confederates.

As with the virtual environment, experimenters have "full experimental control over the actions and reactions" of a virtual interaction partner (Schönbrodt & Asendorpf, 2012, p. 431). Compared to human confederates, virtual confederates provide a number of benefits. Since they are programmed, virtual confederates require no training, thus reducing costs such as time and money. They are also subject to less random error compared to human confederates: Virtual confederates will always be blind to condition (unless programmed otherwise), and act exactly the same for each repetition of the experiment (unlike human confederates, virtual confederates can't forget their scripts!) (Blascovich et al., 2002). The use of virtual confederates (and VR experiments in general) also allows for near-perfect replications, both inside and across labs. Researchers need to only share the program containing the experiment through a hard drive, the cloud, or email for another researcher to gain access to the entire experiment. This direct "handing-over" of the study helps eliminates some common problems and/or difficulties of trying to replicate another laboratory's work, such as differences between the original laboratory environment and the replication laboratory's environment, accurately recreating the experimental situation and materials, training new confederates, and so on (Blascovich et al., 2002).

Due to its technological nature, virtual reality also lends itself well to certain types of data collection. Because the participant's location and movements are continuously tracked in order to render the virtual environment, data regarding distance from other virtual people or objects, direction of eye gaze, and body movement (e.g., head, hands, arms, legs; assuming trackers are being held or attached) can be automatically collected by the computer during the experiment. Such data becomes especially useful when conducting research in areas that include interpersonal distance (Bailenson, Blascovich, Beall, & Loomis, 2003; Gillath, McCall, Shaver, & Blascovich, 2008; Yee, Bailenson, Urbanek, Chang, & Merget, 2007), eye contact (Bailenson & Yee, 2006; Garau et al., 2003; Gillath et al., 2008; Yee et al., 2007), and mimicry (Bailenson & Yee, 2005; Hasler, Hirschberger, Shani-Sherman, & Friedman, 2014). For scientists interested in collecting physiological or neurological data, additional methods of data collection (e.g., skin conductance, heart rate, EEG) can be easily paired with VR. Indeed, such research may even benefit from the use of immersive virtual environments, due to VR's ability to incorporate dynamic, interactive stimuli into psychophysiological and neuropsychological assessments. Thus, adopting VR could help researchers in areas such as the social, affective, and clinical neurosciences better understand real-world functioning, compared to the traditional method of paper-and-pencil assessments (Parsons, 2015).

So far, a small handful of studies have been conducted on areas in close relationships research (such as adult romantic attachment theory) using virtual reality and virtual environments. Kane et al. (2012) examined the effects of a romantic partner's presence and the partner's nonverbal support behavior on participants during a threatening, cliff-walking task in VR. The authors believed that, similar to infants with regard to their mother, adult participants would be sensitive to their romantic partner's availability and responsiveness when experiencing a threatening or frightening situation. Participants whose partners were present, available, and responsive would feel more confident in completing the threatening task, and would experience "lower stress, a greater sense of

emotional security, and reduced behavioral vigilance" (Kane et al., 2012, p. 38). On the other hand, participants whose partners were not present during the threatening task, not available, and/or not responsive would experience greater attachment needs, higher vigilance for the partner's attention, and be less able to cope with the task. For the study, the authors had participants come into the lab with their romantic partner. Participants were led to a separate room from their partner and assigned to one of three conditions: partner-absent, partner-present and unresponsive, and partner-present and responsive. After putting on a head-mounted display, participants were placed inside a virtual world, at the end of a path on the edge of a canyon, and asked to complete a cliff-walking task. Depending on the condition they were assigned to, they would either be alone in the virtual world, or their partner would be present on a visible but separate part of the canyon. In the two partner-present conditions, participants were told that their partner would be controlling the "partner" avatar from a different room in the laboratory. In reality, however, the partner avatar was actually being controlled by preprogrammed computer algorithms. In the responsive-present condition, the "partner" avatar was programmed to "wave, clap, nod their heads, and actively orient their bodies toward the participant during the task" (Kane et al., 2012, p. 39). In the unresponsive-present condition, the "partner" avatar was programmed to face away from the participant's avatar, looking over the canyon instead. Before and after the cliff-walking task, participants completed a series of questionnaires that included the study's dependent measures.

Overall, the authors found that partner responsiveness played a greater role in how participants experienced the threatening task, compared to the mere presence (and lack of presence) of the partner. As in parent–child interactions, participants reported feeling less stressed, safer, and more secure in exploring the virtual canyon world when they felt that their romantic partner was present, attentive, and responsive—a secure base which they could look to for comfort and encouragement. On the other hand, participants whose partners were present but inattentive reported experiencing levels of stress similar to those who completed the task alone, and became more preoccupied and vigilant in monitoring their partner for cues of responsiveness during the task. Additionally, partner inattentiveness during the threatening VR task affected participant's behaviors towards their partner in a subsequent task as well, where they kept a greater distance from their partner compared to participants in the other conditions. These findings suggest that attachment related-goals and behaviors are activated in adulthood similarly to childhood, and that the attachment system operates in adult intimate relationships.

In two related studies, Schönbrodt and Asendorpf (2011, 2012) examined interaction and attachment dynamics though the use of virtual environments and preprogrammed virtual agents. For both studies, the authors created and used a virtual environment, which they named "Simoland," that contained inhabitants called "Simos." Of the many Simos living in Simoland, one was a character representing the participant, and another was a character representing the participant's character's partner, or "virtual spouse." Besides the participant's own character, all other Simos (including the virtual spouse) were controlled by preprogrammed algorithms. Participants were able to move their character around Simoland, and could interact with other Simos by opening up a menu bar and choosing an action from a list of possible options.

Depending on factors such as mood, previous interactions, and familiarity with the participant's character, the Simo that the participant interacted with would then react to the participant's interactions accordingly. For example, if the participant complimented their virtual spouse, the virtual spouse would react delightedly. If the participant annoyed their spouse and then asked for a kiss, however, the spouse character would react angrily and refuse to kiss (Schönbrodt & Asendorpf, 2011).

In their first study, Schönbrodt and Asendorpf (2011) investigated whether intimacy motivations, autonomy motivations, and relationship satisfaction with a real-life partner influenced participants' behaviors towards a digital partner (the virtual spouse) in Simoland. They hypothesized that participants would behave differently towards their virtual spouse (but not other Simos), depending on their level of intimacy motive (i.e., the need for closeness to a romantic partner), their level of autonomy motive (i.e., the preference of individuality and independence from a romantic partner), and their relationship satisfaction with their real-life partner. Participants with a higher intimacy motive were expected to display more positive and less negative behaviors towards their spouse, and to be more persistent in engaging in intimate, positive behaviors, compared to participants with a lower intimacy motive. Higher relationship satisfaction with a real-life partner was also expected to lead to more positive and less negative behaviors towards the virtual spouse; moreover, the authors hypothesized that participants' real-life relationship satisfaction would set the initial level (i.e., intercept) of positivity in the interactions with the virtual spouse. Due to the unrestricted nature of the study's implementation of Simoland, and the lack of control or instructions from other Simos and the virtual spouse, the authors predicted that autonomy motives would not affect participants' actions towards the spouse or other Simos. The results of the study supported all of the authors' hypotheses, suggesting that "real-life" expectations, schemes (e.g., intimacy and autonomy motives), previous experiences, and behaviors from a current relationship can transfer over into the digital sphere, towards a virtual spouse. These findings highlight the efficacy of utilizing virtual reality paradigms for studying or observing actual, dynamic behavior in close relationships research, compared to "hypothetical choices or self-reported intentions" (Schönbrodt & Asendorpf, 2011, p. 15).

Bolstered by the findings from their first study, Schönbrodt and Asendorpf (2012) conducted a second study that extended the Simoland paradigm to address whether real-life internal working models of attachment would also transfer over into the digital world and affect behaviors towards a virtual spouse. The authors modified Simoland to include scenarios that emulated Ainsworth et al. (1978) famous "strange situation" procedure (edited from the original procedure used for infant attachment research to reflect situations relevant to adults). They hypothesized that a participant's attachment style (e.g., secure, anxious, avoidant) would predict how the participant controlled their character to act towards the virtual spouse in three different "strange" scenarios that contained an attachment-related threat: a separation scene, a conflict scene, and an illness scene. For example, participants who scored high on the anxiety dimension of attachment were predicted to "engage in hyperactivating strategies" and increase their vigilance for cues of availability from their partner during times of stress (e.g., being separated from the partner), whereas participants who

scored high on the avoidance dimension were anticipated to engage in "deactivating strategies" and limit the activation of their attachment system and related attachment-seeking behaviors in response to the attachment-threatening situation (Schönbrodt & Asendorpf, 2012, p. 436). The results of the study provide evidence for their hypotheses, indicating that internal working models of attachment do indeed transfer over into the digital realm, towards virtual partners. Importantly, the authors were able to not only replicate classic, existing findings in the attachment literature originally conducted in real-life settings by using a virtual environment, but also contributed to adult attachment theory by providing supporting evidence for the emotional versus behavioral regulation model proposed by Fraley and Shaver (2000).

Close Relationships in Virtual Reality

Beyond adopting virtual reality as a means or tool to study theoretical interests (e.g., adult attachment theory) in the close relationships literature, virtual reality can also be seen as a platform for the formation and maintenance of relationships. With the influx of new VR home users, the increasing popularity of VR, and the availability of multiplayer social virtual worlds such as Facebook Spaces (by Facebook), Sansar (by the creators of Second Life), and AltspaceVR, it becomes easy to imagine a world in which people meet, interact, and form relationships with others in a virtual world—all from the comfort of their living rooms. The consequences of these relationships in VR contain further abundant research possibilities and potentially wide-reaching implications. Imagine this: Sam comes home from work and turns on his computer. Donning his VR headset, he enters a virtual town square, where he sees the avatars of other users like him. He hears the faint conversation of two friends at the small café by the corner, and notices another person browsing the quaint bookstore off to the side. Walking forward, Sam enters an open collaborative art area, where anyone can draw in the 3D space, and meets Rachael, who invites him to draw with her. While drawing together, they discover that they share similar interests and continue to meet in the virtual world, eventually forming a romantic relationship. Although this is an imaginary scenario conjured up for the purposes of providing an example, social (e.g., networked) virtual reality is slowly becoming a mainstream reality. Through the aforementioned publicly available social VR worlds, users can already interact with other users in a digital, 3D space, with the potential for forming and maintaining relationships. Understanding the consequences of these relationships, then, becomes ever more important.

Unfortunately, not much research has been conducted in this area so far. Research in social VR has mainly focused on the learning sciences (usually in a classroom context, see McCall, Bunyan, Bailenson, Blascovich, & Beall, 2009; Bailenson, Yee, Blascovich, Beall, Lundblad, & Jin, 2008; Bailenson, Yee, Blascovich, & Guadagno, 2008; Monahan, McArdle, & Bertolotto, 2008) and on specific aspects of social interaction via virtual reality, such as the ability to "transform" the physical appearance and behaviors of one's avatars (e.g., changing one's avatar's height to be taller than the interaction

partner's avatar; Bailenson, Yee, Blascovich, & Guadagno, 2008; Bailenson, Beall, Loomis, Blascovich, & Turk, 2005). While the latter area of research may be useful in understanding particular aspects of relational processes in VR, such as impression formation and interaction dynamics, many of the study paradigms involved only one interaction session. Only a few researchers have conducted longitudinal studies examining the effects of social interactions in VR across time (see Bailenson & Yee, 2006). Thus, the long-term consequences of such interactions (which, assuming things go well, would lead to the formation and maintenance of a relationship) remain mostly unknown.

Despite the lack of research in a virtual reality setting, research conducted in online, web-based settings can help shed light on what the consequences of forming and/or maintaining relationships in VR may be. Many studies have examined purely online romantic relationships, where communication in the relationship occurs predominantly through computer-mediated means (e.g., instant messaging, massive multiplayer online games, online forums, chat rooms), in comparison to face-to-face relationships, where partners mainly interact in person. Three major perspectives have been offered to explain how intimacy, a major factor in relationship development and satisfaction (Anderson & Emmers-Sommer, 2006), develops in online interactions. Parks and Floyd (1996) argue that, due to the lack of cues such as facial expressions, body language, and verbal nuances, computer-mediated interactions are fundamentally impersonal, and as a result, impair the development of intimacy. Lea and Spears (1995) suggest that online interactions are interpersonal, but take longer to develop similar levels of intimacy compared to face-to-face interactions. In comparison, Walther (1996) proposes that the lack of cues, in combination with the asynchronous nature of computer-mediated communication, actually allow people to experience greater (hyperpersonal) levels of intimacy online than they would face-to-face, due to having more cognitive resources (from not having to monitor cues such as facial expressions) and time to compose messages. Walther's hyperpersonal model has been supported by research in online text-based contexts, where users believe they are better able to express their "true self" and meet others that share similar interests, leading to increased self-disclosure, trust, and intimacy, and the development of close, intimate relationships (McKenna, Green, & Gleason, 2002). Given that avatars in virtual reality can be programmed to display cues such as facial expressions and body language, and that users in virtual reality can communicate through voice-chat systems with the addition of a microphone and headphones or a speaker, it is interesting to consider which perspective may best describe intimacy development in virtual reality.

Although not fully immersive, Second Life, a freely available online 3D virtual world where users have the ability to interact with other users, provides a potentially enlightening look into the perceptions and inner workings of online relationships. In Second Life, users can control their digital avatar to engage in social activities—such as attending parties, chatting, sexual activity, and even marriage—creating opportunities to meet new people and develop intimate bonds. Gilbert, Murphy, and Clementina Ávalos (2011a) surveyed participants who were currently involved in an intimate, romantic relationship on Second Life, and found that participants perceived their relationship to be just as real as romantic relationships that take place in the

physical world (i.e., face-to-face), suggesting that to those who are involved in one, online relationships go beyond gameplay and are not simply just an aspect of the online world or role-playing online. Other research in an online newsgroup setting has also described feelings of online relationships as real, deep, and meaningful (McKenna et al., 2002). Furthermore, Quackenbush, Allen, and Fowler (2015) investigated attachment bonds in romantic relationships on Second Life, and discovered that participants formed equally strong attachments in online, virtual relationships as they did in real-life relationships.

Perhaps more interestingly, participants idealized their romantic relationships on Second Life more compared to romantic relationships that occur face-to-face in real life (Gilbert et al., 2011a). Anderson and Emmers-Sommer (2006) discovered a similar finding in text-based, computer-mediated contexts, positing that the hyperpersonal nature of communication with online partners creates "idealized/heightened perceptions of similarity, commitment, intimacy, trust, attributional confidence, and communication satisfaction" (p. 167), especially when participants communicated frequently and for long periods of time with their online romantic partner. Consequently, this increase in idealization and therefore positive perceptions of online romantic relationships may be one factor explaining participants' reports of higher relationship satisfaction levels in their online relationships compared to face-to-face relationships (Gilbert, Murphy, & Clementina Ávalos, 2011b).

Online relationships are not without risks however. The provision of anonymity that allows people to express their "true" self (McKenna et al., 2002) can also be used to express a "fake" or deceptive self, where a person may lie about their gender, appearance, interests, and other factors that are taken into consideration when forming relationships online (Drouin, Miller, Wehle, & Hernandez, 2016). The term "catfishing" was created specifically to describe such deceptive behavior in online romance settings, and the need for caution with regard to being "catfished" is a major concern for participants of online romances (Wildermuth & Vogl-Bauer, 2007). In a virtual reality environment, a person could create a fake avatar which they deceive others into believing is a realistic representation of them in real life. The ability to form romances online has also increased people's abilities to engage in extramarital affairs, which can then negatively impact one's relationship with their real-life partner (Gilbert et al., 2011a; Wildermuth & Vogl-Bauer, 2007).

Implications and Future Directions

Being in a romantic relationship is associated with multiple psychological benefits. One especially noteworthy benefit is that of increased health and well-being. For example, researchers have consistently established a link between relationships and mortality, finding that people who are more socially connected tend to live longer, even after controlling for factors such as socioeconomic status, health behaviors (e.g., smoking, alcohol consumption, and physical activity), and mental health (e.g., depression), among others (Sarason, Sarason, & Gurung, 2001). People who are in

relationships are able to seek and receive social support from their partners to cope with negative stressors (e.g., upcoming exam or job interview) and life events (e.g., death of a loved one), helping them deal effectively with such events when they occur (Cohen & McKay, 1984). Furthermore, close relationships can function as a self-bolstering resource, not only buffering people in relationships from potentially negative or threatening information (e.g., subpar results on an intelligence test) but also increasing their openness to challenges and feedback (Kumashiro & Sedikides, 2005). The ability to capitalize on positive events such as graduations, births, and job offers together with relationship partners can also lead to important benefits for health and well-being. Sharing positive news and commemorating positive events with a partner is linked to improved relationship quality and increased positive affect, and can even increase the significance and memorability of the event (Gable, Reis, Impett, & Asher, 2004; Gosnell & Gable, 2013).

For the above reasons and others, advancing our understanding of the formation, maintenance, and consequences of close romantic relationships is essential. Further work is needed to explore the utility of virtual reality as a method for studying adult attachment processes and for theory-building. For example, the ability to manipulate the presence, distance, and actions of a partner's avatar could help shed light on the impact of nonverbal behavior on the activation of attachment-related behavior and goals. Longitudinal studies would be particularly beneficial for examining the long-term consequences of interacting socially in a virtual setting, particularly in comparison to face-to-face interactions and purely text-based communication. Given the added affordances of virtual reality (e.g., avatars, body language, perceived "physical" distance), how does intimacy develop in immersive virtual environments? The use of virtual reality would also aid researcher efforts in understanding the neurological underpinnings of adult attachment styles, especially given the growing body of literature at the intersection of cyberpsychology and the social neurosciences (Parsons, 2017). Future research should also examine the potential positive and negative effects of virtual reality as a platform for developing both online and offline relationships, especially as virtual reality becomes increasingly viable and accessible in mainstream society.

Conclusion

Social scientists have recently begun to explore the fruitful intersection of close relationships research and virtual reality. With its ability to be used both as a tool for studying close relationship processes, and as a means of forming and maintaining relationships, the use of virtual reality holds great potential for future research. The studies conducted so far at the intersection of adult attachment theory, virtual reality, and neuroscience provide both promising results and far-reaching implications for deepening our understanding of how relational processes work, especially in an increasingly digital society.

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