Perceiving interpersonally-mediated risk in virtual environments

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Abstract

Using virtual reality (VR) to examine risky behavior that is mediated by interpersonal contact, such as agreeing to have sex, drink, or smoke with someone, offers particular promise and challenges. Social contextual stimuli that might trigger impulsive responses can be carefully controlled in virtual environments (VE), and yet manipulations of risk might be implausible to participants if they do not feel sufficiently immersed in the environment. The current study examined whether individuals can display adequate evidence of presence in a VE that involved potential interpersonally-induced risk: meeting a potential dating partner. Results offered some evidence for the potential of VR for the study of such interpersonal risk situations. Participants' reaction to the scenario and risk-associated responses to the situation suggested that the embodied nature of virtual reality override the reality of the risk's impossibility, allowing participants to experience adequate situational embedding, or presence.

Keywords

Presence; Sexual risky; Embodiment; Interpersonal risk

1 The promise of virtual reality

Virtual environments (VE) have shown promise for putting people in situations that would otherwise be difficult, unwise, or simply impossible to examine scientifically. These range from training officers to handle submarines (Vincenzi et al. 2003) to modeling virtual patients for surgical practice (McCloy and Stone 2001) to simulating battles in Iraq (Rizzo et al. 2005) for treatment of post-traumatic stress disorder (PTSD). The key to the successful use of virtual reality (VR) for these applications requires that the person interacting with the VE truly has an embodied experience of the virtual environment. One assumption regarding this sense of presence is that if the person feels engaged in the VE, the perceptual and psychological processes that are normally activated in the real world are similarly activated by the VE (Biocca et al. 2003). This ensures, in turn, that physical actions that occur in the VE are likely to reasonably represent and transfer to participants' actions in analogous real world situations.

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1.1 Risk in VR

The suspension of disbelief while in a VE is critical for situations in which VR is used to demonstrate physical or psychological risk. For example, in a study of participants' response to the outbreak of a fire in a VE (Gamberini et al. 2003), participants who saw a virtual fire directly below their avatar's[1] body raised their actual arms to avoid injury from the virtual fire. This action suggests that the virtual threat was viewed as one that could physically harm them (Gamberini et al. 2003). This logic extends to the use of VR for the treatment of PTSD. It is critical that through experiencing simulated battle, patients feel some risk of harm to themselves so that they can learn to regulate relevant reactions and emotions. Interestingly, it is not presumably by an act of will that participants suspend disbelief and decide to experience the situation as if it is a real one. Rather, the power of a VE to evoke naturalistic reactions comes through the VE respecting the perception-action processes that occur when one is normally embedded in situations in the real world, in which one has embodied experiences (information from one's sensory and action systems). Key processes involve tight coupling of one's actions and movements in that world with one's perceptual experience of that world—processes that hold true not only for single actors interacting with their physical environment (Gibson 1979) but for socially grounded environments as well (Marsh et al. 2006; Marsh et al., in press).

1.2 Presence is needed for social interactions in VR

Fundamental to the promise of VR for studying social interactions is the assumption of a sense of presence in that social interaction. Extensive reviews of the presence research suggests not only factors about the VE (such as resolution, vividness, and interactivity of the VE) but also factors about the person that can affect sense of presence (Schubert et al. 2001; Sanchez-Vives and Slater 2005). For instance, research suggests that to be present in VR a person must both focus their attention on the VE, but also actively ignore input from the real world. Similarly, Schuemie et al. (2001) suggests that one of the most important features of presence, especially with interpersonal situations, is that VR evokes emotions and action that would be similar to the real world. This same need for engagement in an environment extends to social interaction situations that would be nearly impossible to examine unobtrusively in real-world settings, such as intimate interactions.

Thus, the embodied experience of an adequate virtual interpersonal situation can override our knowledge that the environment is computer-mediated. This has been demonstrated through the replication of classic social psychological phenomena in VE in the research domains of persuasion (Eastwick and Gardner 2005,2009) and ostracism (Williams et al. 2000). More broadly, Blascovich et al. (2002) have extolled the virtues of VR for use in social psychology. These results are supported by the ideas of Reeves and Nass (1996) who suggest that people act toward computers, in this case VR, as if it were the real world. The lack of distinction between computers and people works to the advantage of VR allowing real-world phenomena to transfer to VR. Consequently, VR can obviate the need for complicated experimental designs that are often needed to replicate a "real world" phenomenon under appropriate experimental control.

The criticality of presence is especially apparent if one wishes to observe social interaction situations in VR that are nearly impossible to do unobtrusively in real-world settings, such as intimate interactions. Paradoxically, the methods commonly used to study these situations outside of VR require processes that are at odds with those necessary for total engagement. These situations traditionally have been examined through discussing past encounters or by

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[1]The terms "agent" and "avatar" both refer to computerized representations of humans in a virtual environment. By convention, "agents" are computer-driven and "avatars" are controlled by real people. We use these terms according to this convention in the present article.

using role-playing to practice for future ones. However, research (Grice 1975; Clark 1996; Gilbert 1996, 2000) suggests that "pretend" communications require simultaneously operating at dual layers—monitoring reality and the content of the communication simultaneously (Austin 1962; Clark 1996). This heightened mindfulness required in role-playing cannot reflect online behavior in the "now" because there is always awareness that one is co-participating in "pretend play." While engaging in "practice" behavior, a person is also aware of their actions and thinking about how their actions should be different, which does not often happen in the analogous real-world situation.

However, when one is fully immersed in a VE, this dichotomy can vanish. Without this dual monitoring of both the real self ("I am interacting with a computer") and pretend self ("I am pretending to talk to an attractive man in a bar") in the eyes of the other, a fully immersed self-awareness remains in which the self in the VE can be experienced as ones' true self ("I am talking to an attractive man in a bar"). Paradoxically, it is because the other "person" we are interacting with in VE does not have a dual reality outside of the situation (as a peer in a role play does) that the meta-cognitive processes of monitoring both the real-world and the play world can be suspended.

1.3 Evidence for perceived risk in VR

Despite this logic, it is tempting to conclude that studying sexual behavior in a virtual environment will still be limited because participants can cognize that their behaviors are always "safe," regardless of the choices they make. In other words, participants may feel a low level of risk in interpersonal dating situations they encounter in VEs because the interactions may not evoke real physical consequences (e.g., they rationally can understand nothing will happen if they agree to engage in sex without a condom). Prior research, however, counters these assumptions, demonstrating that physiological reactions in VR mirror real-life situations in which there is no objective risk. For example, agoraphobics feel shakiness in their knees, sweaty palms, and dizziness when forced to confront their phobias in VEs (North et al. 1997). In addition Lee et al. (2003) found that cues (such as a lighter) to nicotine craving can elicit more intense responses in VR than static pictures of the cue. Similarly, Bordnick et al. (2008) have found greater alcohol cravings in an environment in VR that included visual, auditory, and olfactory cues. Taken together, these results suggest that cues presented in a virtual environment can trigger psychological responses that are at least as intense as would be triggered by the real-world. In addition, virtual cues may be more effective at eliciting psychological responses compared to traditional (static) methods of cue exposure. Moreover, Biocca et al. (2003) and Bailenson et al. (2003) suggest that because computers allow us to both control and study social cues and social cognition that go along with our actions, mediated environments may be optimal for studying interpersonal communication processes. Despite all this implied promise, there is little evidence to date that immersive virtual sexual situations can be construed as risky or that individuals respond to them in ways that match their normal behavior.

The purpose of the current study, is specifically to explore presence, and particularly, perception of risk in a VE in order to examine real-world contexts in which condom use may subsequently take place. Unlike other health domains, self-report measures of sexual behavior and attitudes toward sex and condoms are of limited value when predicting precursors to that behavior, provided it is occurring in impulsive contexts (Marsh et al. 2001). Because the precursors to sexual behavior often occur in a highly impulsive situation, and are often cued by features of the environment, their measurement should ideally also capture these features. For example, potential sexual partners that are attractive are often seen as posing less HIV risk than those that are less attractive (Epstein et al. 2007). Similarly, the simple presence of an object, such as condoms, in the room during an interaction could influence evaluations (e.g.,

heighten or lower riskiness) of others in that room because of a phenomena known as priming (Bargh et al. 1996). These environmental influences are critical to studying risk behavior. As a first step in that direction, however, the utility for using VR to examine interpersonally-mediated risk (sexual or otherwise) must first be established.

1.4 The present research

As an initial step in exploring the utility of immersive VR for examining risk-related interpretations of a virtual situation, we exposed participants to a simple interpersonal encounter with an opposite-sex agent. Afterwards, participants' risk-relevant interpretations of the situation and willingness to engage in risk-related behavior were assessed. Our purpose was to assess whether participants' risk-related reactions to the virtual situation paralleled the behavior that participants normally would engage in outside of the laboratory or if participants would respond as if the situation was risk-free. In addition, to examine whether reactions to the setting might be affected by the presence of a sexual stimulus that could evoke varying reactions, we manipulated whether participants saw condoms.

This study examines how visual cues in the environmental and interpersonal cues related to interpersonal risk can influence attitudes and intentions about behavior that would normally be considered risky in the real world. We predict that participants will feel at least somewhat present during their interaction with the agent. This presence will manifest in traditional self-report measures as well as behavioral correlates of presence. Behavioral correlates will be evidenced in behavior in the VE conforming to social norms for real-world interaction (e.g., responding to questions asked of them) and their responses to the VE that are congruent with their own typical risk behavior (e.g., willingness to drink with an agent in the VE only if they typically do so in real life). This sense of presence in the VE will hamper participants from viewing the situation as totally risk-free because it isn't perceived as "real." Consequently, we predict that participants will be able to infer the risk in the situation, and the agent with whom they interact.

2 Method

This study design was a 2 (Condition: Condoms Visible, No Condoms Visible) × 2 (Participant sex: Male, Female) factorial design. Condition was a manipulated, between-subjects variable, and participant sex was a (non-manipulated) subject variable. Participants were randomly assigned to condition.

2.1 Participants

Forty-six students and staff from a mid-size university in the northeastern United States were recruited for a study entitled "Assessing Virtual Reality Situations" via e-mail and flyers posted around campus. Participants were paid $10 for their participation in the 30-min study. Participants were, on average, 21.6-years-old (SD = 6.03, range: 17–52), nearly evenly split on sex (55% men), predominantly White (76.1%), and all self-identified as either Heterosexual (93.5%) or Bisexual (6.5%).

2.2 Virtual environment (VE) and equipment

The VE was designed to look like the living room of an apartment with attractive furnishings that included a couch, coffee table, end table, and decoration on the walls and objects in the room (including a half-full cup on the coffee table). Participants interacted with the VE using a Dell Workstation PWS350 (*Dell*, *Round Rock*, *TX*), using an i-glasses Video 3D Pro Head Mounted Display (HMD; *i-O Display Systems*, *Menlo Park*, *CA*), an InterSense MiniTrax Head Tracker (*Intersense*, *Bedford*, *MA*), and a Microsoft sidewinder joystick (*Microsoft*,

Redmond, *WA*). The VE was programmed in Python and run using Vizard (*World-Viz LLC*, *Santa Barbara*, *CA*).

The agent ("Blair") was an attractive Caucasian male or female designed to be approximately college-aged. In a pilot study validating various aspects of the VE ($N = 19$) Blair was rated to be attractive ($M = 5.05$ out of 7), significantly higher than the scale midpoint, $t(18) = 3.47$, $p = 0.003$. In the present study, participants interacted only with the opposite-sex agent. The audio track that represented Blair's voice within the VE was recorded by research assistants who did not participate in data collection. The audio content did not differ as a function of Blair's sex. The participant viewed the VE from a first-person perspective through the HMD, and they could see their own avatar's body from that perspective only if they looked down.

2.3 Procedure

To enhance immersion, participants were run individually in a darkened room. The research assistant sat quietly behind the participant during the experimental phase and answered participants' technical questions if directly asked, but otherwise only observed the session. After giving their consent to participate, participants were then oriented to the VE and HMD, tracker and joystick by the research assistant using a virtual office environment. After the research assistant demonstrated the functions of each device, the participant explored the office environment for approximately 5 min to practice the skills necessary to interact with the VE during the experimental phase of the study. Participants practiced moving their body (using the joystick) and head (using the HMD and attached tracker), and manipulating objects, including closing a drawer on a file cabinet (using the joystick) until they demonstrated their competency to perform these actions. They also were instructed how to sit down in the VE. After being oriented to the VE, the research assistant told participants that they were about to enter Blair's apartment where a party was about to start. Participants were told Blair was their friend Sam's roommate who thought they were cute. This was done to set the scene and also to engage the salience of the participant's potential interpersonal relationship (Biocca et al. 2003) with the agent. The participant then guided their avatar into the apartment.

2.3.1 Interaction with agent in virtual environment—Upon walking through the door to the apartment, Blair, who was seated on the couch, looked up from a book, greeted the participant and asked their name. Next, Blair prompted the participant to "look around" the apartment. After 25 s, while the participant was walking around behind the couch, Blair casually asked the participant if they would mind closing a drawer that s/he had left open in a desk near the participant. When participants used the joystick to shut the drawer, among other objects in the drawer, some saw a box of condoms and three individually wrapped condoms (Condoms Visible Condition); other participants did not see condoms (No Condoms Visible Condition). Seeing the condoms among the objects in the drawer or not constituted the main independent variable of the study.[2] After shutting the drawer, Blair asked participants to sit and "Tell me something about yourself." Participants maneuvered their avatar to one of the available seats next to Blair and hit a button on the joystick to sit. About 4-s after their avatar sat, the screen faded to black. After completing the experiment, which lasted an average of ten minutes, participants completed the outcome questionnaire.

2.4 Measures

2.4.1 Evaluation of environment and agent—Participants rated the ease of navigating the VE, the attractiveness of the VE, and the attractiveness of Blair all on 7-point Likert-type

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[2]The VE was programmed so that participants had to be very close to the drawer in order to shut it. Consequently they had to stand directly in front of the open drawer and look down to ensure they were close enough to shut it. This ensured the contents of the drawer (e.g., condoms) were in their visual field.

scales anchored by 1 (*not at all*) and 7 (*very much*). In addition, participants rated their general attitudes toward the VE and Blair on a thermometer scale where 0 indicated they felt cold or unfavorable and 100 indicated they felt warm or favorable.

Open-ended qualitative measures included asking participants to: recall as many items in the apartment as they could (to probe for mention of condoms), to report what they thought was in a cup on the table in front of Blair (to probe for mention of alcohol), and to describe how Blair looked (to evaluate type of characteristics mentioned).

2.4.2 Measures of presence—Although self-report measures of presence have been criticized as being overly broad or circular (Biocca et al. 2003), they are still the most widely used and accepted method. Therefore, one measure of presence was a 7-item modification of the Igroup Presence Questionnaire (Cronbach's α = 0.577, 0.792 with one item deleted[3]) from Schubert et al. (2001). This questionnaire was selected because of its parsimony, as well as its focus on involvement in the VE and realism, which are critical for experiencing interpersonal risk in a VE. Additionally, the authors suggest that the scale is related to cognitive processes instead of media effects of the VE, and as such may be better tied to the level of immersion necessary to perceive risk in a VE.

Participants' responses on these items were averaged to create a composite score that indicated how immersed the participants felt in the VE (see Appendix for items used). To expand upon the traditional measures of presence, behavioral measures were also used. At two points during the experiment, Blair asked participants questions (e.g., "What's your name?"). Responses to these questions were recorded by the research assistant monitoring the session. Responding to Blair's questions indicated the participants felt immersed in the environment enough to interact with Blair as they would a real person. Participants also completed a 13-item modified version of the SAFECOM scale (Buck et al. 2004) to indicate what emotion they perceived Blair to be experiencing during the interaction (e.g., Confident).

2.4.3 Measures of Risk—To assess if interpersonal risk could be inferred in a VE, and thus an indirect indication that participants had some minimal level of psychological immersion, participants were asked to report on Blair's risk-taking proclivity using the 10-item JPI-Risk Taking Scale (Cronbach's α = 0.848, Goldberg et al. 2006). For example, items assessed how willing participants thought Blair would be to "Stick to the rules" or "Seek danger".

To measure participant risk behavior, participants were asked if they would engage in a series of behaviors with Blair such as smoking, drinking or having sex with possible responses of yes, no, or not sure. If they indicated that they would not have sex with Blair, they were asked to provide a reason in a single open-ended question. Finally, to assess their own risk profile, participants indicated how often they smoked, drank, and had sex during the previous week. They then answered demographic questions, including previous computer game experience to use as a potential covariate in the analysis to control for familiarity with interacting with computer driven agents.

3 Results

3.1 Ratings of VE and Blair

Participants rated the VE as attractive (*M* = 4.50, *SD* = 1.47) and realistic (*M* = 4.48, *SD* = 1.30), both of which were significantly higher than the scale midpoint, *t*(45) = 2.304, *p* = 0.026 and *t*(45) = 2.505, *p* = 0.016, respectively. Most participants (82.6%) rated Blair above the

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[3]After dropping the one item (see Appendix), Cronbach's alpha was 0.792. Analysis using this revised scale did not change the interpretation of any of the effects. Therefore, all analyses reporting on the presence score report results using the full scale.

midpoint of the scale on attractiveness. Six participants (13.1%) rated Blair either six or seven (out of seven) on the scale. On the thermometer scale, participants reported feeling warm/ favorable toward both the VE ($M = 61.6$, $SD = 18.92$) and Blair ($M = 56.4$, $SD = 21.8$), both of which were significantly higher than the scale midpoint of 50, $t(45) = 4.17$, $p < 0.001$ and $t(45) = 2.1.99$, $p = 0.05$, respectively. On the thermometer scale, nearly threequarters of participants (74%) rated the VE at 60 or higher (out of 100) and nearly half of participants (47.7%) rated their feelings toward Blair at 70 or higher. Blair was rated as slightly attractive ($M = 4.20$, $SD = 1.33$), which was not different from the scale's midpoint, $t(45) = 1$, $p = 0.323$. Ratings of attractiveness of Blair were not moderated by sex, $F(1, 42) = 0.017$, $p = 0.898$, or condition, $F(1, 42) = 0.670$, $p = 0.418$.

3.2 Presence within VE

3.2.1 Presence measured by scale—Participants rated their experience of presence in the VE as near the midpoint of the scale, $M = 4.06$, $SD = 1.13$ (range: 1.43–5.86). This was not significantly different from the midpoint $t(45) = 0.356$, $p = 0.724$, thus indicating that, on average, they neither agreed nor disagreed that they felt immersed in the environment during the study. Two participants had composite presence scores of between 1 and 2, seven had scores between 2 and 3, eight had scores between 3 and 4, 20 had scores between 4 and 5, and nine had scores between 5 and 6. No participants had presence scores between 6 and the maximum possible score (7). However, presence differed by condition. Participants in the condom condition felt more present than those in the no condoms visible condition, $t(27.07) = 2.78$, $p = 0.01$ ($M = 4.43$ vs. 3.48).

3.2.2 Presence measured by behavior in VE—We also assessed how immersed participants felt within the VE by assessing whether they verbally responded to questions posed by the agent. When asked their name, 76.1% (n = 35) of participants responded. When asked by the agent to tell him/her something about themselves 64.0% (n = 29) responded.[4] Overall, 78.3% (n = 36) of participants verbally responded to at least one of the questions posed by the agent. There were no differences by age, previous computer experience, or presence (as measured by the questionnaire) between those that responded to at least one question and those that responded to neither, ts(44) < 1.2, ps > 0.233.

3.2.3 Presence measured by reaction to Blair—Another measure of presence was participants' written responses when asked to physically describe Blair. Two research assistants blind to experimental hypotheses independently coded statements as relating to either: physical, objective characteristics (e.g. "Blair had brown hair"), valenced physical characteristics (e.g. "Blair looked pretty"), inferences made about Blair's mental status (e.g. "Blair seemed happy"), disbelief in agent's reality (e.g., "Blair looked fake"), or miscellaneous. There was 98.3% agreement between the coders with kappa = 0.905 indicating excellent agreement, and ratings well above chance levels. Disagreements were resolved through discussion.

On average, participants provided 4.6 statements about Blair's appearance ($SD = 1.90$, range: 1–10). The majority of statements were physical objective ($M = 2.6$), followed by inferences about Blair's mental status ($M = 1.2$), and valenced physical statements ($M = 0.22$). There were no statements questioning Blair's reality, indicating that Blair was primarily perceived to be a person, and not a computer-driven agent. Examining the first thought listed as an indicator of the most cognitively accessible and primary response, 91% (n = 42) listed a physical objective characteristic of Blair, again indicating a degree of presence in the VE. The content of the first

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[4]Coding of the content of responses to this question was not possible because the VE was programmed to fade to black 4-s after this question was asked; in most cases participants stopped their responses mid-sentence when the VE closed.

thought was not affected by participant sex, $X^2(2) = 3.273$, $p = 0.195$, or experimental condition, $X^2(2) = 0.741$, $p = 0.690$.

Measures of perceived emotion felt by Blair, using the SAFECOM scale, also provide some evidence that participants were immersed in the VE and saw Blair not as a computer-driven agent, but as a person. Blair was perceived to be feeling not at all afraid, nervous, embarrassed, angry, hostile, isolated or sad (with means significantly below the midpoint) and very happy, satisfied and confident and somewhat sexy (with means significantly above the midpoint for all items except "feeling sexy," for which $p = 0.08$). The only emotion rating influenced by sex or condition was "feeling sexy". Overall, men viewed Blair as feeling sexier than women viewed Blair, however, there was a significant interaction between participant sex and condition, $F(1, 41) = 6.19$, $p = 0.017$. Women in the no condoms visible condition perceived Blair to be feeling less sexy ($M = 1.29$) than did women in the condoms visible condition ($M = 3.58$) and men in both the no condoms visible condition ($M = 4.30$) and condoms visible conditions ($M = 3.93$).

Although the participants' presence would not necessarily lead to a strengthening of the valence of perceived emotion, the *extremity* of emotions could well be enhanced by presence. To explore this question, we correlated presence scores the extremity of inferred emotion, such that a positive correlation would indicate more extreme inference of some kind of emotion for participants who reported more immersion. The correlations were not significant when examining the individual emotion items or the SAFECOM subscales, rs < 0.27, ps > 0.05.

3.3 Risk measures

3.3.1 Recall measures—Examining the content of the items recalled by participants, there was no effect of condition on proportion of participants mentioning seeing condoms, $X^2(1) = 0.862$, $p = 0.352$, with four participants in the condom condition and one in the no condoms visible condition mentioning condoms among the items they recalled seeing in the VE. The responses to the probe for mention of alcohol were nearly uniform; only one participant reported thinking alcohol was in the glass. No further analyses were performed with this outcome measure.

3.3.2 Perception of risk—A primary interest was to examine if the agent Blair would be perceived as posing a risk to participants. Using the modified risk scale, participants rated Blair as somewhat risky, $M = 4.21$, $SD = 0.742$ (95% CI: 3.99, 4.43), which was marginally significantly higher than the scale midpoint, $t(45) = 1.920$, $p = 0.06$. There was a significant interaction between sex and condition on this rating, $F(1, 42) = 5.05$, $p = 0.03$, $\eta^2 = 0.107$. Simple effects revealed that women who saw condoms in the drawer rated Blair as riskier than women who did not, $F(1, 45) = 5.47$, $p = 0.024$, whereas there was no difference by condition for men (Fig 1). Presence and perceived risk were not correlated, $r(36) = 0.147$, $p = 0.330$.

3.3.3 Risk intentions—To examine if participants' past real-world risk behavior would be replicated in the VE, we compared participants' intentions to smoke, drink and have sex with Blair with self-reported behavior during the week prior to the study. Only participant reported smoking during the last week, thus no statistical analyses (as a function of past behavior) were conducted on this item. Half of the participants (n = 23) reported intending to drink with Blair. Those that reported drinking in the last week had more than three and a half times the odds of reporting intentions to drink with Blair than did participants who reported no drinking in the last week, $X^2(1) = 3.92$, $p = 0.048$, $OR = 3.6$ (95% CI: 2.30, 4.90). Nine participants, all of whom where male, reported intending to have sex with Blair. Participants reporting sex in the last week were no more likely to report intending to have sex with Blair compared to participants reporting no sex in the last week, $X^2(1) = 0.755$, $p = 0.437$.

Further examining intentions for sex, participants who saw condoms were marginally more likely to report intending to have sex with Blair (33.3%) than those who did not see condoms (11.5%), $X^2(1) = 3.105$, $p = 0.078$. Reasons for not intending to have sex with Blair were coded by two independent raters (Fig 2). Slightly less than a third (32.5%) of the responses focused on the fact that Blair was in fact a computer-driven agent and not real. The remaining reasons focused on the short time knowing Blair (37.5%), Blair not being attractive enough (15%), the participants currently being in a relationship (12.5%), and potential risk of the encounter (2.5%).

Participants who reported intending to have sex or drink with Blair rated Blair as more attractive than participants who did not intend to perform these behaviors, $t(42) = 2.794$, $p = 0.008$ and $t(44) = 3.018$, $p = 0.004$, respectively (Fig 3). There was no reported difference in Blair's attractiveness as a function of smoking intentions. In addition, there were no differences in willingness to engage in any risk behavior with Blair by either reported presence in the VE, $F(3, 40) = 0.349$, $p = 0.79$, or Blair's perceived riskiness, $F(3, 40) = 1.242$, $p = 0.30$).

4 Discussion

The purpose of this study was to explore psychological presence in the context of a potential dating scenario through risk-related perceptions and reactions to the VE. These responses are critical before beginning to use VR in contexts such as interpersonal encounters that precede potentially risky sex.

4.1 Results supporting presence

Many results of the behavioral and psychological measures suggested some degree of presence, albeit relatively modest presence: a majority of participants answered the agent's questions in the scenario out loud, they showed context-appropriate reactions to the agent's attractiveness, and made appropriate interpretations of the agent's mood and perceived riskiness. The experimental manipulation, presence of condoms in the VE, had relatively limited, but intriguing effects. First, adding an interesting or perhaps unexpected stimulus in the situation heightened presence in the scenario; participants in the condoms visible condition felt more presence than if they saw only ordinary objects in the drawer. Notably, the presence of condoms had an effect on the perceived riskiness of the Blair, moderated by participant's sex. A standard self-report measure of presence showed an adequate, but not high, degree of psychological presence within this brief interaction. Yet, a fifth of the sample did not respond verbally when prompted by the agent, and there was no relation between presence score as measured by questionnaire and the number of questions responded to orally. These findings may suggest that behavioral measures of presence, such as responding appropriately to a question asked in a VE, may only indicate if there is the most minimal level of presence in a VE, whereas more extensive measures may be more accurate at gauging the level of presence. Similarly, a significant minority of those who expressed reasons why they would not have sex with the Blair were due to the imaginary nature of Blair.

4.2 Risk behavior

Evidence of parallels between behaviors in the real world and willingness to engage in them with the virtual agent were mixed. Importantly, participants' tendencies for engaging in sex and drinking in the real world were not suspended in the virtual world. Participants who had reported drinking in the past week were more likely to report being willing to drink with Blair. Only a small subset of men (and no women) reported that they would have sex with Blair. Participants who saw condoms in the VE were marginally more likely to report willingness to have sex with Blair compared to those who did not see condoms. Viewing the condoms may have increased sexual associations which led to greater intentions to have sex rather than acting

to reduce the perceived risk of Blair. This explanation may be plausible as willingness to engage in risky behaviors was not associated with the perceived riskiness of Blair. However, as other have found (Lance 2004), sex may play a role in these risk perceptions; women who saw condoms perceived Blair as riskier than women who did not, whereas there was no difference for men. Providing more evidence that risk-related behavior in the scenario was not arbitrary, perceived attractiveness of Blair was related to participants' willingness to have sex and drink with Blair.

4.3 Limitations

Although these data appear to support the idea that people can and do perceive risk that is not visually apparent, such as that posed by a potential sexual partner, there are limitations to these conclusions that must be acknowledged. First and foremost, while we stressed that the major benefit of using VR in studying such situations allowing for behavioral measures of risk, we relied on self-report measures asking participants which behaviors they would engage in. Although this was not optimal, it did allow us to get a sense of whether any risk could be perceived, and was the most that could be done with the available programming capacity and funding for this project. Future studies using this paradigm will incorporate more behavioral measures of risk-taking behaviors such as having the participants engage in behavior within the VE, including having them "drink" a bottle of beer or undress their avatar in anticipation of sex.

Another limitation of the current research is the possibility of the measures of presence reflecting some level of experimenter demand, which could have been exacerbated by the research assistant's presence in the room as the participant interacted with the VE. To attempt to control for this, the research assistant remained silent except when specifically asked a question by the participant; they were not in the room when participants completed the self-report measures. We interpreted participants' verbal responses to and ratings of Blair as a proxy for presence in the VE. However, it is conceivable participants believed that we were asking them to respond as if Blair were real, while maintaining the idea that Blair was, in fact, not real. In that case, the level of psychological presence, and corresponding level of emotional engagement, would approximate what occurs in role-playing. Even if this were the case, the environmental cues that often influence behavior in these situations, such as Blair's attractiveness and the presence of condoms, still had influence in line with their impact in actual behavioral settings. Such results seem somewhat harder to explain in terms of demand, as participants are unlikely to be able to project how they are meant to respond for hypotheses they are unlikely to know because they involve complex interactions among variables. Finally, one limitation may be that participants interacted with Blair in the VE for only 10 min, a seemingly short time to determine if they would engage in risk behavior with Blair. However, research has shown that judgments of a person's traits can be accurately made quite rapidly (Ambady and Rosenthal 1992). More to the point, sexual encounters can, and do, occur between strangers who have just met (Paul et al. 2000).

4.4 Conclusion

In sum, this study suggests that research that uses virtual interpersonal interactions to examine the link between social cognitive and motivational behavior that offers potential health risks is warranted. Participants can feel at least some modest sense of presence in a virtual situation, which allows for the perception of interpersonal risk from an agent. We see this study as a first step in establishing the potential of embodied processes that VEs can provide, which would otherwise be impossible to do in the real world settings using traditional techniques.

Acknowledgments

Appendix

Modified Igroup Presence Questionnaire (Schubert et al. 2001)

| Question	Scale anchors
In the computer generated world I had a sense of "being there"	Not at all—Very Much
I felt like I was really in a room.	Strongly disagree—Strongly Agree
I really felt like I was interacting with Blair.	Strongly disagree—Strongly Agree
After a while, it felt like the virtual room was a real room.	Strongly disagree—Strongly Agree
I was motivated to be involved with the scenario.	Strongly disagree—Strongly Agree
The thought that Blair was not a real person crossed my mind constantly.[a]	Strongly disagree—Strongly Agree
How disturbing was the lag or delay between your movements of the controls and the response in the computer-generated world?	Didn't notice it—Very Disturbing

[a]*Note*: Cronbach's Alpha = 0.577. Deleting the item "The thought that Blair was not a real person crossed my mind constantly" increased Cronbach's alpha to 0.792. Analysis using the presence scale without this item did not change interpretation of any effects. For analyses reported we have retained this item as it is key to our hypotheses about risk perception in impulsive situations

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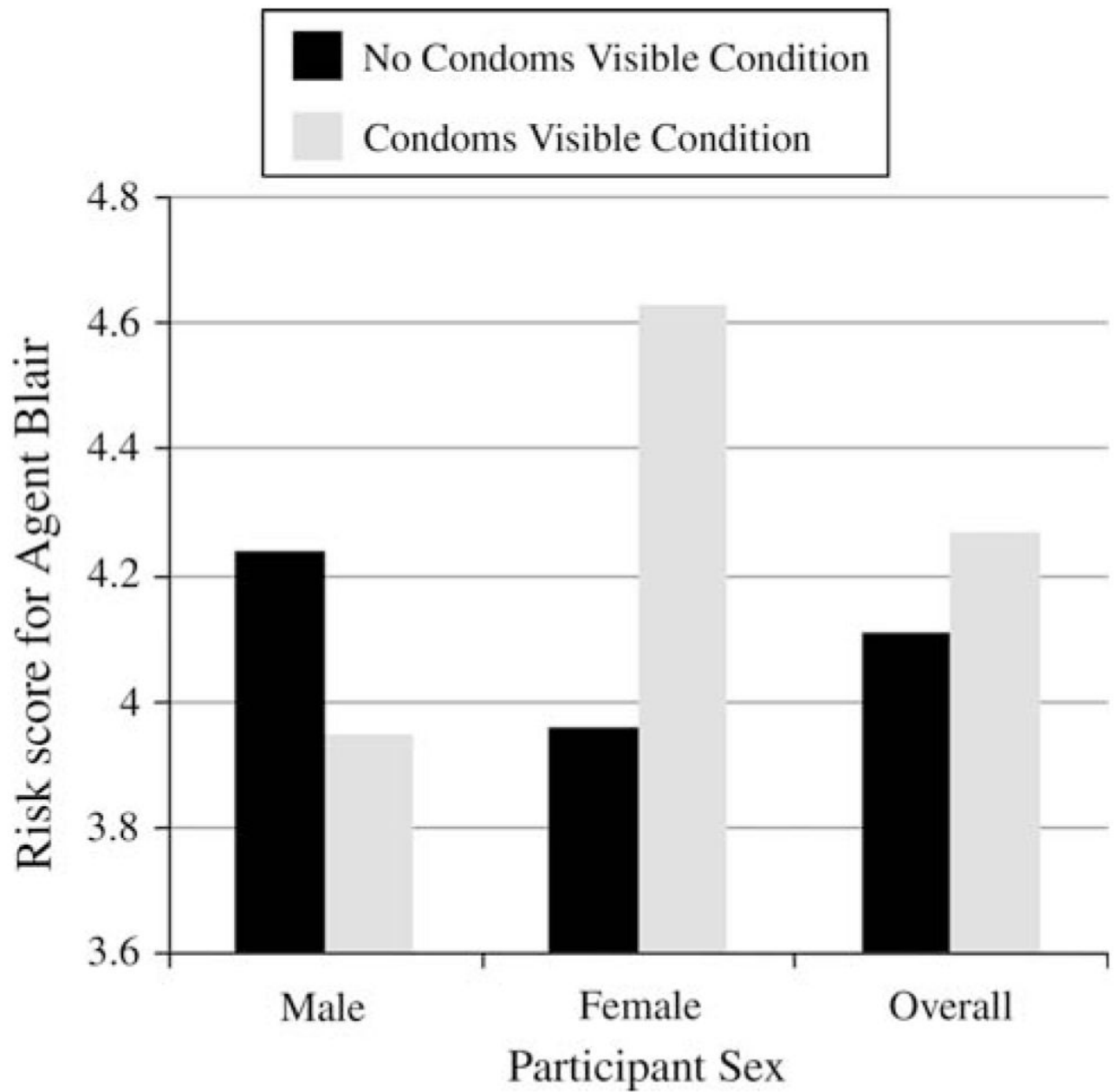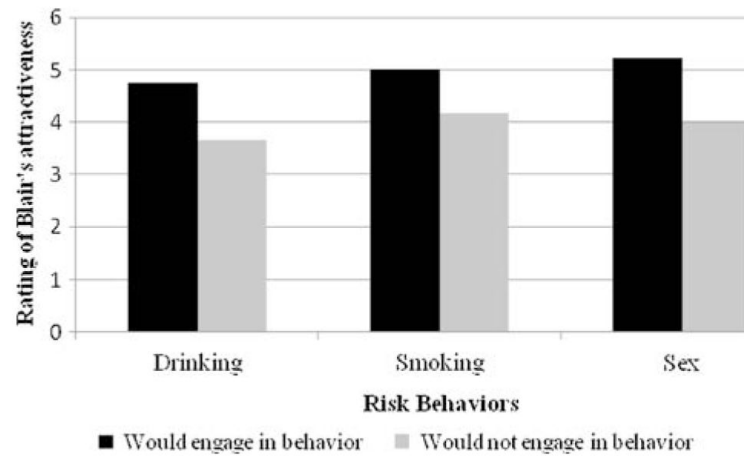
Fig. 1.
Perceived riskiness of agent by participant sex and condition
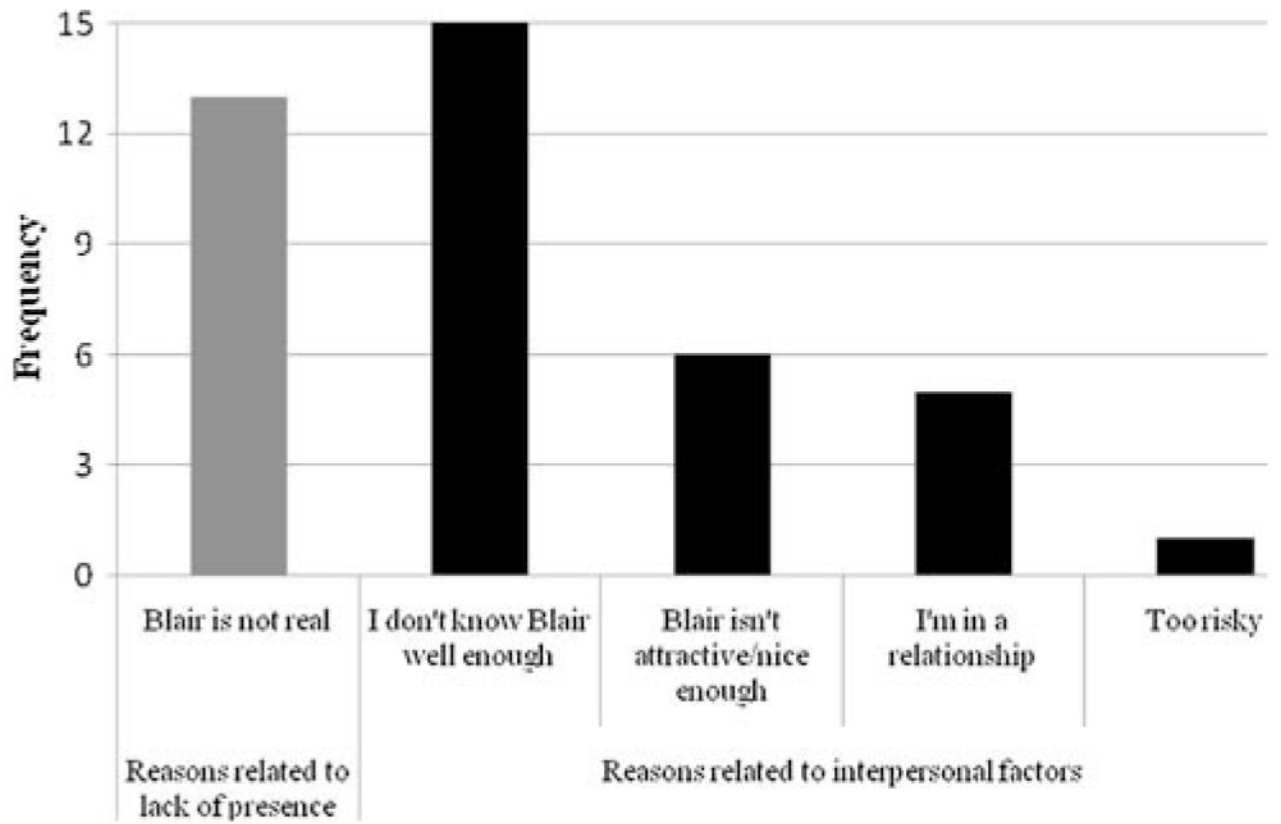
Fig. 2.
Reasons given for not having sex with agent (Blair)

Fig. 3.
Associations between perceived agent (Blair's) attractiveness and willingness to engage in risk behaviors