



Articles

Your Responses Guide Me: Decreased Attachment Anxiety Through an Online Relationship-Building Paradigm

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Abstract

This study aims to improve self-reported attachment anxiety and avoidance through an online relationship-building paradigm. Seventy-seven undergraduate participants completed an online attachment-focused paradigm in which they developed a relationship with a virtual partner, and fifty participants successfully completed a second laboratory-based phase of the study. During the online phase, all participants completed the Experiences in Close Relationships—Revised questionnaire (ECR-R), the experimental group engaged in an interactive relationship-formation story with a virtual partner designed to enhance secure attachment, and control participants engaged in the program without guidance. Participants then visited the laboratory, were asked to recall the online interaction, and again completed the ECR-R. Overall, participants exhibited a significant decrease in their attachment anxiety, but not avoidance; however, change in attachment security did not differ based on study group. Change in the experimental condition was attributed to the secure focus of the guided interaction with the virtual partner. Change in the control condition, on the other hand, was attributed to general relationship practice and behavioral principles of operant conditioning. These results provide preliminary evidence for the effect of a virtual practice relationship on attitudes towards real-life attachments to significant others.

Keywords: anxiety, attachment, avatar, avoidance, online, relationships

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Successful romantic relationships are vital for human well-being (Be, Whisman, & Uebelacker, 2013), contributing to both psychological and physical health (Braithwaite, Delevi, & Fincham, 2010). However, support for individuals experiencing romantic relationship discord is often provided via marriage counseling, which may be lengthy and unavailable to diverse cultural and socioeconomic groups (Gaubert, Gubits, Alderson, & Knox, 2012). Recently, relationship conflict interventions have been adapted through electronic means for easy dissemination and access. For instance, Doss and colleagues (2016) tested an online program designed to improve couples' relationships via activities and tailored feedback. The 8-hour program improved relationship satisfaction and other measures of well-being. However, since over 30 percent of young adults are not in committed romantic relationships (Scott, Steward-Streng, Manlove, Schelar, & Cui, 2011), addressing individuals' *general* romantic relationship patterns might both improve current relationship satisfaction for partnered individuals and enhance the formation and maintenance of future relationships for single individuals. Examining relationships through the lens of attachment theory (Bowlby, 1969), the present study aims to foster adaptive attitudes towards romantic relationships through practice with a virtual partner.

Attachment Theory

Originally developed in the middle of the 20th century from an evolutionary framework, attachment theory attempts to explain close relationship behavior across the lifespan (Bowlby, 1969, 1982). According to Bowlby, a child's experiences with seeking proximity toward a caregiver and the caregiver's responsive behavior (or lack thereof) are sources of information that mold the child's working models of the interpersonal environment and the child's own capabilities (Bowlby, 1982). These models of self and other are detailed, foundational ways of defining one's own abilities and personality and explaining others' behaviors. Yet, as the term "working" suggests, these models are flexible enough to be modified by stimuli that do not fit into an extant framework (Mikulincer & Shaver, 2007a).

In the late 1980s, Hazan and Shaver (1987) theorized that adult relationships could be described according to similar working models of self and other. They posited that attitudes in romantic relationships reflected attachment styles formed in childhood. As in children, attachment behavior in adults involves seeking proximity to a significant other, and that other's responses influence the security or insecurity of internal relational schemas (Fraley & Shaver, 2008; Mikulincer & Shaver, 2007a).

In an attempt to elucidate gradations in the adaptiveness of relational schemas, Bartholomew (1990) placed models of self and other along two distinct axes, each with varying levels of positivity. Brennan, Clark, and Shaver (1998) summarized factor analytic data from 1,086 participants suggesting that positive models of self and other indicate secure attachment styles, whereas increasingly negative models of self suggest increased attachment anxiety and increasingly negative models of others suggest increased attachment avoidance. Individuals who score high on either the anxious (self) or avoidant (other) axis can be considered to have an "insecure" attachment schema. Securely attached adults are interdependent with their partner and see interactions with others as experiences conducive to positive change. Anxious adults fear abandonment and cling to romantic partners. They are also easily disappointed and often worried, especially in relationship contexts. Avoidant individuals tend to shun intimacy with others, preferring isolation and often lacking empathy, caring, or other attributes designed to enhance interpersonal interaction (Mikulincer & Shaver, 2007a).

Secure attachment has been linked to adult interpersonal functioning and relationship quality. Securely attached adults are more able to trust and to be kind, sensitive, empathetic, compassionate, and open (Collins & Read, 1990; Kuncle & Shaver, 1994; Lopez & Brennan, 2000; Mallinckrodt, Porter, & Kivlighan, 2005; Mikulincer, 1997; Mikulincer & Orbach, 1995; Rogers, 1961) than those with high levels of attachment anxiety or avoidance. They show love and forgiveness, feel connected, commit to altruistic and ethical behavior, and have a generally positive view of others (Lopez & Brennan, 2000; Mikulincer et al., 2003; Mikulincer & Shaver, 2003, 2007a; Mikulincer, Shaver, Gillath, & Nitzberg, 2005). Secure attachment promotes stronger feelings of safeness, resiliency, optimism, hopefulness, positivity, curiosity, positive self-esteem, and the absence of personality disorders (Levy, Johnson, Clouthier, Scala, & Temes, 2015; Lopez & Brennan, 2000; Mikulincer & Shaver, 2005). All in all, attachment security appears to undergird successful interpersonal and romantic relationship interactions, and fostering attachment security has the potential to improve individuals' relationships with others.

Influencing Attachment

Although some literature exists on long-term and intensive interventions for altering attachment styles (Cicchetti, Rogosch, & Toth, 2006; Levy et al., 2006; Travis, Bliwise, Binder, & Horne-Moyer, 2001), the preponderance of research on modifying attachment has focused on short-term outcomes. These studies have consistently shown that attachment schema and associated processes can be activated and influenced via subliminal priming. Laboratory-based priming paradigms have been linked to brief changes in security-related constructs, such as increased empathy (Mikulincer, Gillath, et al., 2001), altruism (Gillath, Shaver, & Mikulincer, 2005; Mikulincer et al., 2005), self-worth (Baccus, Baldwin, & Packer, 2004), and openness to new experiences (Mikulincer, Hirschberger, Nachmias, & Gillath, 2001), and decreased fear of relationship threat (Gillath & Shaver, 2007). Dandeneau, Baldwin, Baccus, Sakellaropoulou, and Pruessner (2007) used facial expressions as secure primes over five consecutive days to decrease levels of stress and increase self-esteem in a group of college students after a final examination at the end of the five-day period. Sohlberg and Birgegard (2003) succeeded in producing improvements in mood in Swedish college students through security priming, which lasted over a week (see Gillath, Selcuk, & Shaver, 2008, and Mikulincer & Shaver, 2007b, for reviews).

These studies used stimuli associated with attachment security (e.g., security-related words) to effect changes in secondary positive variables such as compassion. However, fewer studies have attempted to experimentally modify underlying attachment models themselves (Gillath, McCall, Shaver, & Blascovich, 2008). In one such study, Pierce and Lydon (1998) subliminally primed undergraduate students with words related to both secure (e.g., *supportive*) and insecure (e.g., *distant*) styles of attachment. Securely primed participants reported an increased willingness to engage in secure attachment behavior than those in the insecure condition. Rowe and Carnelley (2003) examined recall of attachment-related words, affect, and expectations in close relationships after a writing task used to supraliminally prime specific attachment styles. Undergraduates were randomly assigned to write about a secure, avoidant, or anxious-ambivalent relationship with a significant other that they had previously identified. Participants who wrote about secure relationships reported more secure expectations and had less negative affect after the task than the other two groups. The authors found that these differences remained significant after a two-day delay in a second undergraduate sample (Carnelley & Rowe, 2007). Interestingly, the authors also found trend-level decreases in self-reported attachment anxiety, but not avoidance, in this sample. In sum, these studies suggest that individuals' attachment schema may be modifiable via secure attachment stimuli and that these changes may last beyond momentary measurement in the laboratory setting.

One major limitation to the priming research outlined above is that these studies have required participants to be physically present in a laboratory setting. A security priming procedure that can be widely delivered, such as via the internet, has significant advantages over traditional priming tasks. Such paradigms are highly affordable, broadly accessible to diverse populations, and may be especially relevant given the frequency of social interactions that now occur through technological means.

To our knowledge, only two studies have attempted to influence attachment processes remotely via technology. Carnelley, Otway, and Rowe (2016; Otway, Carnelley, & Rowe, 2014) have recently examined the efficacy of a text-based priming paradigm administered via mobile phones. These studies showed significant effects of priming attachment security compared to a neutral prime. However, these studies did not involve a social interactive component. Recent research has suggested that attachment styles play an important role in

individuals' use of online social environments, such as Facebook (Jenkins-Guarnieri, Wright, & Hudiburgh, 2012; Oldmeadow, Quinn, & Kowert, 2013). Relatedly, a body of literature has indicated that virtual environments mirror real-world environments in terms of social interactions (Jarrett, 2009; Reeves et al., 2007; Yee, Bailenson, Urbanek, Chang, & Merget, 2007), suggesting their utility in terms of practice arenas for real-world interactions. In fact, many individuals may now seek out virtual environments in order to initiate or form relationships with others (McKenna, Green, & Gleason, 2002; Yee, 2006). Technologically-mediated social interactions provide the individual the ability to transform or modify natural styles of interaction in ways not afforded by real-world interactions. In what they termed the "Proteus Effect," Yee and Bailenson (2007) found that participants' virtual appearance (represented by a computer generated "avatar") influenced how they interacted with others in the virtual world. Others have suggested that individuals attempt to portray their *ideal* self when online in order to facilitate romantic relationship formation (Ellison, Heino, & Gibbs, 2006). Clearly the flexibility of the virtual environment provides individuals a place to present certain aspects of themselves and not others and strive for a more ideal self-representation. However, it is unknown whether practice interacting in new ways—for instance, insecurely attached individuals engaging in secure romantic relationship behavior with a virtual partner—may provide sustainable changes in attitudes towards real-life relationships. The present study aims to shed light on this gap in the literature.

In 2007, Vicary and Fraley (2007) developed an online interactive relationship formation paradigm in order to assess individuals' romantic attachment styles. The authors presented participants with a series of twenty scenarios with a virtual partner with two decisions at each scenario that produce different responses from the partner. The scenarios were designed to imitate real-world situations in which a decision would need to be made regarding advancing (or hindering) a relationship with a significant other. Participants' scenario choices were recorded and then used to assess their respective styles of attachment. Attachment anxiety and avoidance were accurately measured by the paradigm when compared to scores on the Experiences in Close Relationships-Revised (ECR-R; Fraley, Waller, & Brennan, 2000) questionnaire, a validated measure of adult attachment. Interestingly, Vicary and Fraley found preliminary evidence that virtual relationship-building may shift attachment patterns, as they found increases in participants' selections of relationship-promoting choices during the paradigm. These increases persisted regardless of the preexisting attachment style of the participants. However, Vicary and Fraley did not attempt to directly promote secure attachment behaviors through guided decision options, nor did they reassess attachment schema after the paradigm to ensure alterations of attachment were not simply momentary response biases but were in fact generated through an influence on self-schema. More specifically, Mikulincer and Shaver (2007a) have suggested that successfully forming a *positive* relationship with a romantic partner can restructure maladaptive working models and increase attachment security. Therefore, the present research adapts the design of Vicary and Fraley by allowing participants the opportunity to experience and practice forming a successful relationship with a virtual partner with the goal of motivating lasting improvement in attachment attitudes.

Objectives and Hypotheses

The primary goal of the present study is to effect change in maladaptive attitudes toward interpersonal relationships, specifically attachment anxiety and avoidance, using an easily accessible and readily modifiable online interactive paradigm. Virtual paradigms provide several benefits over traditional lab-based or in-person primes: They are generally affordable, they are easy to disseminate (including to remote populations), and they allow participants the ability to flexibly change aspects of their self-representation and behave in new ways

without the physical and mental limitations of real-world interactions. The results of the present study may foster the use of adaptable online interventions for a variety of interpersonal skills training and for successful relationship formation.

Based on the research outlined above, we offer the following specific hypotheses: First, participants who practice forming a successful relationship with a virtual partner will report significant decreases in attachment anxiety on the ECR-R scale. It is unclear whether or not attachment avoidance will change post-manipulation: [Carnelley and Rowe \(2007\)](#) found no declines in avoidance after their writing priming study, but [Vicary and Fraley \(2007\)](#) found increased relationship-promoting behavior in both anxiously and avoidantly attached adults. Thus, we explore avoidance-related changes in attachment via the paradigm but do not make a directional hypothesis. Second, decreases in attachment insecurity are hypothesized to be significantly greater in the experimental condition than changes reported by a control group that engages in the online program without a secure attachment focus.

Method

Participants

A total of 100 students from a mid-sized southeastern United States private university were recruited from the university's undergraduate population via three methods: 1) Recruitment flyers were posted across the campus on publicly available bulletin boards in both academic and non-academic buildings (e.g., cafeterias). 2) Three randomly selected departments from each of the humanities (English, History, and Theater), "hard" sciences (Chemistry, Biology, and Physics), and social sciences (Anthropology, Sociology, and Political Science) were selected, and within these two classes were randomly selected for class visits for recruitment into the study by the research staff. 3) Finally, a recruitment email with a brief description of the study and access to the online portion of the study itself was sent out to the entire undergraduate body enrolled during the spring semester. Recruitment materials described the study as testing a "newly-developed virtual interaction story" in which the participant would "create [their] own adventure story with a virtual partner" and would help "improve current understanding of human interaction." Seventy-seven participants completed the online portion of the study (Phase I) and 50 completed both Phase I and Phase II ([Figure 1](#)). Demographic information and mean attachment subscale scores at each time point are displayed in [Table 1](#). The sample was ethnically diverse, although participants were predominantly female at both time points.

Inclusion Criteria

Participants were eligible for the study if they were currently registered undergraduate students, had access to a computer with an internet connection, and indicated willingness to participate after reading an information sheet presented online (Phase I) and who signed an informed consent form in person (Phase II). All study procedures were approved by the university's Institutional Review Board.

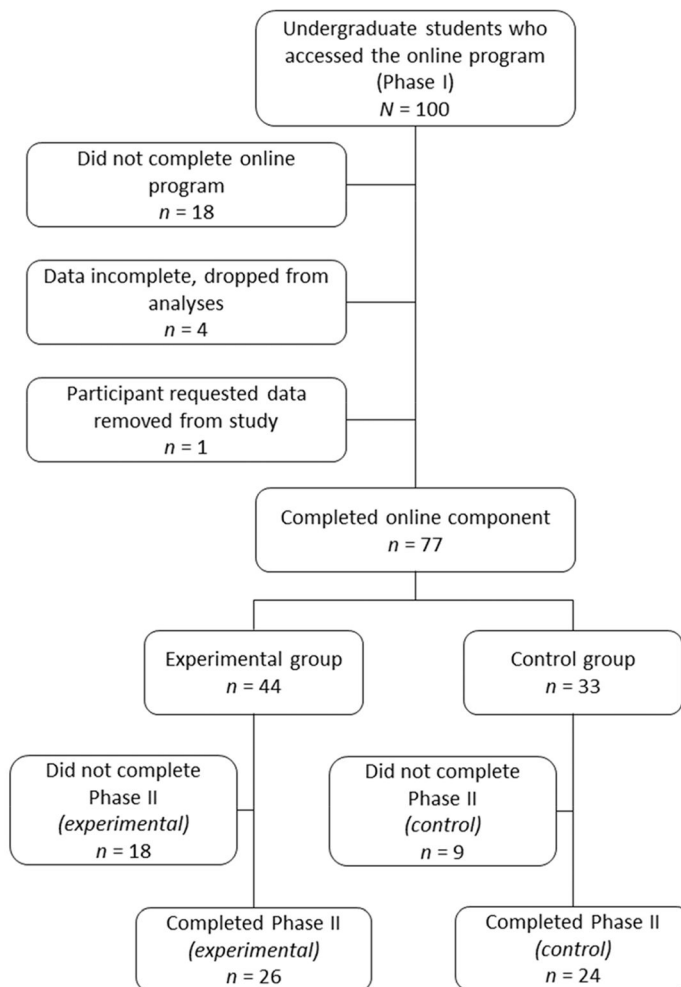


Figure 1. A Consolidated Standards of Reporting Trials (CONSORT) diagram showing participant flow through all phases of the study.

Virtual Attachment Manipulation Paradigm

The study employed a mixed-model experimental design that was divided into two components: an online virtual program and a post-test laboratory visit. The interactive adventure portion of the online program was designed to promote attitude change in attachment security through practice of a secure romantic relationship with a virtual partner. The current research extended [Vicary and Fraley's \(2007\)](#) paradigm in order to increase participants' access to internalized secure attachment representations. Similar to Vicary and Fraley's program, the current study's paradigm first allowed participants to select the name and gender of their virtual partner, increasing how much they could customize and identify with the story. Participants were then prompted with one of twenty consecutive story-based paragraphs each describing an interaction with their virtual partner. After each paragraph, participants were presented with three possible behavioral or speech actions, which, when selected, would generate a tailored response from the virtual partner. Each juncture's decision items were presented in random order. The twenty scenarios were designed to be stages of a fictional storyline in which the participant was approached by a classmate, whom he or she did not yet know well, who invited them on a week-long vacation during an academic break. Each scenario depicted a possible interactive choice-point along

this storyline. For example, the participant might be asked to choose among three options to respond to their partner's expression of worry at dinner about financial difficulties in their life.

Table 1

Participant Demographics and Attachment Data

	Group					
	Phase I			Phase II		
	Experimental (<i>n</i> = 44)	Control (<i>n</i> = 33)	Total (<i>n</i> = 77)	Experimental (<i>n</i> = 26)	Control (<i>n</i> = 24)	Total (<i>n</i> = 50)
Demographics and Attachment Styles						
Gender: <i>n</i> (%)						
Female	32 (72.7)	24 (72.7)	56 (72.7)	21 (80.8)	18 (75.0)	39 (78.0)
Male	12 (27.3)	9 (27.3)	21 (27.3)	5 (19.2)	6 (25.0)	11 (22.0)
Race: <i>n</i> (%)						
American Indian or Alaskan Native	1 (2.3)	0 (0.0)	1 (1.3)	0 (0.0)	0 (0.0)	0 (0.0)
Asian	12 (27.3)	7 (21.2)	19 (24.7)	8 (30.8)	6 (25.0)	14 (28.0)
Black/African American	7 (15.9)	5 (15.2)	12 (15.6)	3 (11.5)	4 (16.7)	7 (14.0)
Hispanic/Latino/Latina	2 (4.5)	0 (0)	2 (2.6)	2 (7.7)	0 (0)	2 (4.0)
White/Caucasian	22 (50.0)	20 (60.6)	42 (54.5)	13 (50.0)	13 (54.2)	26 (52.0)
Unknown	0 (0.0)	1 (3.0)	1 (1.3)	0 (0.0)	1 (4.2)	1 (2.0)
Romantic Relationship Status: <i>n</i> (%)						
Current relationship	16 (36.4)	11 (33.3)	27 (35.1)	10 (38.5)	9 (37.5)	19 (38.0)
No current relationship, but relationship history	17 (38.6)	15 (45.5)	32 (41.6)	10 (38.4)	11 (45.8)	21 (42.0)
No relationship history	11 (25.0)	7 (21.2)	18 (23.4)	6 (23.1)	4 (16.7)	10 (20.0)
Age, Attachment Anxiety, Attachment Avoidance: <i>M</i> (<i>SD</i>)						
Age	19.88 (1.18)	19.85 (1.35)	19.87 (1.25)	20.00 (1.26)	19.92 (1.14)	19.96 (1.19)
Attachment Anxiety	3.49 (1.26)	3.67 (1.39)	3.36 (1.29)	3.08 (1.06)	3.26 (1.34)	3.16 (1.19)
Attachment Avoidance	3.04 (1.31)	3.02 (1.20)	3.05 (1.24)	3.16 (1.38)	2.94 (1.23)	3.06 (1.30)

Note. Because of rounding, percentages may not sum to 100.

Participants were randomly assigned into an experimental or control group upon accessing the online program. In the control condition, the three decision items at each juncture were designed to reflect secure (i.e., the absence of anxiety and avoidance), anxious, and avoidant attachment, instead of simply the secure and insecure choices used by Vicary and Fraley, in order to increase similarity to real-world decisions and examine independent changes in attachment anxiety and avoidance. The virtual partner responded to participants' secure decisions in a way that indicated improvement of the interpersonal relationship, whereas the partner responded to insecure decisions in a way reflective of distancing or rupture in the relationship (see [Appendix A](#) for example control condition scenarios). A battery of participant decision items was generated by the first author in a theory-driven, a priori fashion. These were then rated independently by three researchers (including the first and second author) versed in attachment theory and/or having published in the area of attachment research. Each rater assigned each item as reflective of "secure attachment," "anxious attachment," "avoidant attachment," or "none at all." Items that were unanimously rated as indicative of a specific attachment pattern were used in the present study. Subsequently, possible responses to adventure scenarios were rated in terms of their respective attachment styles (secure, anxious, or avoidant) by an independent rater versed in attachment theory and unassociated with the present research. These ratings reflected 100% agreement with

the consensus ratings ($\kappa = 1.00$), further confirming the reliability and accuracy of the online paradigm response choices.

The experimental condition included three options at each juncture, each associated with secure attachment. Selecting any of these would lead towards a successful relationship with the virtual partner. A supportive and caring romantic partner can facilitate an individual's own secure attachment attitudes (Mikulincer & Shaver, 2007b; Vicary & Fraley, 2007). Therefore, the virtual partner in the experimental condition responded to participants' selections in a secure way in order to encourage participants' own attachment security through repeated exposure to secure attitudes (see Appendix B for example experimental condition scenarios). Therefore, while the control participants were given the range of attachment schemas upon which to base their decisions, the experimental condition guided participants through a positive relationship with their online partner. Although we allowed the possibility for control participants to act in a way identical to experimental group participants (i.e., the secure option for the control group was included among the experimental response options), potentially minimizing the difference in group effects, we hypothesized that control group participants would rather make choices consistent with their baseline attachment schema, since the social conventions of the virtual world tend to match those of the real world (Yee & Bailenson, 2007).

Measures

The Experiences in Close Relationships—Revised Questionnaire

The primary outcome measure used in this study was the Experiences in Close Relationships—Revised questionnaire (ECR-R; Fraley et al., 2000). The questionnaire consists of 36 items that measure two domains of attachment: anxiety and avoidance. Each item is measured on a Likert scale of 1 (*Strongly Disagree*) to 7 (*Strongly Agree*). Anxiety is measured by items such as: "I'm afraid that I will lose my partner's love." Avoidance is measured by items such as: "It's not difficult for me to get close to my partner" (reverse coded). The average of the 18 anxiety items and the average of the 18 avoidance items give two independent scores for each type of attachment insecurity. Studies have shown that this measure has very high internal consistency for both independent axes ($\alpha_{\text{anx}} = .95$, $\alpha_{\text{avd}} = .93$; Sibley & Liu, 2004), and the current research supported these findings ($\alpha_{\text{anx}} = .94$, $\alpha_{\text{avd}} = .95$).

Procedure

The study was comprised of two parts: the online program, which participants could complete from any computer with internet access, and a lab component conducted in a research laboratory on the university's campus. The online program was divided into three sections: demographics, the ECR-R, and the interactive adventure paradigm described above.

After completing the online program, participants were asked to visit the lab approximately one week later to complete a variety of behavioral tasks as part of a separate study. While the average number of days between the online program completion and the lab visit was 6 days, scheduling difficulties resulted in a range of 1 to 26 days between sessions (see Results). During the laboratory visit, participants were interviewed by a researcher regarding their experiences with the online paradigm. Participants were asked to describe the relationship they had formed with their virtual partner. This component of the study facilitated representational priming, allowing participants to "self-prime" based on their preexisting experience with the online partner. Specifically, as participants in the experimental condition engaged in a guided secure interaction with their virtual partner, a

secure relationship representation would be activated for individuals in this group, while control participants would have activated a mental representation characterized by a diversity of secure and insecure interactions with their virtual partner. It is important to note that, whereas previous research has primed participants directly with attachment-relevant stimuli, we purposely wished to avoid such specific priming, choosing to utilize pre-existing attachment schemas that were activated during the online paradigm. This was designed to ensure that the manipulation both was self-congruent and produced change in internal attachment schema. After recalling their experience in the online program, participants then again completed the ECR-R.

As compensation for their time, participants were entered into a lottery for a \$50 gift card, awarded to three randomly selected individuals at the completion of the study.

Data Analysis Plan

Analyses were divided into two sections: Analyses of baseline participant characteristics were conducted on the “intent to treat” sample—those who were randomized and completed the ECR-R and online interaction program but who may not have returned for the post-test portion of the study ($n = 77$). We report Pearson product-moment correlations between the anxious and avoidant ECR-R subscales and analyze the relations between ECR-R subscales and the proportion of secure paradigm response options selected by control participants via linear regression. We also examined differences between experimental and control conditions in style of response options via repeated measures ANOVA (using a Greenhouse-Geisser correction for heteroscedasticity as appropriate). Finally, logistic regression was used to evaluate the likelihood of control participants to select a secure response over time, as a comparison with results from [Vicary and Fraley \(2007\)](#).

Data from study completers ($n = 50$) were used for analyses of the effect of the program. Before testing the first study hypothesis, we ran a manipulation check to determine distinction between the experimental and control versions of the online program. Participants’ verbal unguided descriptions of the relationship with their virtual partner were coded categorically (yes/no) independently by both the first and second authors (blind to condition) in terms of hypothesized group membership. These ratings were made based on a combination of two facets: 1) mention of negative aspects of the partner, interaction, or relationship (control condition), and 2) mention of participant’s ability to respond in both positive and negative ways (control condition). Reliability between ratings was acceptable ($\kappa = .74$). Ratings successfully discriminated the experimental and control conditions, $\chi^2_{\text{rater1}}(1, N = 50) = 21.08, p < .001$, $\chi^2_{\text{rater2}}(1, N = 50) = 35.24, p < .001$, suggesting participants clearly responded differently to the two study conditions.

In order to ensure that participants were engaged in the paradigm itself, we also rated participants’ descriptions of the paradigm in terms of level of engagement, based on four facets: 1) participant mentioned interest in or enjoyment of paradigm, 2) participant mentioned negative affect in relation to partner’s responses (e.g., “Bob was like, ‘No, I’m really tired’ and that was sad.”), 3) participant mentioned goal-oriented behavior in terms of virtual interactions (e.g., “How am I going to get with this chick virtually?”), and 4) participant mentioned identifying with the character or interaction (e.g., “I was trying to think like, ‘Oh, if this were actually me in real life, this is what I would say’”). Interrater reliability of these codes was acceptable ($\kappa = .70$), and potentially attenuated due to the high proportion of participants who reported engagement in the virtual interaction. Across conditions, 82-88% of participants reported engagement in the paradigm, with no significant difference between

groups, $\chi^2_{\text{rater1}}(1, N = 50) = 0.95, p = .47$, $\chi^2_{\text{rater2}}(1, N = 50) = 2.68, p = .19$, suggesting that participants in both conditions reported engagement with the virtual partner and the online interaction.

To test the main hypotheses, we examined decreases in attachment anxiety and avoidance in the experimental group with a paired samples *t*-test of the experimental group and compared change in attachment between groups via a mixed factorial ANOVA. We also attempted to determine if any demographic variables (gender, race, or relationship status) predicted change in attachment attitudes via independent samples *t*-tests (gender, relationship status) and one-way ANOVA (race) in order to better contextualize study findings. Finally, in order to ensure that delay between the online program and the laboratory visit did not produce (or attenuate) change in attachment insecurity, we examined correlations between delay and pre/post changes in ECR-R subscales.

Results

Online Program (Pre-Test Analyses)

The online ECR-R subscales were significantly correlated, $r(75) = .48, p < .001$. The moderate correlation is consistent with previous research and confirms that these subscales, while related, measure different components of attachment behavior and attitudes. Given this overlap, however, the other attachment subscale is controlled for in subsequent analyses of change in attachment. There was no significant difference between the control and experimental groups in baseline levels of attachment anxiety, $t(48) = 0.49, p = .63, d = 0.14$, or avoidance, $t(48) = -0.056, p = .96, d = 0.016$, indicating the success of the randomization procedure.

As expected, attachment anxiety was strongly negatively associated with the proportion of secure responses selected in the control version of the interactive program, $b = -0.10, t(31) = -3.88, p = .001, R^2 = .33$, and strongly positively associated with the proportion of anxious responses selected, $b = 0.76, t(31) = 3.64, p = .001, R^2 = .30$, but not associated with the proportion of avoidant responses selected, $b = 0.02, t(31) = 1.77, p = .09, R^2 = .09$ (Figure 2).

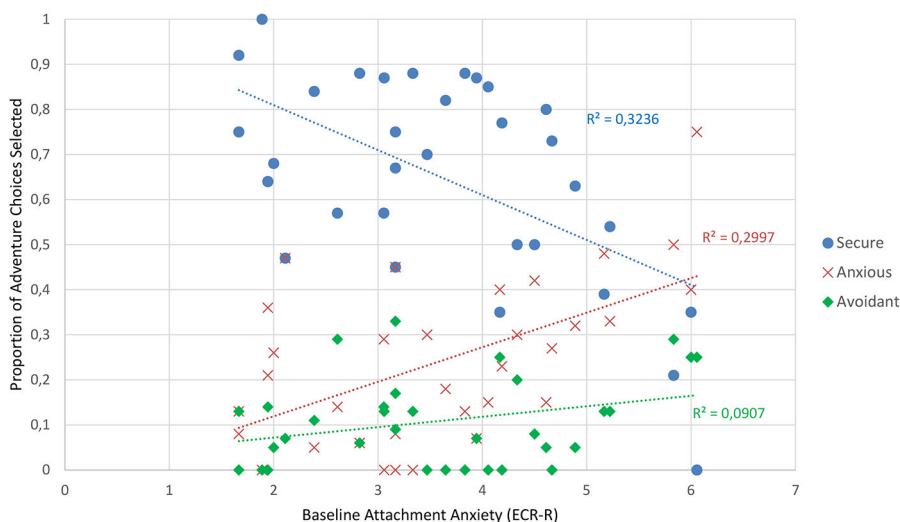


Figure 2. Proportion of adventure choices selected as a function of control participants' baseline attachment anxiety scores.

Similarly, attachment avoidance was moderately negatively associated with the proportion of secure responses selected by control participants online, $b = -0.07$, $t(31) = -2.15$, $p = .04$, $R^2 = .13$, and moderately positively associated with the proportion of avoidant responses, $b = 0.35$, $t(31) = 2.36$, $p = .03$, $R^2 = .15$, but not associated with the proportion of anxious responses selected, $b = 0.04$, $t(31) = 1.35$, $p = .19$, $R^2 = .06$ (Figure 3). These results reveal that participants tended to choose adventure options consistent with their own attachment styles, further indicating that control participants engaged with the virtual partner as they might in their everyday life.

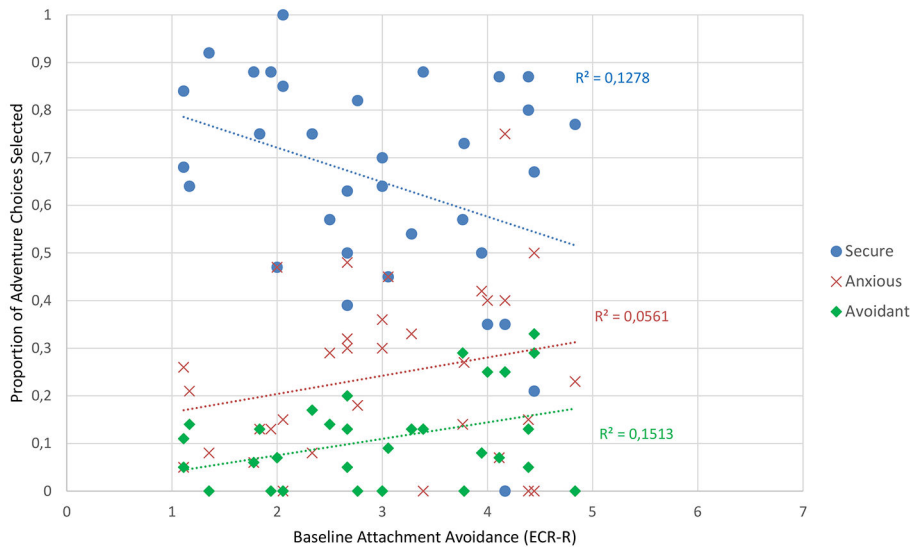


Figure 3. Proportion of adventure choices selected as a function of control participants' baseline attachment avoidance scores.

Control group participants selected secure adventure options significantly more often than either anxious or avoidant choices, $F(2, 32) = 180.17$, $p < .001$, $\eta_p^2 = .90$, suggesting the relatively well-adjusted nature of this specific study sample. Importantly, there was a significant increase in the likelihood of selecting a secure choice over time, such that at each juncture, the log odds of selecting a secure option increased by .083, $\text{Wald}(1, N = 33) = 31.18$, $p < .001$, $OR = 1.09$ (Figure 4). In other words, control group participants were on average nearly 10% more likely to respond in a secure fashion at each subsequent choice-point in the online program.

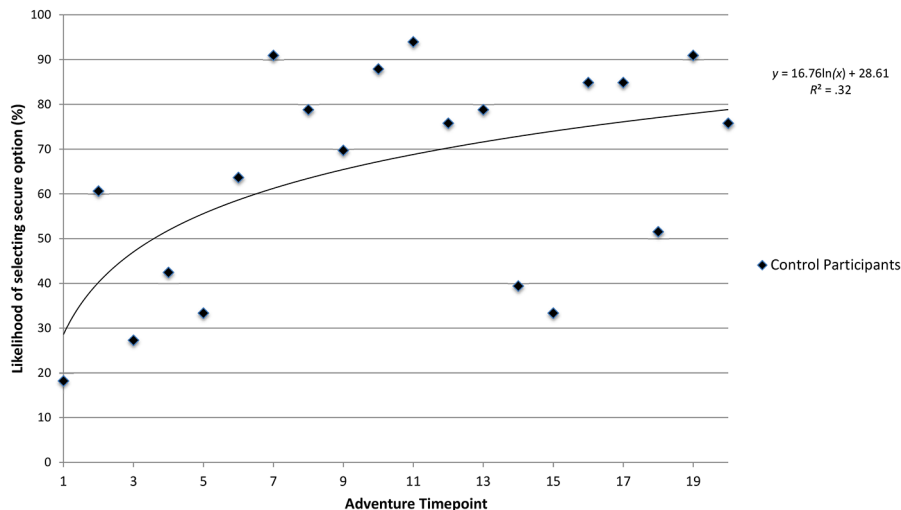


Figure 4. Scatterplot of control participant adventure data, showing likelihood of selecting a secure relationship choice regressed on adventure time point.

Laboratory Visit (Post-Test Analyses)

There was no significant difference between participants who completed the study and those who only completed the online component on age ($t(74) = -0.85, p = .40$), gender ($\chi^2(1, N = 77) = 1.31, p = .25$), race ($\chi^2(4, N = 76) = 3.94, p = .41$), and either current ($\chi^2(1, N = 77) = 0.23, p = .63$) or historical ($\chi^2(1, N = 77) = 0.45, p = .50$) dating status. There was a significant difference in attachment anxiety between groups, such that those who completed the study had higher levels of baseline anxiety than those who did not, $t(75) = -2.11, p = .038$. This finding raised some concern of regression to the mean producing any subsequent experimental effects. However, the mean anxiety score ($M = 3.58$) and standard deviation ($SD = 1.31$) of the completer sample resembled population norms ($M = 3.56, SD = 1.12$; Fraley, 2012), suggesting that regression to the mean would not produce the appearance of study effects in this sample. There was no difference in levels of baseline attachment avoidance between groups, $t(75) = 0.14, p = .89$. The average length of time between completion of the online program and the lab visit was 5.92 days ($SD = 4.28$; median = 6.0, range = 1 to 26).

In tests of the main study hypotheses, the experimental group showed a significant decrease in attachment anxiety after the online program, $t(25) = 4.69, p < .001, d = 1.03$, but no decrease in attachment avoidance, $t(25) = -0.96, p = .35, d = 0.19$, and there was no significant difference between the two study groups on either change in anxiety scores, controlling for baseline avoidance, $F(1, 47) = 0.39, p = .54, \eta_p^2 = .008$, or change in avoidance scores, controlling for baseline anxiety, $F(1, 47) = 0.49, p = .49, \eta_p^2 = .010$, from pre-test to post-test. A post-hoc power analysis determined the power of these tests to be .92 and .91, respectively, suggesting non-significance was not due to a small sample size. However, there was a significant decrease in anxiety from pre- to post-test for the entire sample, $t(49) = 6.17, p < .001, d = 0.90$. This decrease was not carried solely by the experimental group, as there was also a significant decrease in the control group, $t(23) = 4.00, p = .001, d = 0.82$. There was no significant change in avoidance from pre- to post-test for the control group, $t(23) = 1.00, p = .33, d = 0.21$. There was no association between the delay in completing the post-test laboratory visit and change in anxiety, with ($r(48) = -.18, p = .22$) or without ($r(46) = -.018, p = .90$) the outlier cases, which fell at 19 and 26 days of delay, suggesting that decreases in anxiety were stable regardless of the amount of time between the relationship-formation program and follow-up testing.

Prior to interpreting the effectiveness of the intervention, we examined potential differences in attachment insecurity and change by demographic variables. There were no differences by gender or race on either attachment anxiety or avoidance pre- or post-manipulation or on changes in attachment ($p > .10$). Participants who reported having been in a romantic relationship at some time (either past or present) were significantly less anxious and less avoidant than participants who had never dated before, both before and after the intervention ($p < .01$) but did not differ in terms of change in attachment styles ($p > .45$). More specifically, those who were currently in a relationship were less anxious and avoidant than participants who were not currently dating, even if they had been in a relationship in the past at both time points ($p < .02$), but again not in terms of change in attachment ($p > .90$). Given that relationship status appeared to be associated with general attachment security, but did not facilitate (or impede) attachment style change through the current intervention, results are interpreted across all participants regardless of relationship status.

Discussion

The present study attempts to fill a gap in the attachment manipulation literature by examining the effect of forming a positive, secure relationship with a virtual partner on participants' attachment anxiety and avoidance. In utilizing an interactive online paradigm, this study harnesses the flexibility of individuals' virtual behaviors and self-representations in order to attempt to modify underlying schema about close relationships, while also aiming to provide a foundation for a highly adaptable, affordable, and easily distributed framework for positive relational skill-building.

The first main hypothesis predicted that experimental group participants would show a decrease in attachment anxiety as measured by the ECR-R after completing the relationship-building program. This hypothesis was supported by the data, as analyses showed a decrease in anxiety after the online program. We found no significant change in attachment avoidance after the program, consistent with the findings of [Carnelley and Rowe \(2007\)](#). The second hypothesis, however, was not supported by the data, as there was no significant difference between study groups on change in ECR-R anxiety scores from pre- to post-test.

Analysis of the manipulation check suggested that participants in the experimental condition did perceive their interaction with the virtual partner as more positive than controls. Thus, since both groups showed decreases in anxiety, we propose different mechanisms of change at work in each group. For the experimental group, in line with the literature reviewed above, practice of a secure relationship with a virtual partner appears to have accessed underlying attachment schema, allowing individuals to practice adaptive behaviors and decrease their reported levels of attachment anxiety. Similar to the paradigm utilized by [Vicary and Fraley \(2007\)](#), the program in the present study created the impression of a real-life relationship, thus allowing participants' views on romantic attachment to translate from the virtual world into their everyday life.

The decrease in attachment anxiety in the control group is perhaps explained in light of considerations of [Mikulincer and Shaver \(2007b\)](#), who report that a simple imaginary encounter with a supportive dating partner may lead to decreases in attachment insecurity. Furthermore, [Gillath and Shaver \(2007\)](#) point out that the quality of a relationship context may guide responses to relationship-specific scenarios, such that positive relationships may lead to secure behavior, and negative to insecure. Supplementary analyses of the control condition suggested that participants' likelihood of selecting a secure adventure choice increased as they

continued through the paradigm. These findings resemble those of [Vicary and Fraley \(2007\)](#) who found steady increases in the number of relationship-enhancing options selected over time in their “Choose Your Own Adventure” attachment paradigm. The ability of control group participants in our study to engage in a positive relationship with the virtual partner may have increased their own likelihood of participating in secure behaviors, based on behavioral principles of reward and punishment ([Catania, 2011](#); [Skinner, 1938](#)) and in line with [Gillath and Shaver’s \(2007\)](#) proposition. The control condition was designed to simulate attachment-based real-world interactions, such that positive actions on the part of the participant generated intimacy-increasing responses and negative actions generated intimacy-decreasing responses. Therefore, positive responses from the partner may have reinforced secure selections, while negative responses may have punished anxious or avoidant choices. This may explain the similarity in attachment anxiety decrease in the control and experimental groups, although from a different underlying impetus.

The current study found changes in self-reported attachment anxiety over an average delay of six days between pre-test and post-test measures. In addition, improvements in attachment anxiety showed no decrease with the length of the delay, indicating that the effects of the online program may be able to be primed beyond the time frame included in this study. These findings suggest that representations of virtual partners may have similar effects on individuals’ adaptive relationship attitudes as prior laboratory-based priming research ([Carnelley & Rowe, 2007](#); [Pierce & Lydon, 1998](#); [Rowe & Carnelley, 2003](#)).

Our study found no decrease in attachment avoidance from pre-test to post-test. This finding is consistent with at least two studies that failed to find changes in attachment avoidance after a security-focused manipulation ([Carnelley & Rowe, 2007](#); [Lavi, 2007](#)). [Schindler, Fagundes, and Murdock \(2010\)](#) suggest that those who are avoidantly attached tend to be more hesitant to form a committed relationship with a partner than secure or anxiously attached individuals. In our sample, it is possible that, unlike for anxious attachment, avoidant attachment schemas were not effectively activated by the virtual relationship-building program or the representational priming procedure. Given that avoidant attachment is characterized by a tendency to withdraw from intimacy, the guided virtual relationship and the supportive responses of the virtual partner may have been insufficiently immersive to access avoidant attachment schema.

The current study extends the existing body of attachment priming literature by providing preliminary support for the use of internet-based paradigms for encouraging attachment security. Use of the internet for social interactions, such as through social media websites like Facebook, has increased dramatically over the past decade. Thus, online relationship-promoting interactive programs may be well-situated to help a range of individuals experiencing relationship difficulties. Although the present study focused solely on short-term effects on self-reported attachment schemas, future research should test similar paradigms to both produce long-term modifications in insecure attachment patterns and examine behavioral changes in attachment security, as our study focused on attitudinal change.

Limitations

The present study is limited in several ways. Allowing control participants the option of choosing secure responses reduced the gap between the experimental and control groups. We posit that, although the underlying mechanisms of change may have been different in the two groups (as indicated by the different group ratings of the positivity of the virtual interaction), the similar results suggest that the positive effects of

virtual relationship practice may not be restricted to only practice of secure behaviors and interactions. Rather, engaging with a virtual partner who both encourages positive behaviors and reacts negatively to negative ones may also serve to facilitate a decrease in preoccupation surrounding relationship interactions. We considered including a third group of participants who were limited to insecure adventure options, to test the presence of reinforcement in the paradigm, but were concerned that such a group might *increase* attachment insecurity, and thus we chose to avoid the potential risk to our participants. As [Carnelley and Rowe \(2007\)](#) discuss in their own research, the similarity of experimental and control conditions in our study may mask underlying effects of the manipulation. Including a control condition that engaged in an online program without a relationship-formation component would be informative in revealing the potential comparative benefits of relationship-focused interactions with a virtual partner. In addition, although the relationship scenarios were created and validated based on expert opinion (with agreement by an independent rater), and the manipulation check in the present study suggested group differences in the positivity and negativity of the two conditions, further validation of the relationship-formation paradigm is warranted.

The study's small sample size precluded us from conducting true moderator analyses (e.g., by race). Also, there was considerable attrition between the online program and laboratory visit, which decreased the sample size for analyses of the program's effect. Interestingly, twice as many participants in the experimental group dropped out ($n = 18$) compared to the control group ($n = 9$), suggesting a possible group effect on attrition. Future studies should provide both pre- and post-program assessments online so as to reduce participant dropout between time points. The majority of participants were female, suggesting that findings may not be generalizable to male populations. Participants were undergraduate students participating during the academic year; as [Mikulincer and Shaver \(2007b\)](#) have pointed out, examinations and other academic stressors may shift attachment insecurity and were not controlled for in our study, potentially contributing to the mixed results regarding the efficacy of the online program. However, the lack of change in attachment avoidance between time points provides some buffer against the concern of history effects on attachment insecurity. Finally, the present paradigm was limited in terms of its graphical involvement and immersive nature in comparison to some other research on attachment behaviors in the virtual world (e.g., [Yee & Bailenson, 2007](#)). It is possible that, although we found decreases in attachment anxiety and high levels of engagement with the paradigm across both study conditions, these effects (and potentially changes in avoidance) would be greater in an immersive, graphically intensive virtual world.

Conclusion

Attachment theory describes highly integrated attitudes and behaviors that define, in part, how we relate to others and form close relationships. The current study suggests that attachment anxiety may be able to be manipulated through both guided and non-guided interactions with a virtual relationship partner. While the findings of the present study are indeed mixed, they prove promising and open the door to the online social world as an arena for fostering successful relationship attitudes. Future researchers may be able to build from the present findings to develop more nuanced self-concept-focused paradigms to improve relationship formation. Virtual worlds may soon become training grounds for perfecting social skills and improving human well-being.

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Competing Interests

The authors have declared that no competing interests exist.

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Data Availability Statement

For access to the virtual program, data, or other materials utilized in this research, please contact the corresponding author, Benjamin N. Johnson, at bnjohnson@psu.edu.

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Appendices

Appendix A: Interactive Adventure Story Excerpts – Control Condition

Control Condition Scenario 3

Morning comes around and the sun is shining through the blinds into your room. Time to get up for breakfast! You wonder what John is doing and remember he said the two of you would meet downstairs at 8AM. You glance at the clock and realize you only have 20 minutes! Soon you're downstairs and you see him by a table. You walk over to him and he asks you where you want to sit.

1. You tell John you'd rather have breakfast on the go. "Maybe we can pick up something to eat on the way to our first outing?"
2. Another couple invites you to sit at their table and you agree.
3. You choose to sit at a two-person table in the corner.

(Participant selects option 1—Avoidant)

"You just don't want to sit down so you don't have to talk to me, is that it?" John asks. "It's fine, let's just go get some bagels or something."

Control Condition Scenario 13

Mentioning family leads to John talking about his own. He looks down at his food as he starts talking about his mother. "I've been worried about my family," he says. "My mom thinks she may lose her job in this economy."

1. "Oh, that's terrible, does that mean you're going to have to drop out of school? Does school have a way to support you?"
2. "That's a bummer. I should cheer you up, do you want dessert?"
3. You frown. "How's the rest of your family taking it?"

(Participant selects option 1—Anxious)

"Oh, wow, I don't know, I didn't even think of that! This is stressing me out so much..."

Appendix B: Interactive Adventure Story Excerpts – Experimental Condition

Experimental Condition Scenario 2

You and Jane carry your luggage to the front desk of the hotel to check in to your rooms. She gives you the information about checking in and you begin talking to the staff member on duty. Soon, you've got your room, although you realize Jane is not done checking in yet. You wait patiently and then talk to her.

1. **“Did they have everything in order?”**
2. **“Would you like to get some dinner together later, or would you rather rest a bit?”**
3. **“Did they give you directions to your room? Do you want me to get the bellman for your luggage?”**

(Participant selects option 1)

“Everything's in order!” Jane replies. “Let's just bring our luggage up to the room and we then we should definitely get something to eat, I'm starving!”

Experimental Condition Scenario 12

The conversation is going well as the two of you enjoy your dinner. It seems to be getting quite serious, actually, and Jane asks you a question: “Tell me about your family,” she says.

1. **“We get along pretty well. Sometimes we disagree about politics, but it's okay. I always tell myself, ‘If that's the worst thing we've got going on, we're great.’”**
2. **“Sometimes I worry about my younger brother in the army... But I know he'll be okay.”**
3. **“I just saw them over break actually. My mother tried to get my little sister to eat Brussels sprouts, but she made this disgusted face. It's a crazy but fun house most of the time.”**

(Participant selects option 3)

Jane smiles and says, “Sounds like you get along pretty well. I didn't get to see my family over the break, but I'm looking forward to when I do.”