Socially Optimized Learning in Virtual Environments (SOLVE)

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Abstract. Although young men who have sex with men (MSM) are at high risk for contracting HIV, few interventions address the affective/automatic factors (e.g., sexual arousal, shame/stigma) that may precipitate young MSM's risk-taking. A National Institutes of Health (NIH)-funded DVD interactive video intervention that simulated a "virtual date" with guides/mentors reduced sexual risk over 3-months for Black, Latino and Caucasian young MSM. In the current work, limitations of the DVD format (e.g., number of different risk challenges MSM encounter; DVD quickly becomes dated) were addressed with 3-D animated intelligent agents/interactive digital storytelling using a Unity Game platform. The development (e.g., design, art, social science formative research, etc.) of this NIH funded game for changing risky behavior is described as well as the ongoing national randomized "on-line" evaluation over 6 months.

Keywords: Virtual Characters and Agents, Narrativity in Games, Games for Health, HIV Prevention, Intelligent Agents, PsychSim, 3-D Animated Characters, Interactive Digital Storytelling (IDS), SOLVE.

1 Introduction

1.1 Gaps in HIV Prevention for Men Who Have Sex with Men (MSM)

HIV infection continues to rise, especially among young men (18-24) who have sex with men (MSM) [1]. Surprisingly few HIV prevention interventions address young MSM's specific needs. Most existing interventions focus on changing more cognitive and deliberative processes. Many MSM, however, guided by contextual cues in

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sexually and emotionally arousing scenarios, "get caught up in the moment" and make more automatic decisions they later regret [2]. Shame, for example, left unaddressed, might be activated in MSM's sexual narratives; with sexual arousal, shame might precipitate risk-taking [2].

Conventional one-on-one and group interventions neglect more contextual and affectively-based decisions. Alternative methods are needed to simulate the ongoing narrative that involves complex and intimate emotions. Although interventions to reduce shame or self-regulate emotion are unavailable, developmental work (on parent-child interactions) suggests ways to achieve this [3]. Adaptations of these interventions might change adult behavior if a similar parent-like mentor/guide could intervene at the critical decision points. But, using real-life mentors raises feasibility concerns.

1.2 Virtual Interactive Interventions Using Interactive Video

Virtual Interactive Interventions Can Successfully Fill the Gap. Virtual interactive interventions can engage young MSM in sex positive narratives that simulate real life risky contexts. Within virtual narratives, these risky situations afford opportunities for self-regulatory interventions. Using an approach called Socially Optimized Learning in Virtual Environments (SOLVE), "virtual date" narratives based on extensive formative research with MSM were constructed [2] and targeted by ethnicity (Black, Latino, and Caucasian) for 18 to 30 year old MSM [2]. On the virtual date, players made a series of decisions (e.g., about alcohol, sex, condoms, etc.) that affected how the action proceeded. If they took risks (e.g., chose unprotected sex) peer mentors/guides intervened to interrupt and challenge their risky choices, acknowledging their emotions and motives, and providing a means to effectively address their choices using what we refer to as "narrative self-regulatory circuitry." Then, after rethinking choices MSM continue the date. MSM's choices were recorded. In two longitudinal studies [2, 4] compared to the control condition, MSM exposed to the SOLVE intervention reduced unprotected anal intercourse (UAI) more over the subsequent period (up to 3 months); although in the second intervention [2] this effect occurred only for younger MSM (18-24). The intervention significantly reduced shame compared to the control and that reduction in shame, rather than cognitive variables (e.g., intentions, beliefs) predicted reduced sexual risk-taking over 3 months [2].

Limitations of Interactive Video. Because Read [4] used human actors and interactive video to create the narratives and guide interventions to risky choices, the intervention could quickly become outdated and updates to the scenarios, dialogue, and interventions were not feasible. In addition, given the space/branching structure limitations of DVD technology, MSM could not be offered a richer experience with more alternative interpersonal challenges. Furthermore, migrating this intervention for over the web use is difficult.

1.3 New Game Approach

Games with animated intelligent characters could readily address these limitations. First, changes using existing interactive digital media within games afford adaptive

potential. Visual features of actors (e.g., clothing, hair styles) or dating scenes (e.g., club characteristics) can be updated relatively easily. With sufficient recorded dialogue initially, re-edits and re-animating characters for dialogue changes are feasible. Researchers can modify the nature of and the specifics of the intervention at critical choice points. Second, new venues (e.g., parks, bathhouses) can be added to provide additional risky challenges within which to intervene. Third, because agents have modifiable underlying parameters that guide their behavior, alternative choice points (e.g., given different agent motive settings) can be added. Fourth, migrating game assets is more feasible with cross-compatible platforms (e.g., UNITY).

2 Theoretical Issues and Design Criteria

2.1 Neuroscience Model of Decision-Making: Role of Cognition *and* Affect

Overview. SOLVE is based upon a neuroscience-based model of decision-making [5] that argues that when individuals encounter a situation, two parallel processes are activated. In one, decision-makers use deliberative and conscious processes. In parallel, decision-makers rely on a second set of affect-based processes in which "non-conscious biases," based on the individual's prior emotional experiences in similar situations, initially guide behavior automatically before more conscious processes take effect. SOLVE argues that decisions – in a virtual environment -- can alter players risky decision-making patterns. To do so narratives should first be similar to those in real life.

Cognitive Factors. Second, changes in cognitions are needed. The options for decision-making should be similar to ones typically afforded individuals in that situation. Options may be expanded to more effectively challenge individuals' representation of themselves, others, or the situation. *Knowledge* relevant to reducing risky sex and HIV outcomes should emerge from the narrative, and the interaction should enable changes in client/player's beliefs [4]. Self-efficacy is key to effective behavior change [3]. SOLVE concurrently incorporates observational learning, *virtual* decisional choices/performance outcomes, and persuasive techniques to increase user self-efficacy. Perceptions of one's options in decision-making may also be influenced by *one's beliefs about one's partner*, the ongoing interaction, and future outcomes. To achieve individual's goals, an "if-then" plan specifying when, where, and how to instigate the behavior may be needed. SOLVE incorporates the specific contexts, timing, and procedural sequences needed where users can make choices for their character. The intervention should also facilitate new skills and procedural knowledge (e.g., how to negotiate safer sex) to afford safer options. Critical to interventions is their ability to 1) recreate situations and narratives virtually that are similar to ones that automatically activate risky decisions in real life, and 2) provide opportunities for players to learn to better monitor and effectively respond – both cognitively *and* affectively -- in risky contexts.

Affective Factors. Emotions mediate decision-making processes [5]. Especially under conflict or uncertainty, emotional responses mark the situation as "good" (approach) or "bad" (avoid), assisting, often non-consciously, in decision-making. Research on state dependent learning suggests that if learning occurs (e.g., in virtual

contexts) when individuals are sexually aroused, MSM might more automatically activate, retrieve, and integrate relevant skills, knowledge, beliefs, etc., pertaining to safer sex when MSM are in similar real-life risky contexts [4]. Shame is a self-conscious emotion that is directly tied to one's social identity. This painful feeling results when a perceived moral transgression is believed due to a stable, uncontrollable characteristic of the self [6]. Individuals ashamed of their sexual identity may suppress it, which can further intensify negative self-evaluations [6]. If not sufficiently acknowledged and regulated, these negative feelings (e.g., disgust with self; anger with self) may be automatically elicited during sexual situations and increase alcohol/drug consumption and sexual risk-taking [6].

2.2 Role of Self-Regulatory Feedback for Envisioning the Future and Reducing Shame

Self-regulation and Risky Decisions. Risk-taking can be viewed as a failure of self-regulation or the ability to monitor and respond effectively to one's emotions and motives and develop plans to optimize immediate and long-term goals. Self-regulation depends upon accurately labeling emotions and cognitions associated with them, and understanding what these mean for motives, goals, problem solving, decision-making, and behavior [2, 3]. The emotional meanings (e.g., good or bad) of the links among these components can be affected by social interaction (e.g., with caregivers, coaches, mentors, and peers), through, for example, the co-construction of narratives regarding what has just happened. With positive outcomes, self-regulated learners can enhance their self-efficacy and ability to achieve approach goals while avoiding harm more automatically[3].

In SOLVE using interactive video (SOLVE-IAV), guides were two peer counselors who interrupted users when they made a risky decision. Guides would then scaffold self-regulation of emotions, cognitions, motivations, and behavioral options using an **I**nterrupt-**C**hallenge-**A**cknowledge-**P**rovide (ICAP) process [7]. Thus, guides *interrupt* risky choices and players' decisions are frozen before the sequence proceeds. Guides provide *challenging* messages, *acknowledging* MSM's emotions and short and long-term desires (e.g., anal sex with an attractive man, staying healthy) and provide a means (e.g., condoms) to satisfy long-term and short-term goals. We refer to this narrative reframing process as the "narrative self-regulatory circuitry".

Shame reduction. Shame was significantly reduced in SOLVE-IAV compared to the control [2]. To achieve this for MSM, we first acknowledge MSM's desires for attractive men as normative/acceptable for them. The intimacy between men is portrayed in a sex and gay-positive way. Models also non-verbally stress the value of the self as loveable while guides encourage players to have fun but also protect themselves because "we don't want you to get this disease."

Virtual Future Self. In SOLVE using intelligent and gaming technologies (SOLVE-IT), we had to decide who/what would assume the role of the mentor/tutor/guides. Because players could create their own characters, that also made it possible to "age" each player's "self" to create a virtual future self (VFS) who was a few years older.

Prior work suggests that messages are more persuasive if the virtual character delivering the message appeared or acted similar to the self [8]. This virtual future self-character is illustrated in Figure 1.

2.3 Variability

Different MSM experience different obstacles to safer sex. For example, a major obstacle for some MSM to using condoms was ensuring that they took condoms with them (and ensuring that they had fresh ones). Other MSM had obstacles associated with certain drugs (e.g., methamphetamine) or with drinking too much alcohol. Other MSM were concerned that their partner might reject them and this led them to not insisting on safer sex. This variability was addressed by incorporating as many obstacles as feasible given budgetary constraints.

MSM vary considerably (e.g., in the types of sexual behaviors preferred; positions preferred, types of relationships sought): The game incorporates this. Some variability in MSM's responses is predicted by varying beliefs about the self and others as loveable. We developed options for players reflecting those attachment differences. Player style differences are measured and might provide agent parameters to model user game choices.

2.4 Tailoring

Message Framing. Part of the ICAP process involves selecting an effective challenge message for the guides/virtual future self. Prospect Theory [9] predicts that with low risk, gain-framed messages (what the player stands to gain) should work better but under high risk, loss-framed messages (emphasizing what the player might lose) might work better. A recent meta-analysis of prevention-oriented framing, though, found little gain-frame advantage. Pilot work (see below) illuminated what messages to use and when.

3 Design

3.1 Overview of Criteria and Formative Research

The theory and research delineated above suggests a number of criteria to implement in the game's design, including (1) ensuring venues for risk are similar to those MSM encounter in everyday life, (2) ensuring attractive partners, appropriate sexual positions, and similar narrative structures (to engender sexual arousal as in real life), (3) ensuring dialogue is realistic for target audience, and (4) tempering decision-making and ensuring appropriately tailored framed messages in interventions that are discussed in more detail below.

Ensuring Similar Venues for Risk. In our national sample 501 MSM 18 to 24 years of age from each of three ethnic groups indicated the most common place in the last 90 days to meet a sex partner. Although hooking up was over the Internet is most common, a game within a game is artistically boring and compared to face to face negotiation MSM find

internet negotiation less challenging (in terms of achieving their goals). Therefore, we use the next two most popular venues (meeting at a dance club or at a house party). The house party may be especially relevant to rural/small town MSM and 18-20 year olds who are excluded from bars. Most MSM eventually frequent a bar/dance club. As is typical in real-life, the game player is invited to the party by his friend.

Inducing Similar Affective States. Inducing sexual arousal within the game is important since this typically occurs prior to unsafe sex. In prior work with interactive video, the video successfully enhanced sexual arousal compared to the control. We achieved that by ensuring attractive partners, appropriate sexual position options, and sexual and dating narrative structures that activated sexual arousal. Formative research with a national sample determined which faces and body types were most attractive and what sexual positions were most preferred. Earlier extensive formative research established the nature of the scenarios to virtual dates for MSM [2,4].

Ensuring Appropriate Options at Decision Points for Target Audience. The primary purpose of a formative pilot study was to understand the various ways men who have sex with men (MSM) might verbally respond to a sexual partner that wants to engage in unsafe sex. The information gained might then inform the dialogue and choices in the videogame. Those eligible to participate were 18 to 24 years old, HIV negative, previously had anal intercourse with another man, and self-identified as Black, Latino, or White. Participants were asked to imagine a situation in which their sexual partner wanted to have UAI. Participants were then asked to rate the likelihood they would say 10 possible phrases in response. The likelihood scale was 7 points from (1) very unlikely to (7) very likely. A paired-sample t-test indicated that, across the sample, participants reported that they were significantly more likely to "directly" object to unsafe anal sex compared to suggesting safe, "alternative" sexual activities.

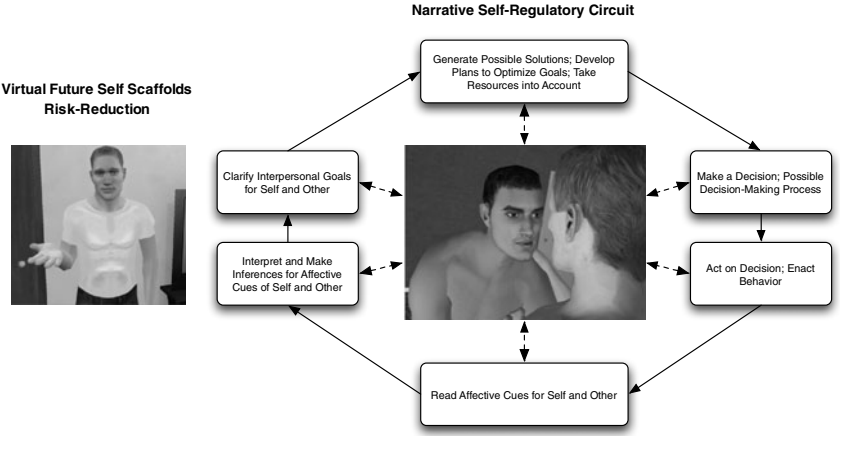

Fig. 1. Narrative self-regulatory circuitry enhanced by one's virtual future self (Source: Miller et al., 2011)

Tempering decision-making. Acknowledging MSM's emotional responses (e.g., attraction to another man) could backfire, and result in MSM engaging in risky behavior if shame is activated – without defusing it appropriately. While enhancing

sexual arousal/partner desirability via the art/animation, one must ensure sex-positive and protection-promoting VFS animation and verbalizations.

3.2 Interactive Story

Basic Structure. The SOLVE-It game begins with the player "dressing" in his apartment by customizing his character's hair color, eye color, ethnicity/skin tone, T-shirt, shoes, and jeans. Before going to a house party, his Virtual Future Self (VFS), an embodied conscience throughout the game, introduces himself.

From then on, the player's goal is to meet a guy, go home with him, and negotiate safe sex. In Level 1 he meets guys at a friends' party, in Level 2 he meets them at a dance club. He can walk up to guys and have a conversation with them, and if things go well, can have a drink or dance with them. The player's conversational choices are via a menu system. Once the player chooses a partner, the game moves into a critical living room scene, where the player has an interactive negotiation about safe sex. This VFS comments on the outcome of that negotiation. Following a transition to the bedroom, another negotiation about safe sex occurs. The player can change his mind about condoms, or the type of sex he wants. He can perform different sex acts. The bedroom scene ends the level, followed by a "recap" scene, where the VFS reviews choices. Tracked choices are number of drinks, type of sex chosen, and the final decision about condoms. After Level 1 (House Party) the player enters similar scenes for level 2 (Bar/Club), and the negotiation is more difficult. At level 2's end there's another recap with new messages about meth and condom use.

3.3 Feedback Design (VFS)

In a pilot study, we examined participants' risky decision-making as a potential moderator. After choosing to either avoid or take a virtual risk, MSM were randomly assigned to a gain-frame condition, a loss-frame condition, or a no message control condition. Participants' resultant intentions indicated that when players made risky (safer) choices we should use a gain (loss) frame message.

3.4 Art and Animation Design

The design goals were to realize an engaging environment creating emotional states similar to that in real life. Having designed the characters to be physically attractive, their behavior needed to support this. Known male flirtation signals (e.g., complimenting each other's appearance, direct gaze, smiling, coy glances, intimate touching) primed the player for the greater intimacy to come. Given the role of affect in decision-making, the game, especially the bedroom scenes, is purposefully quite steamy.

3.5 Technology Design

Just as in the art and animation design, there were pedagogical design concerns that raised challenges for the technology design. A key concern was to create a rich, engaging experience that adhered to the pedagogical concerns. It should be possible for the player to tailor the experience by selecting from a range of partners and choosing a range of topics when they meet. We wanted challenging negotiations

about safe sex between the player and his chosen partner that gave the player the ability to chose between offers, to reject the partner's offer, make counter-proposals, and concede, as well as employ affective strategies (e.g., trust appeals). Still, this richness had to be achieved under budgetary constraints.

The game is realized in Unity. Because non-programmers would be informing the game design, we developed an XML scripting environment to control all aspects of the game, including dialog choices, events, animation, camera control, and level changes. To afford players partner choices while keeping animation costs within budget, we used a set of floating dialogs in those scenes. These floating dialogs were attached to a specific character when the player conversed with that character. Once used, a floating dialog couldn't be reused. Subsequent characters chosen used different dialog. The final dialog the player encountered, in effect the last one remaining to be used, was designed so a player could not reject the agent so as to ensure the player would move to the living room negotiation.

Each floating dialog was additionally designed to support a range of discussion topics (Where are you from? what do you do for fun? what is your favorite film? etc.). These topics existed in "topic pools" that allowed the player to choose a topic and then when that topic was exhausted optionally to select another topic or alternatively move on to essentially sealing the deal. The floating dialogs and topic pools overall supported a rich, tailored experience in these opening scenes while keeping production costs down.

The pedagogical concerns for the living room negotiation were different – here the concern was for the player to be engaged in a negotiation that mirrored and therefore provided practice for the kinds of open-ended challenges and negotiation moves that would occur in a real world negotiation over safe sex. Also, because different players as well as different characters may be more or less risk averse, have different sexual preferences, and differ in attraction to the other partner, they may very different behavior in the negotiation. This need for richness and variation led us to an agent based approach that generated the scene automatically, discussed below. We could incorporate such a space of variations by varying the goal preferences of an agent-based model.

However, because we would deliver the game over the web, it was not feasible to incorporate the agent code itself in the game and have the player play against an agent directly. Instead, different variants of two agents were played against each other. The system then passed the negotiation paths to a simple natural language generation system that generated the surface utterances, coalesced the paths and generated the XML script automatically to control the scene, including providing menu choices for the player's character. Using this approach, numerous multiple negotiation paths could be generated automatically during development, as many as feasible given development resource limits. The paths generated by the agent system were vetted/filtered by the pedagogical design team as realistic, balanced in terms of various negotiation moves (e.g., complimenting occurring on paths resulting in safer and riskier choices) and finally constrained to always result in some negotiated settlement that enabled the next scene/level. The final bedroom scene was a hand-scripted scenario where player and partner could renege on the agreement and thereby re-open negotiation.

3.6 Agent Design

The SOLVE-IT game consists of two agents that can make various negotiation moves, offering, counter-offering and complimenting in an effort to persuade the other to accept their offer. The agents were modeled in the PsychSim multi-agent system [10] that uses a decision-theoretic framework for quantitative modeling of multiple agents that allows agents to reason about tradeoffs in achieving their goals. PsychSim agents are additionally equipped with a Theory of Mind that allows them to reason about beliefs and behavior of other agents.

A full description of the agent models is beyond the scope of this article but is described elsewhere [11]. Key aspects of the model include the basic goals of the agents – which are the conflicting goals of maximizing affective states of arousal and feeling safe and an agent's relative preferences for those goals (how important each is). In addition, there are the basic mechanisms of keeping track of the negotiation state (e.g., who has offered what) as well as the state of the agents. The latter includes how risky another agent is (i.e., does the other agent have an STD) and how attractive the other agent is. In addition the model distinguished between actual state (e.g., having an STD) and an agent's beliefs about that state (does an agent believe another has an STD).

Agents have a set of actions that they can take: proposing or counter-proposing various forms of safe or unsafe sex, complimenting the other agent, making trust appeals ("trust me I am not infected with HIV"), *accepting* an offer or *rejecting the negotiation*. The actions influence the negotiation state and more interestingly the agents' affective states. For example, *Compliment* can alter an agent's beliefs about the riskiness and attractiveness of another agent. This has the consequence that he is more willing to accept an unsafe offer for two reasons: First, he will believe there is a higher reward for *Arousal* which is caused by the increased *Attractive*ness of the other agent and second, the smaller penalty for *FeelingSafe*, caused by the lower *Risky* value. In essence, the compliment changes one's view of the payoff, the benefit and cost, of having sex with the other, while agreeing to sex impacts arousal (as well as feeling safe). And of course having sex will impact the agents' *Arousal* and *FeelingSafe* states, depending on how Attractive and Risky, respectively, the other agent is. The agents are able to think several steps ahead, so they can reason about their future actions and, because of the Theory of Mind, can reason about the other one's future actions. This affords reasoning about potential benefits of complimenting.

Variations of this basic general model can be created by altering the goal preferences of the agents for getting aroused and being safe as well as altering the state of the agents (how attractive the agent is and how risky they are). In having two agent variants negotiate to generate the negotiation, we chose the extreme parameter settings, so, for example, one would prefer feeling safe more and the other would prefer getting aroused more to maximize negotiating training. To entice the agent who preferred feeling safe, the other agent would be especially attractive to him. The user could take on one position and the negotiation partner will demonstrate the other extreme position for a more challenging negotiation. Also to make the level 2 negotiations more difficult, the agents have even more extreme preferences that make them harder to negotiate with in order to enhance training effects. Regardless, the

negotiation is biased towards an agreement so the user experiences the rest of the game. In future versions of the game we plan to explore additional factors like drinking alcohol that would change an agent's preferences for *Arousal* or *FeelingSafe*, their beliefs about the other's attractiveness or their decision-making. Thus, when drunk, they will perceive others as less risky and more attractive, their arousal will go up and their horizon over which they compute the consequences of their behavior reduces. Therefore, the likelihood for unsafe sex increases.

4 Future Work

The SOLVE-It game is being evaluated in a randomized controlled trial over 6 months with over 2500 MSM nationally. Participants are recruited online, fill out a baseline measure (demographics, personality, cognitive and affective measures, past sexual behavior) then download the game (if in that condition), fill out an immediate post assessment of cognitive/affective variables. Participants' perceptions of the game and the agents are also assessed. After three months and six months, participants will fill out the baseline measures again. Game choices are recorded.

An additional goal is to collect individual difference measures relevant to the parameters in PsychSim (e.g., beliefs about self and others involving differences in attachment styles). Our plan is to use individual data to model the behavior of agents set to their human users' parameters to attempt to anticipate and model the decision making choices of the user in the game.

5 Conclusion

Over the last decade, there has been a rapid growth in the use of interactive narrative games and agent technologies in the design of health interventions. For example, Carmen's Bright IDEAS [12] uses interactive stories to teach problem solving skills to mothers of pediatric cancer patients. FearNot![13] enables children to consider coping strategies for school bully issues. A virtual café populated with conversational agents [14] is used to teach children with autism spectrum disorders social skills. In this paper, we report on the design of SOLVE-IT, an animated interactive narrative game to address risky behavior and HIV prevention. The game has been crafted based on a model of the cognitive and affective biases that influence decision-making and as well as our earlier experiences in developing an interactive video for AIDs prevention. SOLVE-IT is currently in a large scale, 6-month longitudinal clinical trial. This paper highlights the nuanced ways social science research and theory can be incorporated into and leverage intelligent design.

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