Reducing Risky Sexual Decision Making in the Virtual and in the Real World

Serious Games, Intelligent Agents, and a SOLVE Approach

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Everyday millions of adolescents and young adults take potentially life-altering risks, including not using a condom when having sex. Sadly, nearly half of all new HIV infections are contracted in adolescence and young adulthood (Fisher, Fisher, Bryan, & Misovich, 2002). Although HIV is increasingly prevalent among heterosexual individuals, over 18,000 men who have sex with men (MSM) are newly diagnosed with HIV/AIDS annually, representing 70% of all male adults and adolescents diagnosed, and 51% of all newly diagnosed cases of HIV/AIDS in 2004 (Centers for Disease Control [CDC], 2006). Among those 18 to 30, younger MSM engage in more risky sexual behaviors (MacKellar, et al., 2005; Xia et al., 2006). Despite these numbers, progress in stemming new HIV cases seems stalled. One reason may be that a younger, tech-savvy generation of MSM may “tune out,” or disregard conventional prevention messages (for a review, see Wolitski & Valdiserri, 2001, pp. 883–884).

Younger MSM may instead be responsive to interactive interventions (e.g., interactive video, intelligent agents/games) especially when delivered via the Internet—a “potentially powerful tool for use with HIV prevention interventions” (CDC, 2006, p. 4). Certainly, in educational domains, interactive media—compared to noninteractive media—has been shown to enhance transfer of learning (e.g., Moreno, Mayer, Spires, & Lester, 2001), but the literature on the effectiveness of interactive health interventions is more limited. Nevertheless, there are educational interventions that show promise for enhancing health education in a number of domains (e.g., Bartholomew et al., 2000; Lieberman & Brown, 1995; Reis, Riley, & Baer, 2000; Tingen, Grimling, Bennett, Gibson, & Renew, 1997) including diabetes management (e.g., Brown, et al., 1997) and dietary change (e.g., Brug, Campbell, & van Assema, 1999; Campbell, DeVellis, Strecher, & Ammerman, 1994; Kreuter & Strecher, 1996; Winett, Moore, Wagner, & Hite, 1991).
The challenge for researchers, however, is to design interactive interventions that (1) utilize theory that integrates the best intervention efforts from past literature and new opportunities for investigation and discovery that are enabled by interactive technologies, while enhancing our ability to predict future behavior and optimize risk reduction; (2) take advantage of the shared available features of interactive and gaming environments (e.g., the ability to create virtual choices that realistically map onto real-life, interactivity, personalization); and (3) take advantage of the special features of intelligent agent and gaming technologies available today and on the horizon. In this chapter, we discuss work funded by grants supported by the National Institutes of Health (NIH). Our approach to changing risky behavior is called Socially Optimized Learning in Virtual Environments (SOLVE) using interactive technologies (interactive video [IAV] and intelligent agent and gaming technologies [IT] that address each of the above issues).

**Socially Optimized Learning in Virtual Environments: SOLVE Theory**

**Traditional Approaches Help Reduce Risk-Taking: But More Needs to be Done**

Guided by a variety of theoretical approaches, such as Bandura's (1994) cognitive social learning theory, cognitive behavior therapy (Beck, 1970), and the theory of planned behavior (Ajzen, 1985, 1991; Ajzen & Fishbein, 1980), various researchers (for reviews see DiClemente & Peterson (1994) and Fisher & Fisher (1992)) have demonstrated that extensive training in cognitive and behavioral skills can significantly reduce high risk sexual practices (e.g., anal sex without a condom). Based on this work, Kelly (1995) has identified a number of theory-based components that should be included in a behavioral intervention for changing risky sexual behavior for men who have sex with men. For example, intervention components should be designed to increase perceived self-efficacy for engaging in safer choices, support beliefs that those changes will reduce risk (Ajzen, 1991; Bandura, 1994), and form and bolster strong behavioral intentions to use safer sex behaviors when appropriate (Ajzen, 1985). Additional components should support the learning of behavioral skills (such as condom use and assertiveness skills), and enhance self-management skills for managing cognitions and behaviors relevant to risky situations (Beck, 1970; see also Kelly, St. Lawrence, & Betts & Brasfield, 1990; Kelly, St. Lawrence, Hood, & Brasfield, 1989).

Nevertheless, there are several major shortcomings to traditional interventions: (1) they are labor intensive, expensive to deliver, and require large participant time commitment at an intervention delivery site; (2) variance accounted for in risk reduction is typically small (Baron & Brown, 1991; Kirby, 2001; Romer, 2003) even with more sophisticated methodological approaches and
prospective designs controlling for initial behavior/perceptions (e.g., Brewer, Weinstein, Cuite, & Herrington, 2004; Fishbein & Yzer, 2003; Gerrard, Gibbons, Benthin, & Hessling, 1996); and (3) these “kitchen sink” approaches do not tell us what (within the intervention) is (and is not) working for whom under what conditions, thereby making improvement difficult.

**Interactive Environments Can Address Some of These Shortcomings**

Consistent with research on factors that mediate HIV prevention for MSM (e.g., Kelly, 1995) SOLVE argues that changes in cognitions (e.g., self-efficacy; Bandura, 1994), behavioral intentions (Ajzen, 1985) and skills training that support safer sex can reduce risky behaviors (i.e., unprotected anal sex; UAI)—but does so by using virtual instead of one-on-one models and guides that are embedded in a cost-effective and sensory (i.e., visually and aurally) engaging lifelike intervention (for more detail see, Appleby, Godoy, Miller & Read, 2008; Read et al., 2006).

In SOLVE-IAV, MSM assume the role of a character on a “virtual date” who “hooks up” with an attractive other using interactive technology. As the lead character, MSM make choices regarding what to do on the virtual date (e.g., how to talk directly about using condoms), and those choices define the story as the drama unfolds. These guides and models use a variety of strategies to enhance learning and motivation to change risky behavior, which include modeling behavior to enhance procedural knowledge and skills (e.g., modeling condom use, condom initiation, negotiation, and risk, such as drugs, alcohol, UAI refusal skills, and the incorporation of behavior, such as checking condom dates and bringing condoms on a date into “preparation routines”). If the user makes a particular choice for his agent (e.g., talk directly about safer sex), the user is simultaneously making decisions about what to do as well as watching the model that represents them; in essence, show them how to do that. In addition, the guides (peer mentors) may change beliefs by linking risky behavior to subsequent negative outcomes, thus reinforcing “implemental intentions” (Gollwitzer, 1999), addressing beliefs that undermine safer choices (e.g., discussing facts and beliefs about alcohol and drugs, and the relative risks of various sexual behaviors, differentially reinforcing safer and riskier choices), recapping the sequence of choices MSM make, and explaining real-life implications of such choices.

**Need to Address the More Automatic Route to Decision Making**

Decision makers rely on “nonconscious biases” that automatically guide behavior before conscious knowledge does (Bechara, Damasio, Tranel, & Damasio, 1997, p. 1293). With increasing life experience these nonconscious biases become more accurate—guiding more advantageous and less adverse decisions and outcomes. Such experience-based “gist” learning also keeps adults from
being distracted by detail and irrelevant information (Reyna & Farley, 2006). Emotions are key mediators in decision-making processes (Damasio, 2000; Panksepp, 1998; Rolls, 1999); they adaptively elicit, in a highly efficient way, learned responses in social situations (Frijda, 1986; Keltner & Gross, 1999; Levenson, 1994; Oatley & Johnson-Laird, 1996; Plutchik, 1979). These emotional responses, which help mark the situation as “good” or “bad”, assist decision making under circumstances of conflict or uncertainty, operating either consciously or nonconsciously.

Thus, adolescents and young adults may not consciously deliberate risks and benefits. Rather, they may have “unconscious emotional and cognitive reactions to environmental triggers” (Reyna & Farley, 2006, p. 33), making decisions reactively or intuitively. For example, adolescents’ “willingness” to engage in risky behaviors, which they may later regret (e.g., in the heat of the moment), accounts for variance in behavior beyond intentions alone (Gibbons et al., 2004); these reactions are not easily explained by more deliberative models.

However, experience with risk cues is needed to develop accurate “gists” that provide the basis for adaptive automatic reactions. Without prior situational experience to accurately mark a situation as risky, decisions by today’s youth can be catastrophic (see Baird & Fugelsang, 2004). But in many domains, such as HIV/AIDS, gaining the necessary experience can be extremely costly. Among young MSM (15 to 29) who had engaged in UAI, 59% of those testing positive for HIV perceived that they were at low risk for infection (MacKellar et al., 2005). If lack of prior negative outcomes increases risk-taking—until that catastrophic outcome occurs, then we need to find a way to provide the “risk avoidance cues” and the negative outcomes without real risks. Interventions that fully simulate that experience might enable safer learning of more automatic anticipatory emotions (i.e., fear) among young adults (Read et al., 2006). Preventing HIV among new generations of young MSM may require interventions that concurrently address the “two divergent paths to risk taking: a reasoned and a reactive route,” taking into account the developmental trajectories involved in each (Reyna & Farley, 2006, p. 1).

**SOLVE: Combining Reactive as well as Cognitive Routes to Decision Making**

SOLVE simultaneously addresses the more traditional cognitive intervention strategies used in one-on-one counseling as well as the more reactive and more affect-based route to decision making (Bechara et al., 1997; Reyna & Farley, 2006). As indicated in Figure 25.1, our theoretical model suggests that, in the presence of cues associated with a potentially risky situation (including those in the virtual environment designed to simulate real life), both cognitions and affective biases (from prior experience) are activated and guide virtual decisions—both consciously and nonconsciously. Affect associated with these
virtual decisions then biases future decisions (virtual and real-life) that, in combination with cognitions and skills, impact virtual or real-life outcomes.

This SOLVE theoretical model suggests that to change a population's risky behavior, interventions need to incorporate the more experientially and affectively based aspects of learning. Because many of the details regarding the SOLVE components have been described elsewhere (see Appleby et al., 2008; Miller & Read, 2005; Read et al., 2006), we present the highlights of this approach that pertain to the use of interactive media, serious games, and intelligent agents in this chapter.

Is SOLVE-IAV Effective?

In recent experimental longitudinal findings we found that MSM in the interactive condition had lower levels of UAI 90 days postintervention (Miller & Read, 2005; Read et al., 2006) compared to those in a standard of care control group. In an additional longitudinal study with 18- to 30-year-old MSM (using IAVs targeted to African-American, Latino, and White MSM), preliminary findings suggest that SOLVE-IAV reduces UAI over time, especially for younger (18–24), high risk MSM (two or more instances of UAI with nonprimary partners in the past 3 months) compared to wait-list control, yoked control (passively viewing the IAV with the choices of another subject), and one-on-one human interaction conditions. SOLVE-IAV accounts for significant variance above and beyond traditional variables (e.g., intentions, self-efficacy) in predicting to future risk-taking. The question remains: What features of interactive environments facilitate the achievement of effective interventions?
**SOLVE: Shared Technology-Enabled Possibilities**

Since 1989, our research team has been engaged in developing interactive virtual environments using the most current technology with the goal of reducing risky sexual behaviors. Initially, we used CD-ROM and DVD technology. With the most recent advent of effective intelligent agents, we can advance our HIV prevention interventions using intelligent agents and gaming technologies.

**These Interactive Environments**

1. **Enable individuals to identify with, assume the role of, make decisions for, and learn from the modeled behavior of a character on a virtual date.** Because the user can select what decision the character will make (thereby “owning” the decision), the user can watch the “virtual self” model the resulting behavior and consequences; this enables scaffolding of new strategies for achieving goals (e.g., negotiating safer sex) in a specific context (“on the couch”) and under specific conditions (e.g., romantic interest, sexual arousal). This provides modeling for a range of component skills including how to initiate, negotiate, refuse (to have sex without a condom), and use condoms under a range of conditions. Interestingly, the extent to which MSM identify with their self characters in the interactive condition is a significant predictor in our preliminary analyses of unprotected anal intercourse (UAI) risk reduction.

2. **Engage MSM at risk for contracting HIV, in part, because MSM can make and therefore “own” their decisions (instead of just passively observing another’s behavior).** Engaging the attention of MSM and motivating them within an intervention is critical for learning (Grunwald & Corsbie-Massay, 2006). In dating and sexually intimate contexts, individuals are motivated to seek opportunities (e.g., for sex, emotional relationships) and avoid threats (e.g., physical, psychological). SOLVE environments allow for these dynamic interactions by making it possible to experience virtual interactive sexual encounters with attractive others: MSM in our focus groups viewed such environments as fun and engaging and our preliminary analyses with over 300 MSM reveal that participants in the interactive video condition (IAV) found our environments significantly more engaging than MSM who simply observed another MSM’s choices.

3. **Afford opportunities for situated virtual learning in realistic narratives that map onto real-life contexts of risk and therefore are more likely to lead to a transfer of learning without having to experience risks first hand.** Preliminary findings from our NIAID grant indicate that virtual decisions (e.g., sexual position preference, choosing to kiss, cuddle, or use condoms) are significantly and positively correlated with decisions of a similar type within the past 3 months. We found similar significant patterns for predicting to specific future decisions from virtual decisions 3 months prior.
4. Allow MSM to make virtual risky choices in contexts that are affectively and contextually similar to contexts of risk in real life. In standard one-on-one or group behavioral interventions for HIV prevention, many of the affective and contextual cues that guide behavior in real life are missing or inadequate. In most sexual encounters, individuals who are attracted to their partners will experience very salient and immediate affective and motivational reactions (e.g., sexual arousal; fear of rejection) that can potentially lead to risky choices. Research on state dependent encoding and learning (Bower & Forgas, 2000) suggests that if individuals learn behavioral strategies while experiencing even a mild form of the relevant affect (e.g., sexual arousal), they may be better able to more automatically activate, retrieve, and use safer sexual strategies in similar contexts of risk in real life. That is, if interventions afford virtual decision-making opportunities leading up to safer choices under similar emotional conditions of encoding, we may enhance subsequent retrieval of cognitions, goals, and problem-solving skills in similar emotional contexts of risk. Standard interventions rarely take into account the physical context, circumstances, and cues that impact decision making. With interactive media, we can make the when, where, whom, and how of risky situations very concrete, relevant, and realistic for the target audience. For example, we can incorporate visual and acoustic signals from bars, clubs, apartments, and online connections that are typical “scripted” paths to risky choices for distinct populations of MSM.

5. Provide required modeling opportunities through self and other characters (e.g., all participants view the self and other characters pocketing condoms as part of the grooming activities in preparation for a date).

6. Offer optional mentoring. Interactive environments make it possible for MSM to ask for advice or seek out additional information during the video. Although MSM rarely sought advice, unfamiliar situations often prompted users to seek guide advice (e.g., decisions regarding methamphetamine for users who had never encountered the drug).

7. Afford guides and mentors to interrupt risky choices and scaffold self-regulatory change. As mentioned earlier, typical behavioral interventions do not contextualize the sequence of events leading up to risky decision points, and do not allow MSM to make risky choices. Interactive environments make these accommodations and incorporate more advanced components, including the use of ICAP (interrupt; challenge; acknowledge; and provide) framework:
   a. Interrupt risky choice before it is consummated (slowing it down, making it less automatic).
   b. Challenge and frame consequences of risky choice in terms of consideration of future consequences, thus reducing risky sex (Appleby, Marks, Ayala, Miller, Murphy, & Mansergh, 2005). In SOLVE (Read
et al., 2006), we combined the social cognitive intervention with a message framing approach. That is, we (Miller & Read, 2005; Read et al., 2006) include framing elements that map onto prior research, tailoring, and framing guide responses to be responsive to the men's behavioral choices.

In SOLVE, messages are generally framed as gains (e.g., use condoms to stay safe, avoid HIV) because past research suggests that prevention messages are more effective if we focus on what the individual has to gain by engaging in the self-promoting behavior (Rothman, Bartels, Wlaschin, & Salovey, 2006). But when the individual is about to take a risk (e.g., have unprotected anal sex), the guides "popped up," challenging MSM with a loss-framed message (e.g., "Are you kidding! Anal sex without a condom? Don't you know how dangerous that is? Even if you are HIV positive you can still get other strains of the disease and get AIDS faster. Don't fool yourself into thinking being on top is safe. If you still want to have anal sex (and I know you do), you can still change your mind and put one on right now"). The guides challenge risky decisions using loss-frame messages (Salovey & Williams-Piehota, 2004).²

In fact, only loss-frame messages have been shown to reduce unprotected anal or vaginal sex for HIV positive individuals (Richardson, et al., 2004) and have recently been shown to evoke negative affect (Stark, Rothman, Bernat, & Patrick, 2007). In the latter study, Stark et al. measured facial EMG and skin conductance responses while individuals received framed-messages and determined that loss-framed messages elicited more negative affect compared to gain-framed messages.

c. Acknowledge motives and feelings motivating behavior. It is important to articulate the individual's emotions, motives, and goals and link them to decision making and the subsequent consequences. Consistent with work on scaffolding self-regulation (Read et al., 2006), guides acknowledge and make salient MSM's emotions and desires, both short- (e.g., "if you still want to have anal sex...and I know you do..." and long-term (e.g., "you can still...be safe"). The fear that loss-frame messages evoke has been shown to motivate behavior change when associated with a clear method of reducing the fear (Witte & Allen, 2000). The guides also provide a way to be self-efficacious to avoid the threat (fear), yet still achieve desires through statements such as, "...you can still change your mind and be safe...put on a condom right now."

d. Provide strategies for simultaneously achieving approach motives, avoiding immediate negative outcomes, and avoiding negative future consequences (contracting HIV) that may not have been adequately incorporated into decisions within the risk context. Interactive envi-
ronments provide an alternative path to integrate complex motives—what can be done to achieve important goals (short- and long-term) in the same contextualized situation given one’s motives and emotions. The self-character can model a safer strategy that better achieves the user’s goals (if the user selects that choice). If the user does not select that safer choice, guides recap (see below) and review each choice at the end of the interactive experience to ensure that each user observes his character model a safer alternative strategy.

8. **Potentially evoke negative affect (i.e., fear, guilt).** As mentioned above, we used loss-framed messages that are likely to evoke negative affect. Bechara et al. (1997) have demonstrated that this affect may automatically self-guide MSM’s future risky choices in similar situations, even outside of their conscious awareness. Consistent with work on affect-based decision making, preliminary evidence indicates that negative affect (e.g., fear, guilt) immediately post SOLVE-IAV significantly predicts reduction in subsequent real-life UAI (Christensen et al., 2007). These negative affective reactions to decisions may then guide more automatic, subsequent real-world decision making by activating negative emotions triggered by similar risk contexts in the future.

9. **Afford Test, Intervention, and Local Evaluation (TILEs).** Interactive virtual environments afford local tests of whether MSM are likely to make risky sexual decisions in response to specific risky situations and cues, provide interventions designed to alter those specific contextualized decisions, and then formatively evaluate whether this specific intervention is virtually effective. We identify a series of TILEs within the intervention: a context specific set of Test (i.e., the user’s choice in a risky situation), Intervention (i.e., a gain/loss-framed message from the guides regarding the user’s choice), and Local Evaluation (i.e., whether the user chooses the same virtual decision again or a safer one). Interactive environments make it possible to create a landscape of these TILEs, affording discrimination and generalization of different “test” situations and subsequently evaluating the effectiveness of different interventions for a given MSM. This creates a “topology” of when, and under what conditions, a given MSM engages in risky behaviors and what interventions are most effective, for a given MSM.

10. **Provide TILEs for unexpected, but typical, obstacles that increase risk taking.** For example, we incorporated TILEs for interacting with a drug dealer at a club who was peddling methamphetamine, a popular drug in this population (Appleby, Storholm, Ayala, & Miller, 2007).

11. **Review the choices and events that unfolded within the virtual scenario, thus reinforcing good choices and providing models for better choices.** At the end of the intervention, MSM are led through their choices by the guides who highlight the safer and riskier choices that the user made. The choices are automatically recorded and can be repeated and reviewed automatically.
by the guides. When choices were risky, guides provided a less risky alternative for the situation.

12. **Afford personalized risk reduction.** In SOLVE, MSM go on a virtual date and are provided with virtual decision-making experiences instead of real ones. The action proceeds, as it does in real-life, based on the decisions made by the user, including potentially risky choices, to form a narrative. These choice points are designed to be similar to real-life risky situations and can be viewed as “test stimuli” for TILEs, and all are recorded for future data analysis. How the intervention proceeds is a function of MSM’s decisions, with respect to and within these TILEs.

**Limitations and Future Directions: SOLVE-IT**

**IAV Limitations**

Interactive video environments that simulate risky choices appear promising for providing a diagnostic test-bed for past behavior and future real-life risk-taking. Despite its promise, the limitations of IAV technology restrict the number of test situations (e.g., venues, interaction partners, type of risk, risk scenarios, etc.), and this limits personalized risk reduction for MSM. For example, we could not (1) insure that there was at least one risky test situation that was relevant to all MSM; (2) assess whether different MSM exhibited different risk-taking profiles across various situations; (3) assess whether a given MSM’s responses to specific types of test situations predicted similar real-life behavior; (4) assess whether a given MSM learned to self-regulate his initially risky choice (to make a safer choice) in a given virtual situation and whether that predicted subsequent real-life UAI risk-reduction in the same or similar situations; and (5) easily update and change the intervention—providing both an application and an updatable “test-bed” for to incorporate cumulative advances in personalized interventions.

**Intelligent Agents in Serious Gaming Environments: Addressing IAV Limitations**

SOLVE-IT (SOLVE using intelligent agent and gaming technologies) could address these limitations. In the field of artificial intelligence (AI), an intelligent agent is defined as a system that perceives and acts on its environment to maximize its ability to achieve its goals (Russell & Norvig, 2003). Intelligent agents can be embedded in multiplayer games where numerous intelligent agents and humans interact and in which a human can be substituted for an agent. Serious games are applications that utilize innovative gaming technologies to enhance learning and problem solving in domains such as education, national defense, or healthcare (Sawyer, 2007).

Intelligent agents and gaming technologies can provide a nearly infinite
number of alternative realistic partners for humans. Given that intelligent agents also have goals, this provides a wealth of potential scenarios and test situations, thus making it possible to incorporate and readily test (with repeated trials) new interventions or updates in real-time, within the same game.

Members of our NIMH research team have developed, produced, and used these technologies for interventions in a variety of health, training, and educational applications (Johnson, Vilhjalmsson & Marsella, 2005; Marsella, Johnson, & LaBore, 2003). In Marsella et al.'s multiagent-based simulation environment, PsychSim (Marsella & Pynadath, 2004, 2005; Marsella, Pynadath, & Read, 2004; Pynadath & Marsella, 2004, 2005), a researcher can construct a social scenario where a diverse set of entities, either groups or individuals, interact and communicate among themselves.

Each entity has its own goals and policies of achievement, relationships with other entities (e.g., friendship, hostility, authority), private beliefs, and mental models about other entities that include recursive models of their beliefs and goals. That is, each agent has a “theory of mind” about themselves and about all other virtual and real interactants in the program. The simulation tool generates the behavior for these entities and provides explanations in terms of each entity’s goals and beliefs. The rich entity model allows one to examine the potential consequences of minor variations in the scenario. The researcher can manually perturb the simulation by changing the models or specifying actions and messages for any entity to perform. Alternatively, the simulation itself can perturb the scenario to provide a range of possible behaviors that can identify critical sensitivities of behavior to deviations in modified goals, relationships, or mental models. Participants can fill out a variety of different individual difference measures tapping into beliefs, policies, goals, and values that can be used to model agents. For example, the extensive literature on attachment styles can be used to create the computational models.

Attachment Theory: Underlying Basis for the “Theory of Mind” of Agents

Our goal is to use intelligent agents to model individual realistic cases of MSM who take sexual risks (i.e., engage in UAI) with nonprimary partners. Attachment theory (Bowlby, 1969) elegantly describes how coherent beliefs about self and others broadly impacts sexual decision making and behavior (Miller & Fishkin, 1997); it suggests that one’s mental model of others in close relationships as adults depends upon the beliefs and mental models and attachments that we form as children with our caregivers. A voluminous literature in developmental, personality, social, and clinical psychology, as well as in related social sciences, provides the basis for modeling individual agents with coherent differences in their models of the self and others, and their subsequent actions (e.g., Cassidy & Shaver, 1999; Hinde, 2005; Mikulincer & Goodman, 2006; Rholes & Simpson, 2004). Two dimensions underlie adult attachment
styles or "mental models" (Brennan, Clark, & Shaver, 1998): (1) anxiety, with the high end associated with negative views of self (e.g., unlovable, unworthy), and (2) avoidance, with the high end associated with negative views of others (untrustworthy, undependable, unsupportive). These two dimensions form four attachment types: Secure (low avoid, low anxiety), Preoccupied (high anxiety, low avoid), Avoidant (low anxiety, high avoid), and Fearful (high anxiety, high avoid) (Fraley, Waller, & Brennan, 2000). Some risk-taking behaviors (e.g., substance use, participating in sex work) have been associated with the high end of the anxiety dimension (Gwadz, Clatts, Leonard, & Goldsamt, 2004) while poor partner communication that may therefore serve as an impediment to condom use has been associated with the high end of the avoidant dimension (Moore & Parker-Halford, 1999).

While more chronic attachment styles are predictive of risk, the nature of the relationship is also critical. For example, those with the greatest love for, trust in, commitment to, and interdependence with one's primary partner were more likely to engage in unprotected anal intercourse with him (Appleby, Miller, & Rothspan, 1999). Because there is a significant subgroup of these MSM who also had unprotected sex outside of their primary relationship, and because the base rates of HIV are high among MSM, those in committed relationships may paradoxically be at greater risk for HIV than those in non-committed relationships. These findings demonstrate the complex relationship between relationship status, attachment styles, and risky behavior. In our own current NAID R01 funded work, we have found that both avoidant and anxious dimensions predict risky sexual behaviors with nonprimary partners for MSM, and the nature of these predictions may depend upon the current status of one's romantic relationships.

**Modeling Realistic Intelligent Agents**

Intelligent agents provide lifelike interaction partners and "contexts of risk" by creating a range of characters that are realistic and differ in a host of physical and psychological characteristics, a significant advantage over the interactive video (IAV). As in real-life, in the virtual environment MSM will be able to choose virtual "intelligent agent" partners based on their characteristics and profiles, choose preferred venues, including Web sites, bars, and clubs with known demographics, or opportunistically interact with characters at various locations in the gaming environment.

With PsychSim, Marsella and Pynadath's system for creating intelligently realistic agents, SOLVE-IT intelligent agents will have humanlike physical characteristics and humanlike psychological attributes such as goals, beliefs, and policies that produce their behavior. We can populate a virtual environment with a realistic array of psychologically, and physically diverse MSM as potential partners because the underlying activation of various states, goals, beliefs, and policies of the agents differ, thus providing more realistic diverse
interpersonal experiences. Each of our agents will be based on the data of real participants to create each "realistic" agent. Participants' responses to various individual difference measures and scenario-specific questions in our research studies will serve as a primary data source.

By gathering case-based data suitable for modeling an individual's own states, goals, beliefs, and policies, we can model individual cases as intelligent agents. This data will allow us to: (1) run simulations with the intelligent agents created from the data for a given case (e.g., attachment styles) and examine which virtual interactions for that agent are likely to lead to risky behaviors and which are not; (2) compare what the actual human does when interacting in that environment; and (3) if our simulated case accurately predicts the behavior demonstrated by the real individual, that case can be used in the future as a template for the game to choose scenarios that are most challenging for that MSM. Therefore, the modeled case based on an actual MSM becomes a realistic potential sexual partner within SOLVE-IT for another real life MSM interacting with this virtual agent.

**Computational Approach to Modeling MSM and Predicting Risk**

We model the responses of real-life MSM to create realistic virtual characters in the virtual environment. PsychSim's decision-theoretic agents not only provide agents with a theory of mind, but PsychSim has powerful automated fitting algorithms that allow agent models to be readily fitted to empirical data (Pynadath & Marsella, 2004), significantly facilitating its use in research. Therefore, we can use MSM's responses at baseline and in the virtual environment to computationally model the decisions that MSM are likely to make given the precipitating factors in the context (e.g., the type of venue, the partner's characteristics, etc.). With our team of social scientists, statisticians, and computer scientists—we will explore the following question: Can the computational model of PsychSim better predict who is likely to engage in UAI at follow-up, and under what circumstances, compared to conventional statistical tools? Can it also better predict change in real-life UAI? Virtual diagnosticity of behavior may provide an updatable "test-bed" that affords cumulative advances for the science of optimizing behavioral risk-reduction. If we can accurately measure each MSM's beliefs, policies, and goals in predicting the user's risky behaviors, this could shed light on how beliefs get activated and their effect on risky choices in given situations, and lead to subsequent work comparing the virtual choices of each real-life MSM against his modeled self.

**Greater Personalization of Environments for Risk Reduction**

Intelligent agents and games would allow another benefit: they can provide greater tailoring of the environment for each individual MSM, based on his baseline measures (e.g., Kreuter, Farrell, Olevitch, & Brennan, 2000; Skinner,
Campbell, Rimer, Curry, & Prochaska, 1999) and personalization within the environment, based on MSM's patterns of responses during the game and on our intelligent agent based modeling online of that MSM. Such personalization would be highly innovative. If intelligent agents (e.g., potential partners, guides in the game/gaming environment) can be more responsive to the behavior of a given MSM, and if we can “model” the user online in real time, we may greatly advance the science of optimizing personalized risk reduction—doing so online over the Web—thereby potentially providing extraordinary reach.

SOLVE-IT provides a virtual intelligent agent/game test-bed for the creation of a cumulative science of optimizing personalized diagnosis, intervention development, and risk reduction. This advance could revolutionize the way we as researchers conceptualize, understand, predict, and reduce risky behavior—personalizing it to optimize risk reduction for the individual case. Such an approach could simultaneously address health disparities within and across diverse at-risk target populations.

Notes

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2. Prior research indicates that gain frames (e.g., what one stands to gain, such as avoiding AIDS, staying safe) if one engages in a behavior (e.g., uses condoms) are generally particularly effective for prevention promotion (Rothman & Salovey, 1997). But, in the face of greater risk taking, alternative frames (e.g., loss frames, emphasizing what you will lose if you engage in the risk), might be more effective for subsequent behavior change. Framing effects can exert a profound impact on health behavior (Rothman & Salovey, 1997) such that some frames (e.g., gain frames) work best for prevention while other frames (e.g., loss frames) work better when individuals confront more risky situations. Salovey and Williams-Piehota (2004), consistent with others (e.g., Kühberger, 1998; Tversky & Kahneman, 1981), have suggested that for HIV prevention, loss frame messages for high-risk individuals might be more effective (under high risk) than gain frame messages (focusing on what one has to gain).

3. In Bechara et al. (1997) this was indicated by learned changes in galvanic skin responses that anticipated risky choices in a gambling task before cognitions regarding the perceived risk could be articulated.

References


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