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Biting the forbidden fruit: The effect of flirting with a virtual agent on attraction to real alternative and existing partners ☆,☆☆

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ABSTRACT

Virtual encounters are becoming increasingly frequent. These encounters have the dual potential for either posing a threat to existing relationships or promoting relationship stability. Three studies investigated whether interacting with a flirtatious virtual human would inoculate individuals against the allure of real alternative partners. In all studies, partnered participants conversed with a virtual bartender of the other gender who behaved either seductively or neutrally. Then, participants interacted with a real other-gender human being and rated their perceptions of both targets. In Study 1, an attractive confederate interviewed participants. In Study 2, a confederate sought participants' help and recorded their helping behavior. In Study 3, participants interacted with their current partner. Results indicated that following the flirtatious virtual encounter, participants devalued the interviewer's attractiveness, invested less time in helping the confederate, and desired their partner more. This research is the first to show that interacting with a virtual agent promotes real-world relationships.

1. Introduction

Long-term romantic relationships have potential to satisfy human needs for love, intimacy, and security (e.g., Dush and Amato, 2005). And yet, throughout life, fulfillment of these needs is often challenged, as intimates will almost inevitably encounter tempting alternatives to their current partners. Although threats posed by alternative mates may activate strategies to protect the relationship against their allure (e.g., devaluation of alternatives; Lydon and Karremans, 2015), such relationship maintenance strategies often fail. The rate of extradyadic affairs is indeed high (estimates range as high as 70%; Allen et al., 2005; Blow and Hartnett, 2005; Thompson and O'Sullivan, 2016) and may eventually come at the cost of losing altogether the benefits a stable romantic relationship brings (Gordon et al., 2004).

The present research used a virtual reality platform to explore one way in which people maintain satisfying and stable relationships in the face of attractive alternatives. In doing so, we relied on research showing that exposure to temptations that are perceived to compete against a major goal facilitates goal shielding (i.e., prioritizing pursuit of this goal while forgoing temptations; Fishbach et al., 2003; Fishbach and Zhang, 2008). Specifically, we examined whether flirtatious interaction with a virtual human would lead to prioritizing the goal of relationship maintenance by increasing attraction to current partners and thereby helping inoculate participants against the appeal of real alternative partners.

1.1. Sustaining relationships in the face of temptation

For partnered individuals, the availability of attractive alternative partners introduces a self-control conflict between the temptation to pursue the alternative mate and the long-term goal of maintaining a valued current relationship (Lydon and Karremans, 2015). Committed individuals commonly resolve this conflict by regulating their responses to the alternative in ways that help them override temptations (Brady et al., 2020; McNulty et al., 2018). Romantically involved individuals, for example, are more likely than single individuals to be inattentive to potential alternative partners (Maner et al., 2008), to devalue their attractiveness (Lydon et al., 2003), to remember more negative and fewer positive behaviors enacted by these potential partners (Visserman and

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Karremans, 2014), and to show disinterest in interacting with them (Karremans and Verwijmeren, 2008).

Still, the enactment of these relationship maintenance strategies typically depends on an individual's motivation and ability to do so (Birnbaum et al., 2022; Pronk et al., 2011). In an era in which prospective alternative mates are readily accessible, this motivation, along with feelings of commitment to the current partner, may gradually erode, fostering flirtatious and adulterous behavior (Drigotas et al., 1999; Lee and O'Sullivan, 2019). Indeed, when people's self-regulatory ability to resist short-term pleasures (e.g., extradyadic sex) that thwart long-term goals (e.g., maintaining an exclusive relationship) is impaired, behaviors that precede infidelity may be facilitated. For example, among participants whose self-control efforts were inhibited and who therefore had lesser ability to resist the temptation of straying, attending to attractive alternatives produced a greater likelihood of registering for a dating application focused on extradyadic affairs (Brady et al., 2020).

Tempting alternatives can threaten existing relationships even when they do not engender overt adulterous behavior. For example, partners may notice subtle signs of interest in an alternative person – eye contact, body posture, over-attentiveness, or even actual flirting – and become jealous, setting off a cycle of conflicts that can lead to actual relationship deterioration (Burch and Gallup, 2020; Guerrero and Andersen, 1998; White, 2008). Tempting alternatives may also create doubts about whether one would be happier in a different relationship, instilling a sense of uncertainty and distance that over time erodes commitment (Solomon and Knobloch, 2004).

1.2. How inoculation may boost resistance to alternatives

Under precisely which circumstances are people likely to resist temptation by attractive alternatives? To answer this question, we drew on past research into goal shielding. In this work, across diverse self-regulatory domains (e.g., weight-watching), the mere presence of tempting cues (e.g., fattening food) may activate relevant goals (e.g., dieting), thereby increasing awareness of long-term priorities and facilitating resistance (e.g., avoiding the fattening food; Fishbach et al., 2003). Of course, rather than prioritizing long-term goals, people sometimes succumb to momentary temptations, particularly when self-regulatory resources are depleted, when goal commitment is relatively low, or when a goal and a temptation seem complementary rather than competing (Fishbach et al., 2003; Fishbach and Zhang, 2008).

We extended these findings into the domain of close relationships by incorporating the idea of inoculation theorizing, which proposes that exposure to a weakened threat can promote self-control by allowing people to contemplate resistance (Compton, 2013). Herein, we investigated whether exposure to a weak relationship threat—flirtation with a virtual human—would inoculate people who are involved in committed relationships against the enticement of real-world alternatives by enhancing their desire for current partners. Unlike major threats (e.g., real-world active courting attempts) that may undermine committed people's defensive ability (Birnbaum, 2022), exposure to a weakened threat is likely to remind them of their long-term commitments while making them better ready to defend their relationship in the face a more threatening temptation.

In this context, virtual interactions may function similarly to fantasized ones. People commonly use mental imagery to create an alternative reality that helps them regulate reactions to threats and encourages pursuit of relationship-promoting goals (Poerio and Smallwood, 2016). Fantasizing about someone other than a current partner is therefore not only not necessarily harmful for relationships (Birnbaum et al., 2019a), but may actually help sustain desire for current partners by alleviating tensions between autonomy and merger needs (Newbury et al., 2012). Whether this logic also applies to virtual humans is an unexplored question. Virtual interactions are more immersive than purely mental fantasies and by virtue of seeming more real, may emphasize the desirability of alternatives relative to existing relationships. As such, flirtatious virtual encounters may instigate sexual arousal that poses a threat to long-term relationship goals and elicits guilt feelings. These mixed feelings may motivate individuals to resolve the ensuing uneasiness by defending their relationships and transferring the arousal to a more "legitimate" target, namely their existing partner.[1] By doing so, the virtual encounter may prepare people to raise their guard more quickly upon encountering a threat from real alternative partners, desiring their partner more while devaluing the attractiveness of alternatives.

1.3. The present research

Existing research on the effects of fantasized relationships is limited by the lack of experimental control over the content of fantasies, a limitation that also applies to research on real-life flirtation. Virtual reality paradigms have the advantage of maximizing experimental control and participant engagement, while still inculcating a sense of safety, inasmuch as the alternative is not a real person (Blascovich and Bailenson, 2011; Pan and Hamilton, 2018).

Three sequential studies examined whether interacting with a flirtatious virtual human would inoculate participants against the allure of real alternative partners. In all studies, partnered participants conversed with a virtual bartender of the same gender as their partner (either masculine or feminine presenting) who behaved either seductively or neutrally. Then, participants interacted with a real human of the same gender as their partner and rated their perceptions of and attraction to both targets. In Study 1, we examined whether flirtatious virtual encounters would engender defensive responses, manifested in guilt feelings and devaluation of the real alternative's sexual attractiveness — but not this person's less seductive and thus less threatening qualities. Indeed, relationship-protective processes are particularly likely to occur when the relationship is threatened (Lydon and Karremans, 2015). For example, people tend to avoid attractive alternatives and to be less impressed by their physical beauty especially when the alternatives form a realistic threat to the relationship (e.g., they live in close proximity to them (Johnson and Rusbult, 1989; Linardatos and Lydon, 2011). Nevertheless, romantically involved individuals devaluate attractive others only when they have the motivation and self-regulatory capacity to do so (Lydon and Karremans, 2015; Ritter et al., 2010). To test our hypothesis, participants rated an attractive confederate who interviewed them right after the virtual encounter.

Study 2 asked whether flirtatious virtual encounters would lead participants to minimize their interaction with real alternative partners. We examined helping a stranger in need, which may function as a subtle relationship-initiating strategy (Birnbaum et al., 2019c) that is likely to be more acceptable than blatant flirting (Birnbaum et al., 2019b). Therefore, following the virtual encounter, a confederate sought participants' help. We hypothesized that following interaction with a flirtatious virtual agent, participants would be more likely to devalue the sexual attractiveness of real alternative partners and less likely to help them than following interaction with a non-flirtatious virtual agent.

In Study 3, we predicted that sexual desire for a current partner would mediate the proposed effect of flirtatious virtual interaction on the readiness to resist alternative partners. This prediction built on prior theorizing that sexual desire denotes mate value, with higher (vs. lower) desire for existing partners inducing greater efforts toward deepening connections with valued partners (Birnbaum, 2018; Birnbaum and Reis, 2019). In this vein, lower desire for existing partners has been found to predict increased desire for alternatives (Birnbaum et al., 2019b). To examine this mediation hypothesis, participants interacted with their current partner immediately after leaving the virtual environment and then rated sexual desire for their partner and their desire for sex with someone other than their partner.

[1] This idea also is consistent with excitation transfer theory, which posits that arousal generated from one source can be transferred to heighten attraction to a different, more available source (Zillmann, 1983).

2. Study 1

2.1. Method

2.1.1. Participants

One hundred and thirty students (65 women, 65 men) from a university in central Israel participated in the study for course credit or in exchange for 50 NIS (about $15). Sample size was determined via a priori power analysis using G*Power software package (Faul et al., 2009) to ensure 80% power to detect an effect size, d, of 0.50 at $p < .05$. This hypothesized effect size was based on findings from prior research examining the effect of relationship threat on sexual desire for alternative partners (Birnbaum et al., 2019b). Because we wished to exclude newly dating couples who are relatively less committed to the relationship, potential participants were recruited if they were in a committed heterosexual relationship of longer than 4 months. Participants ranged from 20 to 31 years of age ($M = 24.14$, $SD = 1.76$). Relationship length ranged from 4 to 120 months ($M = 27.52$, $SD = 24.12$).

2.1.2. Measures and procedure

Participants were invited to take part in a study of virtual and real interactions. Prior to each session, participants were randomly assigned to either of two conditions in which they interacted with a virtual bartender of the same gender as their partner who either (a) flirted with them (the seductive condition) or (b) behaved neutrally (the neutral control condition). When participants came to the lab, they were met by a research assistant who asked them to sit in a designated chair where the virtual encounter was about to take place. Participants were informed that they would be fitted with a virtual reality device (a head mounted display) and thereby enter a virtual environment in which they would converse with a virtual agent. Participants were told to first look around the virtual environment and upon the agent's arrival, answer all questions asked by the agent and refrain from asking questions back. None of the participants violated these instructions. Participants were assured that the research assistant would remain in the room during the virtual interaction to make sure that it works without interruptions and that they are comfortable in the virtual environment.

The virtual agent (i.e., a human-like bartender avatar) was controlled remotely in a Wizard-of-Oz setup (Riek, 2012). This setup allowed the wizard operator, who was sitting in a control room, to operate the virtual bartender, controlling the bartender's facial and verbal reactions, such that each sentence was manually triggered by the operator, according to a pre-defined sequence, without the awareness of the participants. The virtual bartender implementation was based on a software platform, developed in our lab, on top of a Unity game engine (Unity Technologies, US). The functionality entailed automated verbal and non-verbal communication, based on a simple state machine with states such as "idle" and "speaking." For each state, there were pre-recorded animation and facial movement sequences, activated according to the state and experimental condition, such that only the exact timing of the utterances was controlled by the operator. The virtual environment was a bar populated by a bartender who conversed with the participants. As in a real bar, background music was playing and noises of people talking were heard.

The seductiveness of the bartender was manipulated across three modalities (see Table 1 and Supplemental Materials): (a) the semantic content of the conversation. We pre-recorded a fixed script for each condition that was either flirtatious or not. To keep participants on track and standardized in their interactions with the virtual agent, both scripts were phrased to minimize the possibility that participants' verbal reactions would not fit well with the virtual agent's next scripted response; (b) eye contact; and (c) nonverbal gestures (see an illustration video here: https://www.youtube.com/watch?v=HIDXmpFlIG4; The YouTube video fails to demonstrate the immersiveness of the virtual interaction). These gestures were consistent across sessions and had been pilot tested to verify their experimental realism.

After leaving the virtual environment, participants completed three items assessing the extent to which they felt the bartender was flirting with them (e.g., "To what extent did you feel the bartender was flirting with you?"; "To what extent did you feel the bartender was courting you?"; $\alpha = 0.81$) and 10 items assessing social presence (i.e., the extent to which participants felt they had responded realistically to the bartender; e.g., "To what extent did you respond to the bartender as you would have responded to a bartender in real life?"; "To what extent was your emotional response to the bartender similar to your emotional response to an individual in the real world?"; $\alpha = 0.88$; Pan et al., 2012).

Participants were then asked to move to a different seat and were informed that they would be interviewed by a research assistant about their attitudes on various interpersonal issues. All participants were assigned the same attractive interviewers of the same gender as their partner whose attractiveness had been pilot tested with judges who rated their photo on five adjectives: sexually desirable, sensual, "hot," attractive, and sexually exciting (Birnbaum et al., 2011; e.g., "To what extent do you think that the person in the photo is attractive?"). The interviewers were blind to the experimental condition and were trained to exhibit behaviors that conveyed warmth and immediacy (e.g., close physical proximity, frequent eye contact; Andersen, 1985; Leck and Simpson, 1999) to encourage approach motivation. The research assistant introduced the interviewer to the participants and left the room.

To make participants feel comfortable, the interviewer first asked a set of standard questions about participants' hobbies and future career plans. Then, the interviewer informed participants that they were about to discuss their attitudes on various interpersonal issues. To ensure consistency across experimental conditions, the interviewer used a fixed interview script, in which participants were asked to share their thoughts on several interpersonal topics (e.g., "Is it possible to find a true love online?"; "Should people play 'hard-to-get' at the onset of a relationship?"). All interviews lasted 5–7 min.

Upon completing the interview, the interviewer left the room and participants completed a single item assessing the extent to which they had felt guilty during the interaction with the virtual bartender and four items assessing the degree to which they had felt uncomfortable about what they had thought or felt during this virtual interaction (e.g., "I felt bad about what I said"; "I felt uncomfortable about the thoughts that were running through my head"; $\alpha = 0.82$). Participants also completed the same five items, which were used to pre-assess the interviewer' attractiveness ($\alpha = 0.81$) and five items assessing the interviewer's attractiveness on non-sexual adjectives: intelligent, intellectual, trustworthy, helpful, and a good parent (e.g., "To what extent do you think that the interviewer might be a good parent?"; $\alpha = 0.73$), which were adapted from Hoffman et al. (2014). Ratings of all items (see Table 2 for correlations among study variables) were made on 5-point scales ranging from 1 *(not at all)* to 5 *(very much so)*. Scores on all items were averaged to create the respective scale scores. Finally, participants were asked a few demographic questions (age and relationships duration) and were fully debriefed.

2.2. Results

2.2.1. Manipulation check

A t-test on perceptions of the bartender's seductiveness yielded the expected effect. Participants perceived the virtual bartender as more flirtatious in the seductive condition than in the control condition. A t-test on social presence did not yield a significant effect, indicating that participants did not differ across conditions in the extent to which they felt that they had responded realistically to the bartender (see Table 3).

2.2.2. Main analyses

To examine whether the flirtatious virtual encounter would affect the sexual but not non-sexual attractiveness of the interviewer, we conducted a 2 (Type of encounter: flirtatious, neutral) × 2 (Attractiveness:

Table 1
Manipulating the seductiveness of the virtual bartender across three modalities (Studies 1–3).

	Seduction	Control
Content of conversation	Being flirtatious, complimenting the participant (e.g., "You look like a smart guy!"; "Wow! You look really excited! Is it because you enjoy your major or because of me?")	Replying neutrally, refraining from flirting with the participants.
Eye contact	Repeatedly making eye contact with the participants during the conversation.	Shifting gaze to different areas in the bar.
Gestures	Making occasional gestures that are typically involved in flirting and proximity-seeking behaviors, such as leaning forward towards the participant and decreasing interpersonal distance (Birnbaum et al., 2014, 2016; Moore, 2010).	Refraining from using proximity-seeking gestures.

Table 2
Correlations among Study Variables (Study 1).

	1	2	3	4	5	6
1. Bartender's Perceived Seductiveness	–	.24**	.14	.15	−0.03	−0.10
2. Social Presence		–	.01	.06	.26**	−0.03
3. Guilt Feelings			–	.77***	−0.09	.12
4. Feeling Uncomfortable				–	−0.10	.13
5. Interviewer's Nonsexual attractiveness					–	.19*
6. Interviewer's Sexual Attractiveness						–

Note.
* $p < .05$,.
** $p < .01$,.
*** $p < .001$; Items were rated on a 5-point Likert scale.

Table 3
Means, Standard Deviations, Statistics, and Effect Sizes of Participants' Perceptions and Feelings for the Experimental Conditions (Study 1).

	Seduction	Control	*t*(128)	*p value*	Cohen's *d*	95% CI for Cohen's d
Bartender's perceived seductiveness	3.93 (0.83)	2.94 (1.04)	5.97	.001	1.05	[.68, 1.41]
Social presence	4.31 (1.16)	4.28 (1.03)	0.17	.867	.03	[−0.31, 0.37]
Guilt feelings	1.26 (0.59)	1.09 (0.34)	1.99	.048	.35	[.01, 0.69]
Feeling uncomfortable	1.31 (0.57)	1.23 (0.42)	.87	.386	.15	[−0.19, 0.50]
Interviewer's nonsexual attractiveness	3.87 (0.52)	3.98 (0.59)	1.14	.256	.20	[−0.14, 0.54]
Interviewer's sexual attractiveness	3.71 (0.99)	4.03 (0.77)	2.07	.041	.36	[.02, 0.71]

Note. $N = 130$. All measures were rated on 5-point Likert scales. Standard deviations are presented in parentheses.

sexual, non-sexual) analysis of variance (ANOVA), with repeated measures on the second factor. The analysis yielded a significant effect for type of encounter, $F(1, 128) = \mathbf{4.83}$, $p = .030$, *Partial-*$\eta^2 = 0.036$, 90% CI [0.**01**, 0.**12**], such that participants perceived the interviewer as less generally attractive in the seductive condition ($M = 3.78$, $SD = 0.76$) than in the control condition ($M = 4.01$, $SD = 0.68$). The effect of attractiveness was not significant, $F(1, 128) = 0.4\mathbf{3}$, $p = \mathbf{.512}$, *Partial-*$\eta^2 = 0.0\mathbf{03}$, 90% CI [0.00, 0.05].

Although the Encounter × Attractiveness interaction was not significant, $F(1, 128) = 1.56$, $p = .214$, *Partial-*$\eta^2 = 0.012$, 90% CI [0.00, 0.07], because we had hypothesized differences between the sexual and non-sexual items, we conducted simple effect tests. These tests revealed that participants perceived the confederate as less sexually attractive in the seductive condition than in the neutral condition, $F(\mathbf{1}, 128) = 4.28$, $p = .041$, *Partial-*$\eta^2 = 0.\mathbf{032}$, 90% CI [0.01, 0.11]. However, there was no significant difference between conditions in perceptions of the confederates' non-sexual attractiveness, $F(1, 128) = \mathbf{1}.30$, $p = .256$, *Partial-*$\eta^2 = 0.010$, 90% CI [0.00, 0.07]. These findings are in line with previous research showing that a stranger's seductive features are more likely than a stranger's non-sexual features to elicit defensive reactions when their threatening implications are salient (Landau et al., 2006).

As expected, a *t*-test on guilt feelings revealed that participants in the seductive condition felt significantly more guilty than the participants in the neutral condition. An additional *t*-test on feelings of discomfort did not yield a significant effect, indicating that participants did not differ in either condition in the extent to which they felt uncomfortable in the presence of the virtual bartender (see Table 3). In this study, as well as in Studies 2 and 3, we examined the interactive effect of gender and the manipulation of virtual seduction on the main dependent variables. This interactive effect was not significant in any of the analyses (see Supplemental Materials). Overall, the findings suggest that an early exposure to a weakened version of the threat of alternatives in the form of a flirtatious virtual human allows people to contemplate resistance to real attractive alternatives. Such an experience likely helps strengthen the

defense of the long-term goal of relationship maintenance by eliciting guilt feelings and motivating devaluation (rather than enhancement) of alternatives' perceived attractiveness.

3. Study 2

3.1. Method

3.1.1. Participants

One hundred and thirty-nine students (68 women, 71 men) from a university in central Israel participated in the study for course credit or in exchange for 50 NIS (about $15). Sample size was determined via a priori power analysis using G*Power software package (Faul et al., 2009) to ensure 80% power to detect an effect size, *d*, of 0.50 at $p < .05$. We did not power Studies 2 and 3 to detect an effect of the size that was actually observed in Study 1 as they were conducted before Study 1 had been analyzed. Hence, both studies were somewhat underpowered. Potential participants were recruited if they were in a committed heterosexual relationship of longer than 4 months. Participants ranged from 21 to 37 years of age ($M = 24.99$, $SD = 2.03$). Relationship length ranged from 4 to 168 months ($M = 29.02$, $SD = 26.82$).

3.1.2. Measures and procedure

Participants were invited to take part in a study of virtual and real interactions. The first part of the procedure was identical to Study 1. Participants were randomly assigned to either a seductive condition or to a neutral control condition and interacted with a virtual bartender of the same gender as their partner. After leaving the virtual bar, participants completed three items assessing the extent to which they felt the bartender had been flirting with them ($\alpha = 0.86$), as described in Study 1. Ratings were made on a 5-point scale ranging from 1 *(not at all)* to 5 *(very much so)*.

Participants were then asked to move to a different room and were led to believe that in the next 5 min they and another participant would use plastic wine cups to independently build a five-floor pyramid (each of them had to build a different pyramid). In reality, all participants were assigned the same attractive confederates of the same gender as their partner whose attractiveness had been assessed prior to participating in the study by judges who rated their photo on the same five adjectives, which were used in Study 1. The confederates were blind to the experimental condition. The experimenter then introduced the confederate to the participant, seated them on the floor next to each other, told them that they were allowed to speak with each other while building the pyramids, and left the room.

When the confederate had finished building the third floor (approximately 3 min after the experimenter had left the room), he or she knocked down his or her own pyramid, ostensibly by mistake. The confederate then turned to the participant and asked for help in rebuilding the pyramid, uttering, "I'm so clumsy! Could you please help me in rebuilding my pyramid?" Participants' helping behavior toward the confederate was recorded, assessing the actual time spent in helping rebuilding the pyramids (in seconds), which was measured unobtrusively using a stopwatch hidden in the confederates' pocket. Time invested in helping a stranger was used as a behavioral measure because, in previous studies that assessed interest in alternative partners, it showed a similar pattern of results as other attraction indices (e.g., self-reported romantic interest, overt flirting; Birnbaum et al., 2019b, 2019; Birnbaum et al., 2019c). Accordingly, a longer duration of help indicated greater interest in the confederate. This procedure sometimes led to extreme responses by some participants. Therefore, to maximize robustness, we winsorized extreme values at the 95th percentile (Thomas and Ward, 2006). After five minutes, the experimenter returned to the room and asked participants a few demographic questions (age and relationships duration) and fully debriefed them.

3.2. Results

3.2.1. Manipulation check

A *t*-test on perceptions of the bartender's seductiveness yielded the expected effect. Participants perceived the virtual bartender as more flirtatious in the seductive condition than in the control condition (see Table 4).

3.2.2. Main analysis

A *t*-test on time spent in helping the confederate yielded the expected effect. Participants in the seductive condition spent significantly less time in helping the confederate than participants in the neutral condition (see Table 4). The correlation between perceptions of the bartender's seductiveness and time spent in helping the confederate was not statistically significant, $r = -0.13$, $p = .143$ ($r = -0.21$, $p = .084$ in the seductive condition and $r = 0.08$, $p = .542$ in the neutral condition). These findings demonstrate that a flirtatious virtual encounter not only leads to devaluation of real-world alternatives, but also to fewer behavioral expressions of desire, as reflected in the minimized time spent in helping them.

4. Study 3

4.1. Method

4.1.1. Participants

One hundred and thirty-four romantic couples participated in the study in exchange for 150 NIS (about $43). Sample size was determined via a priori power analysis using G*Power software package (Faul et al., 2009) to ensure 80% power to detect an effect size, *d*, of 0.50 at $p < .05$. Potential participants were recruited if they were in a committed heterosexual relationship of longer than 4 months. Participants ranged from 20 to 37 years of age ($M = 24.99$, $SD = 2.50$). Relationship length ranged from 4 to 180 months ($M = 37.22$, $SD = 28.77$).

4.1.2. Measures and procedure

Both members of romantic couples were invited to take part in a study of virtual and real interactions. The first part of the procedure was identical to Study 1, except that upon arrival to the lab, partners were led to different rooms. One partner interacted with a virtual bartender who behaved either seductively or neutrally, as described in Study 1. After leaving the virtual bar, participants completed three items assessing the extent to which they felt the bartender was flirting with them ($\alpha = 0.81$) and ten items assessing social presence ($\alpha = 0.89$), identical to those used in Study 1. During this time, the other partner watched a neutral video.

Then, partners were reunited and seated in two chairs facing each other. Following the procedure of Mizrahi et al. (2016), partners were asked to discuss satisfying and unsatisfying aspects of their sex lives for 10 min. Following the discussion, partners were led to different rooms to protect their privacy and completed three items assessing their sexual desire for each other (Birnbaum et al., 2016; e.g., "I feel a great deal of sexual desire for my partner"; "I am passionately attracted to my partner"; $\alpha = 0.81$) and a single item assessing their desire for sex with someone who was not their current partner (desire for extradyadic sex; "To what extent would you be interested in having sex with an attractive individual who is not your current partner?"). Ratings of all items (see Table 5 for correlations among study variables) were made on 5-point scales ranging from 1 *(not at all)* to 5 *(very much so)*. Scores on all items were averaged to create the respective scale scores. Finally, participants answered a few demographic questions (age and relationships duration) and were fully debriefed.

4.2. Results

4.2.1. Manipulation check

A *t*-test on perceptions of the bartender's seductiveness yielded the expected effect. Participants perceived the virtual bartender as more

Table 4
Means, Standard Deviations, Statistics, and Effect Sizes of the Bartender's Perceived Seductiveness and Duration of Help for the Experimental Conditions (Study 2).

	Seduction	Control	t(137)	*p value*	*Cohen's d*	95% CI for Cohen's d
Bartender's perceived seductiveness	3.87 (0.90)	2.86 (1.07)	6.02	.001	1.02	[.67, 1.37]
Duration of help	11.67 (8.97)	14.84 (9.16)	2.03	.044	0.35	[.01, 0.69]

Note. $N = 139$. Perceived seductiveness was rated on a 5-point Likert scale. Duration of help was measured in seconds. Standard deviations are presented in parentheses.

Table 5
Correlations among Study Variables (Study 3).

	1	2	3	4
1. Bartender's Perceived Seductiveness	–	.26**	.24**	−0.12
2. Social Presence		–	−0.02	−0.09
3. Sexual desire for one's partner			–	−0.27**
4. Desire for sex with someone other than current partner				–

Note.
** $p < .01$; Items were rated on a 5-point Likert scale.

Table 6
Means, Standard Deviations, Statistics, and Effect Sizes of Participants' Perceptions and Feelings for the Experimental Conditions (Study 3).

	Seduction	Control	*t*(132)	*p value*	Cohen's *d*	95% CI for Cohen's d
Bartender's perceived seductiveness	3.75 (0.69)	2.99 (0.94)	5.35	.001	0.92	[.57, 1.28]
Social presence	3.25 (0.83)	3.25 (0.77)	0.01	.999	0.01	[−0.01, 0.01]
Sexual desire for one's partner	4.58 (0.66)	4.25 (0.81)	2.64	.009	.46	[.11, 0.80]
Desire for sex with someone other than current partner	1.83 (1.10)	2.22 (1.33)	1.84	.069	.32	[−0.02, 0.66]

Note. $N = 134$. All measures were rated on a 5-point Likert scale; Standard deviations are presented in parentheses.

flirtatious in the seductive condition than in the control condition. A *t*-test on social presence did not yield a significant effect, indicating that participants did not differ in the extent to which they felt that they had responded realistically to the bartender in both conditions (see Table 6).

4.2.2. Main analyses

T-tests on sexual desire for one's partner and desire for sex with someone who was not the current partner yielded the expected effect. Compared to participants in the neutral condition, participants in the seductive condition experienced significantly greater desire for sex with their partner and marginally significantly less desire for other people (see Table 6). To examine whether the effect of the manipulation of virtual seduction on sexual desire for someone who was not the current partner (desire for extradyadic sex) was mediated by sexual desire for the current partner, we used PROCESS (Hayes, 2013, model 4), in which the manipulation of seduction was the predictor, sexual desire for someone other than the partner was the outcome measure, and sexual desire for the partner was the mediator. Fig. 1 shows the final model.

This analysis revealed a significant effect of the manipulation of seduction on desire for the partner ($b = 0.17$, $SE = 0.06$, $t = 2.64$, $p = .009$, $\beta = 0.22$, 95% CI [.06, 0.38]), and a significant effect of sexual desire for the partner on desire for extradyadic sex ($b = -0.44$, $SE = 0.14$, $t = -3.23$, $p = .002$, $\beta = -0.27$, 95% CI [−0.43, −0.11]). Also, sexual desire for the partner was uniquely associated with desire for extradyadic sex after controlling for the manipulation of seduction ($b = -0.40$, $SE = 0.14$, $t = -2.89$, $p = .005$, $\beta = -0.25$, 95% CI [−0.43, −0.07]).

More importantly, results indicated that the 95% CI of the indirect effect for the manipulation of seduction as a predictor of desire for extradyadic sex through sexual desire for the partner did not include zero

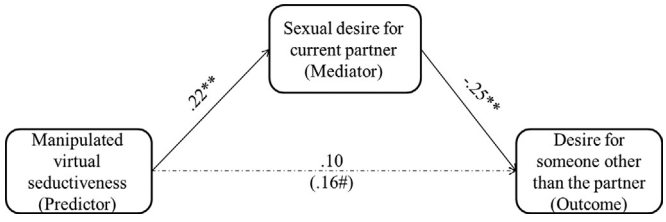

Fig. 1. Mediation model showing that sexual desire for one's partner mediated the effect of manipulated virtual seductiveness on sexual desire for someone other than one's partner in Study 3.
Note. Path coefficients are standardized. The value in parentheses is from the analysis of the effect without sexual desire for the current partner in the equation. # $p < .07$, ** $p < .01$.

and thus is considered significant ($b = 0.07$, $SE = 0.04$, $\beta = 0.06$, 95% CI [.01, 0.13], 5000 bootstrapped samples). Given that sexual desire for current partner and sexual desire for alternative partners were measured concurrently, one could argue that decreased sexual desire for alternative partners might result in increased desire for the current partner through some kind of motivated cognition to see a partner as attractive. To partially rule out this possibility, we conducted an alternative model, which posits that the effect of the manipulation of seduction on sexual desire for the partner is mediated by desire for extradyadic sex. This alternative model was not significant ($b = -0.03$, $SE = 0.02$, $\beta = -0.04$, 95% CI [−0.11, 0.01], 5000 bootstrapped samples).

These analyses supported our hypothesized mediation model, indicating that there was a significant indirect effect of manipulation of virtual seduction on desire for alternatives through desire for current partner. Specifically, the manipulation of virtual seduction led to greater

desire for sex with one's partner, which, in turn, predicted less sexual desire for someone other than the partner. Consistent with this pattern, we found that the more seductive the bartender was perceived to be, the greater the desire for sex with one's partner (see Table 5), suggesting that greater perceived seductiveness was more threatening and thus triggered greater efforts to defend the relationship, as manifested in elevated levels of desire for one's partner. Still, because the current design does not allow us to make clear-cut conclusions about the temporal ordering of desire for current and alternative partners, the validity of this mediation model should be further examined in longitudinal studies.

5. General discussion

Many people initiate monogamous relationships in the hope of maintaining sexual exclusivity and reaping the benefits of such relationships. Nevertheless, in a world of seemingly limitless alternatives, staying faithful to a current partner may be challenging (Blow and Hartnett, 2005; Thompson and O'Sullivan, 2016). The present research employed a virtual reality paradigm to investigate one circumstance that encourages deployment of a strategy that facilitates resistance to attractive alternatives—devaluation of alternatives—and thereby promotes relationship maintenance.

In three studies, we demonstrated that a flirtatious virtual encounter (versus a non-flirtatious interaction) with a virtual human can inoculate romantically involved individuals against the appeal of real alternative partners. In Study 1, interaction with a flirtatious virtual agent led participants to experience guilt and to devalue the sexual attractiveness of a real interviewer. Study 2 showed that a flirtatious virtual encounter affected not only perceptions of real-world alternatives but also actual interactions with them, leading participants to minimize time spent helping a stranger in need. Study 3 extended these findings by highlighting a mechanism by which exposure to a flirtatious virtual agent thwarts the desire for sex with alternative mates: heightened desire for current partners.

Virtual encounters are increasingly common in non-immersive environments (video games, virtual friend applications) and may have important implications for relationship well-being, even though participants are fully aware that these partners are not real humans (Oh et al., 2018). In experimental settings, the use of virtual reality simultaneously improves experimental control and participant engagement. Furthermore, as a research tool, virtual agents overcome the inherent problem of inconsistency in the behavior of human confederates (Pan and Hamilton, 2018). Past studies have rarely demonstrated that interaction with virtual humans affects future responses to a real person. The present research is the first to show that interacting with a virtual agent shapes interactions outside the virtual environment in ways that may increase attraction to current partners and foster relationship longevity.

Overall, our research deepens understanding of how couples maintain satisfying and stable relationships in the face of tempting alternatives, indicating that exposure to a mitigated threat stimulates a process that may help people withstand real temptations. Specifically, our research shows that a virtual relationship threat—one that by definition could not be acted on—may elicit a protective reaction, manifested in heightened desire for a current partner that may reduce desire for alternative mates. By doing so, our research adds to past research showing that in some non-relational domains (e.g., weight-watching, academic pursuits), when long-term goals and temptations conflict, self-control processes may promote the value and pursuit of the goal relative to the temptation (Fishbach and Zhang, 2008). This inoculation process also supports theorizing that sexual desire acts as an attachment-facilitating device that motivates relationship persistence, particularly when threats arise (Birnbaum, 2018; Birnbaum and Finkel, 2015). In such circumstances, the reassurance offered by expressions of sexual desire may intensify connections between partners (Birnbaum, 2018; Birnbaum et al., 2008).

Still, it is unclear whether the virtual inoculation process would translate into real-life encounters with others, such that any mitigated threat (e.g., encounters with alternative others that are perceived to be unattainable), and not just virtual threats, may inoculate partners against the allure of alternatives. For example, would flirting online with an attractive individual who lives in a different country have a similar inoculation effect or is there something unique about virtual interactions that makes them particularly effective in inoculating people against the enticement of alternatives? Another limitation of our research is that because participants interacted only with confederates of the same gender as their partner, we cannot tell whether interacting with a seductive virtual agent decreases interest in attractive alternatives rather than lessens approach tendencies toward other people in general. We also cannot speak to the process that underlies the increased desire for the current partner following the seductive virtual interaction. For example, participants' attraction to the virtual agent, which was not assessed in the present research, might have been transferred to their current partner who served as a more appropriate target for this matter. To be sure, a previous study has found that some people who have a crush on someone outside their primary relationship experience heightened desire for their current partner as well (Mullinax et al., 2016).

Furthermore, because the research assistant remained in the room during the virtual interaction, we cannot be sure whether the participants acted the same as they would have had they been left alone. For example, the exposure to the virtual agent could have been less effective in inoculating the participants had they felt freer to express themselves in the absence of the research assistant's observing presence. Another question concerns the longer-term impact of virtual involvement in scenarios of this sort—would longer involvement yield similar effects? Does heightened desire for one's partner endure beyond the immediate circumstances? Future studies should address these possibilities while using more varied types of weakened threats.

Notwithstanding these limitations, the present studies underscore the function that activation of the sexual system may serve in inoculating people against the lure of attractive alternatives, demonstrating that this process may help bind people to their relationship partners, thereby facilitating fulfillment of long-term relationship goals. In doing so, our research encourages an empirically validated approach to interventions for couples who are susceptible to the lure of an affair (e.g., couples with highly narcissistic or avoidant partners; Birnbaum and Reis, 2019; Fincham and May 2017). These interventions should focus on enhancement of appetitive processes that have proven effective in sustaining sexual desire and relationship functioning over the long-term (e.g., motivating responsiveness and efforts to make the partner feel special; Birnbaum, 2018; Birnbaum et al., 2016, (Birnbaum et al., 2021) as well as on strategies that inspire people to enact relationship-protective responses when attractive alternatives appear.

Declaration of Competing Interest

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

Data availability

Data will be made available on request.

References

Allen, E.S., Atkins, D.C., Baucom, D.H., Snyder, D.K., Gordon, K.C., Glass, S.P., 2005. Intrapersonal, interpersonal, and contextual factors in engaging in and responding to extramarital involvement. Clin. Psychol. 12, 101–130.

Andersen, P.A., 1985. Nonverbal immediacy in interpersonal communication. In: Siegman, A.W., Feldstein, S. (Eds.), Multichannel Integrations of Nonverbal Behavior. Erlbaum, pp. 1–36.

Birnbaum, G.E., 2018. The fragile spell of desire: a functional perspective on changes in sexual desire across relationship development. Pers. Soc. Psychol. Rev. 22 (2), 101–127.

Birnbaum, G. E., 2022. Temptation at your door: Receiving mate poaching attempts and perceived partners' desirability. Personal Relationships 29 (3), 566–580. https://doi.org/10.1111/pere.12433.
Birnbaum, G.E., Bachar, T., Levy, G.F., Zholtack, K., Reis, H.T., 2022. Put me in your shoes: does perspective-taking inoculate against the appeal of alternative partners? J. Sex Res..
Birnbaum, G.E., Finkel, E.J., 2015. The magnetism that holds us together: sexuality and relationship maintenance across relationship development. Curr. Opin. Psychol. 1, 29–33.
Birnbaum, G.E., Kanat-Maymon, Y., Mizrahi, M., Recanati, M., Orr, R., 2019a. What fantasies can do to your relationship: the effects of sexual fantasies on couple interactions. Personal. Soc. Psychol. Bull. 45 (3), 461–476.
Birnbaum, G.E., Kanat-Maymon, Y., Slotter, E.B., Luchies, L.B., 2021. Sexual desire mediates the relationship-promoting effects of perceived partner mate value. Arch. Sex Behav. 50, 3733–3755.
Birnbaum, G.E., Mikulincer, M., Szepsenwol, O., Shaver, P.R., Mizrahi, M., 2014. When sex goes wrong: a behavioral systems perspective on individual differences in sexual attitudes, motives, feelings, and behaviors. J. Pers. 106, 822–842.
Birnbaum, G.E., Mizrahi, M., Kovler, L., Shutzman, B., Aloni-Soroker, A., Reis, H.T., 2019b. Our fragile relationships: relationship threat and its effect on the allure of alternative mates. Arch. Sex Behav. 48 (3), 703–713.
Birnbaum, G.E., Mizrahi, M., Reis, H.T., 2019c. Fueled by desire: sexual activation facilitates the enactment of relationship-initiating behaviors. J. Soc. Pers. Relat. 36 (10), 3057–3074.
Birnbaum, G.E., Reis, H.T., 2019. Evolved to be connected: the dynamics of attachment and sex over the course of romantic relationships. Curr. Opin. Psychol. 25, 11–15.
Birnbaum, G.E., Reis, H.T., Mizrahi, M., Kanat-Maymon, Y., Sass, O., Granovski-Milner, C., 2016. Intimately connected: the importance of partner responsiveness for experiencing sexual desire. J. Pers. 111, 530–546.
Birnbaum, G.E., Svitelman, N., Bar-Shalom, A., Porat, O., 2008. The thin line between reality and imagination: attachment orientations and the effects of relationship threats on sexual fantasies. Personal. Soc. Psychol. Bull. 34, 1185–1199.
Birnbaum, G.E., Weisberg, Y.J., Simpson, J.A., 2011. Desire under attack: attachment orientations and the effects of relationship threat on sexual motivations. J. Soc. Pers. Relat. 28, 448–468.
Blascovich, J., Bailenson, J., 2011. Infinite reality: Avatars, Eternal life, New worlds, and the Dawn of the Virtual Revolution. William Morrow.
Blow, A.J., Hartnett, K., 2005. Infidelity in committed relationships II: a substantive review. J. Marital Fam. Ther. 31, 217–233.
Brady, A., Baker, L.R., Rowland, S.M., 2020. Look but don't touch?: self-regulation determines whether noticing attractive alternatives increases infidelity. J. Fam. Psychol. 34, 135–144.
Burch, R.L., Gallup Jr, G.G., 2020. Abusive men are driven by paternal uncertainty. Evolut. Behav. Sci. 14 (2), 197–209.
Compton, J., 2013. Inoculation theory. In: Dillard, J.P., Shen, L. (Eds.), The Sage Handbook of Persuasion: Developments in Theory and Practice. Sage, pp. 220–237.
Drigotas, S., Safstrom, C., Gentilia, T., 1999. An investment model prediction of dating infidelity. J. Pers. 77, 509–524.
Dush, C.M.K., Amato, P.R., 2005. Consequences of relationship status and quality for subjective well-being. J. Soc. Pers. Relat. 22 (5), 607–627.
Faul, F., Erdfelder, E., Buchner, A., Lang, A.G., 2009. Statistical power analyses using G*Power 3.1: tests for correlation and regression analyses. Behav. Res. Methods 41, 1149–1160.
Fincham, F.D., May, R.W., 2017. Infidelity in romantic relationships. Curr. Opin. Psychol. 13, 70–74.
Fishbach, A., Friedman, R.S., Kruglanski, A.W., 2003. Leading us not unto temptation: momentary allurements elicit overriding goal activation. J. Pers. 84, 296–309.
Fishbach, A., Zhang, Y., 2008. Together or apart: when goals and temptations complement versus compete. J. Pers. 94, 547–559.
Gordon, K.C., Baucom, D.H., Snyder, D.K., 2004. An integrative intervention for promoting recovery from extramarital affairs. J. Marital Fam. Ther. 30, 1–12.
Guerrero, L.K., Andersen, P.A., 1998. The dark side of jealousy and envy: desire, delusion, desperation, and destructive communication. In: Spitzberg, B.H., Cupach, W.R. (Eds.), The Dark Side of Close Relationships. Erlbaum, pp. 33–70.
Hayes, A.F., 2013. Introduction to mediation, moderation, and Conditional Process Analysis. Guilford Press.
Hoffman, G., Birnbaum, G.E., Vanunu, K., Sass, O., Reis, H.T., 2014. Robot responsiveness to human disclosure affects social impression and appeal. In: Proceedings of the 9th ACM/IEEE International Conference on Human-Robot Interaction (HRI 2014), pp. 1–8.
Johnson, D.J., Rusbult, C.E., 1989. Resisting temptation: devaluation of alternative partners as a means of maintaining commitment in close relationships. J. Pers. 57, 967–980.
Karremans, J.C., Verwijmeren, T., 2008. Mimicking attractive opposite-sex others: the role of romantic relationship status. Personal. Soc. Psychol. Bull. 34, 939–950.
Landau, M.J., Goldenberg, J., Greenberg, J., Gillath, O., Solomon, S., Cox, C., Martens, A., Pyszczynski, T., 2006. The siren's call: terror management and the threat of men's sexual attraction to women. J. Pers. 90, 129–146.
Leck, K., Simpson, J., 1999. Feigning romantic interest: the role of self-monitoring. J. Res. Pers. 33 (1), 69–91.
Lee, B.H., O'Sullivan, L.F, 2019. Walk the line: how successful are efforts to maintain monogamy in intimate relationships? Arch. Sex Behav. 48, 1735–1748.
Linardatos, L., Lydon, J.E., 2011. Relationship-specific identification and spontaneous relationship maintenance processes. J. Pers. 101 (4), 737–753.
Lydon, J.E., Fitzsimons, G.M., Naidoo, L., 2003. Devaluation versus enhancement of attractive alternatives: a critical test using the calibration paradigm. Personal. Soc. Psychol. Bull. 29, 349–359.
Lydon, J., Karremans, J.C., 2015. Relationship regulation in the face of eye candy: a motivated cognition framework for understanding responses to attractive alternatives. Curr. Opin. Psychol. 1, 76–80.
Maner, J.K., Rouby, D.A., Gonzaga, G.C., 2008. Automatic inattention to attractive alternatives: the evolved psychology of relationship maintenance. Evol. Hum. Behav. 29, 343–349.
McNulty, J.K., Meltzer, A.L., Makhanova, A., Maner, J.K., 2018. Attentional and evaluative biases help people maintain relationships by avoiding infidelity. J. Pers. 115, 76–95.
Mizrahi, M., Hirschberger, G., Mikulincer, M., Szepsenwol, O., Birnbaum, G.E., 2016. Reassuring sex: can sexual desire and intimacy reduce relationship-specific attachment insecurities? J. Soc. Psychol. 46 (4), 467–480.
Moore, M.M., 2010. Human nonverbal courtship behavior—A brief historical review. J. Sex Res. 47, 171–180.
Mullinax, M., Barnhart, K.J., Mark, K., Herbenick, D., 2016. Women's experiences with feelings and attractions for someone outside their primary relationship. J. Sex Marital Ther. 42 (5), 431–447.
Newbury, R., Hayter, M., Wylie, K.R., Riddell, J., 2012. Sexual fantasy as a clinical intervention. Sex Relation Ther. 27, 358–371.
Oh, S.Y., Bailenson, J.N., Welch, G.F., 2018. A systematic review of social presence: definition, antecedents, and implications. Front. Robot. AI 5 (14), 1–34.
Pan, X., Gillies, M., Barker, C., Clark, D.M., Slater, M., 2012. Socially anxious and confident men interact with a forward virtual woman: an experimental study. PLoS ONE 7 (4), e32931.
Pan, X., Hamilton, A.F.De C., 2018. Why and how to use virtual reality to study human social interaction: the challenges of exploring a new research landscape. Br. J. Psychol. 109 (3), 395–417.
Poerio, G.L., Smallwood, J., 2016. Daydreaming to navigate the social world: what we know, what we don't know, and why it matters. Soc. Personal Psychol. Compass 10, 605–618.
Pronk, T.M., Karremans, J.C., Wigboldus, D.H.J., 2011. How can you resist? Executive control helps romantically involved individuals to stay faithful. J. Pers. 100, 827–837.
Riek, L.D., 2012. Wizard of Oz studies in HRI: a systematic review and new reporting guidelines. J. Hum.-Robot Interact. 1, 119–136.
Ritter, S.M., Karremans, J.C., van Schie, H.T., 2010. The role of self-regulation in derogating attractive alternatives. J. Exp. Soc. Psychol. 46 (4), 631–637.
Solomon, D.H., Knobloch, L.K., 2004. A model of relational turbulence: the role of intimacy, relational uncertainty, and interference from partners in appraisals of irritations. J. Soc. Pers. Relat. 21, 795–816.
Thomas, J.W., Ward, K., 2006. Economic profiling of physician specialists: use of outlier treatment and episode attribution rules. Inquiry 43 (3), 271–282.
Thompson, A.E., O'Sullivan, L.F, 2016. I can but you can't: inconsistencies in judgments of and experiences with infidelity. J. Relationships Res. 7, 1–13.
Visserman, M.L., Karremans, J.C., 2014. Romantic relationship status biases the processing of an attractive alternative's behavior. Pers. Relatsh. 21, 324–334.
White, G.L., 2008. Romantic jealousy: therapists' perceptions of causes, consequences, and treatments. J. Couple Relatsh. Ther. 7, 210–229.
Zillmann, D, 1983. Transfer of excitation in emotional behavior. In: Cacioppo, J.T., Petty, R.E. (Eds.), Social psychophysiology: A sourcebook. Guilford Press, pp. 215–240.