An Interactive Narrative System for Narrative-Based Games for Health

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Abstract

This paper presents an interactive narrative framework we have designed for games that promote health behavior change. The framework aims to address two key issues: player engagement with the game, and player adherence to the health behavior change-related homework they receive in the game. In this paper, we describe our narrative system that tackles these issues and a prototype game that promotes physical activity in which our narrative system is integrated.

Introduction

Intelligent narrative technologies and electronic games are two intertwined domains. The early drama managers were created in the context of games, such as *Façade* (Mateas 2002) and its predecessor *MOE* (Weyhrauch and Bates 1997), which was integrated to the game *Tea for Three*. Short games have been developed to test novel approaches to intelligent narrative, e.g. *Mirage* (El-Nasr 2007) and *PaSSAGE* (Thue et al. 2007), and large scale games such as *Crystal Island* have been created to serve as platforms for this area of research (Rowe et al. 2009).

Games that are designed to change the player's health behavior have received a rapidly increasing amount of attention recently (Kharrazi et al. 2012). These "games for health" use computer games to increase retention and cognitive engagement of users, and to provide information and health behavior change counseling to players. Narrative in games for health serves to improve players' game experience while complementing health behavior change theories (Lu et al. 2012). Research on using narrative in games for health has increased in recent years.

Several problems exist in games for health: unsuccessful collaborations between game design and behavioral medicine can create fun games with little serious content or games heavy on content but low on engagement; poor connections between game content and health message can break immersion, hence alienating players (Skinner 2011); and games for health often lack the length and frequency of interaction required for health behavior change interventions, where up to daily interactions over months or years is ideal (Kharrazi et al. 2012). Previous work in intelligent narrative systems has shed light on an automated and systematic approach to pragmatic problems (Aylett et al. 2005, Rowe et al. 2009, Rowe et al. 2010).

We present a framework that aids the design of interactive narrative systems in the domain of games for health. Our framework provides a procedure to create a narrative-based game from an existing story. The framework aims at solving the above problems by adapting the story at runtime following drama theory and health behavior change theory, using narrative selection algorithms to expedite the coherent combination of the two to ensure the quality of story and health content. The framework is also designed to allow for daily interactions over multiple sessions between which the player is asked to perform discrete, episodic homework assignments related to the behavior change. We also describe a prototype game we have developed following this framework to promote physical activity. It should be noted the framework can be adapted to promote a variety of health behaviors.

Related Work

Narrative-Based Games for Health

Narrative is often part of games for health, but recently it has begun to play an important role in the health intervention. For example, *QuitIT* is a laptop/touchpad game developed to promote smoking cessation using episodic stories that attempt to help the players practice coping skills (Krebs et al. 2013); *Escape from Diab*, a computer game featuring the adventure of a group of teenagers in a world where healthy food is difficult to acquire, was created to reduce childhood obesity (Lu et al. 2012); *SPARX*, a rare health game that is intended to last over multiple sessions, was created to help adolescents overcome depression

(Merry et al. 2012). In addition, Marsella et al. created interactive dramas using virtual agents to help users cope with stress and promote safe sex between men (Marsella et al. 2003, Miller et al. 2011).

Narrative-based games for health are often developed to deliver health messages through the narrative or use storytelling as a type of rehearsal to ready the player for real-life encounters with certain problems. These games can, through immersing the player in the story world, positively affect the player's attitude, observational learning, emotional arousal, self-efficacy, subjective norms, and intrinsic motivation (Lu et al. 2012), and may lead to health behavior change outcomes (Yin et al. 2012).

However, these games suffer from similar problems as games for health as a whole. First, only a minority of games for health adopt a health behavior change theory, and these games are often played for a single session or over at most a few days, and thus fail to take into account the theories that guide longitudinal behavior change (Kharrazi et al. 2012). Gains in health measures from a short intervention are often temporary in nature, whereas a longitudinal health intervention can promote lasting behavior changes (Glanz et al. 2008). Second, no evidence suggests drama theory is used to guide the development of narrative-based games for health. No study has been conducted comparing narrative-based games for health to other types of health interventions, making it impossible to tell whether the use of narrative or the lack of drama theory has any impact on a player's health behavior change. We discuss the related theories in the rest of this section.

Health Behavior Change Theory

Studies have demonstrated that health interventions informed by theories in Behavioral Medicine lead to more powerful effects than interventions designed without reference to health behavior change theory (Ammerman et al. 2002, Legler et al. 2002). Among these theories, the *Trans-Theoretical Model* (TTM) has received a large amount of empirical evidence to date.

We chose the TTM as the behavior change model in our framework because it is an integrated model of leading theories of psychotherapy and behavior change. It posits that individuals who successfully change their behavior go through a series of well-defined *stages of change*. The TTM classifies the hundreds of specific behavior change techniques that have been developed, including Bandura's self-efficacy and the social cognitive theory, into *processes of change*, the covert and overt activities individuals use to progress through stages (Prochaska and Norcross 2013). Ten *processes of change* have received the most empirical support to date. As an example, one *process of change*, *dramatic relief*, involves role-playing, grieving, personal testimonies, health risk feedback and media campaigns that can move individuals emotionally (Prochaska et al. 1994). In essense, individuals at different *stages of change* need discrete, episodic activity to perform in between sessions of the intervention for the purpose of advancing therapy, known as "homework". Health messages and interventions should be tailored to an individual's *stage of change* for them to be maximally effective.

Drama Theory and Interactive Drama

Traditional drama has produced many techniques to capture the audience's prolonged interest and attention (Egri 2007). Some of these techniques have been employed in intelligent narrative systems. For example, *MINSTREL* uses drama techniques such as foreshadowing, characterization, suspense and tragedy to generate coherent stories in the *King Arthur* story domain (Turner 1994). *Façade* builds up tension in the story by selecting beats consistent with player input that create the most desired amount of tension (Mateas 2002). These techniques can be applied in a game for health to improve engagement.

A key question in interactive drama is how to deal with player actions. There are many approaches to this problem. For example, Façade attempts to react to player actions by creating agency, meaning the player's actions result in effects in the story related to the player's intention (Mateas 2002, Murray 1997); *Mimesis* (Young and Riedl 2003) reacts to user actions that potentially break the consistency of the story and conducts narrative planning. In a TTM guided game for health, it is important that the player is given tailored feedback based on their homework performance. A narrative system can react to player homework performance in similar ways as one would react to player actions.

Framework

We propose a framework grounded on health behavior change theory and drama theory. We designed a narrative selector to assign homework in each session and guide the player experience by presenting the most appropriate satellite stories in a narrative-based game for health. The framework has two goals: first, maximizing the player's adherence to the homework, and second, because player engagement may impact their progress in health behavior change (Lu et al. 2012, Yin et al. 2012), using the narrative selector to maintain the player's engagement.

A similar approach that precedes this work is AEINS, which employs a dual narrative generation technique to create adaptive stories that foster character education in children (Hodhod et al. 2011, Hodhod et al. 2010). Our approach differs from AEINS in several major aspects. First, our framework is designed to work with a game that has a linear main story, while AEINS has its stories generated at runtime. Second, our framework facilitates health behavior

change mainly through the use of homework, using satellite stories primarily to serve dramatic goals, maintain engagement and improve homework adherence, whereas AEINS generates stories primarily considering educational purposes, i.e. teaching moments. Finally, our framework is designed to allow for a large number of sessions to be played on a daily basis due to requirements of health behavior change interventions, whereas AEINS targets a single game session.

Adherence Maximization

A primary function of our framework is to use a set of homework based on the *processes of change* in the TTM to help players progress through the *stages of change* of a specific health behavior. Each player that comes to the game may belong to a different *stage of change*. Therefore, the first step toward maximizing adherence is to choose homework that properly fits a player's *stage of change*. This can be done by assessing the player's *stage of change* at the beginning of the game and periodically during the intervention, maintaining a list of homework assignments that the player is eligible for, and choosing one piece of homework from this list each time. The assessment can be done through questionnaires integrated in the game.

The game needs to present homework in a way that motivates the player to complete it. We've chosen to motivate players through various psychological appeals in this work. Roberts et al. have used scarcity to successfully guide players on a certain path in a story (Roberts et al. 2009). We choose to apply five of the six persuasion techniques that Roberts et al. have identified: consistency, social proof, liking, authority and scarcity. Each time a homework exercise is assigned, the narrative selector uses content that appeals to one of these strategies, e.g. a non-player character can assign the player homework while appealing to the player character's responsibility. In addition, each time a player rejects or fails a homework assignment, we take it as a sign of potential lack of motivation; each time a player accepts the homework, it may be a sign the persuasion technique used works well to the player. The narrative selector must adjust its persuasion strategies by taking into account these player responses.

In addition, we've chosen to apply a particular *process of change*, *reinforcement management*, throughout the intervention. *Reinforcement management* is the process of rewarding oneself or being rewarded by others for making changes (Prochaska et al. 2002). The narrative selector can present contents to the player that demonstrate the player's actions have a significant impact in the story when the player reports a completion of homework. In this framework, we use a special type of satellite stories, i.e. transition stories, to fulfill the purpose of positive reinforcement. This will be explained in the next sub-section.

Engagement Maintenance

Because the narrative selector will present homework within the story and will react to the player's homework performance, it must ensure the responses that players receive for their homework performance are also engaging and coherent in the context of the entire narrative. Using a story closely related to the health behavior in question would be ideal. However, other techniques can be employed to make this process contingent, such as breaking the fourth wall (Auter and Davis 1991), where non-player characters speak to the player directly, instead of to the player character. In addition, to maintain engagement while giving feedback to the player, we apply two drama techniques, foreshadowing and transition, to the satellite stories.

Foreshadowing is the technique that shows the audience a danger is about to threat the characters and the balance of the story world, often caused by uncompromising characters (Egri 2007). When a player rejects or fails a homework assignment, the narrative selector should not present an immediate ill consequence lest the player feels being punished. The narrative selector can, however, present a satellite story that foreshadows an ill consequence, which the player may prevent by finishing more homework. Similarly, transition is the process that describes the growth of a character, or the growth of the relationship between multiple characters (Egri 2007). When a player succeeds in a homework assignment, it is important that the narrative selector give the player immediate recognizable encouragement, which can be done through praises from non-player characters, or by giving the player character tangible rewards. In our framework, the narrative selector primarily provides positive reinforcement in more subtle ways, by expediting the transition of a non-player character. The narrative selector may have several transition sequences, each containing a number of satellite stories that will eventually lead to an end state of a character, and several foreshadowing sequences, each containing a number of satellite stories that will eventually lead to a crisis and a climax.

It is important to note the difference between these satellite stories and message framing in Prospect Theory (Tversky and Kahneman 1981), which explains gain-framed messages that emphasize what the player stands to gain, and loss-framed messages that emphasize what the player might lose. The transition and foreshadowing stories in our framework are stories of non-player character growth, not affecting the player's own well-being, although if the player forms a relationship with the characters, one can argue the player may gain or lose as the characters reach a desirable or undesirable ending.

The Narrative Selector

In summary, the narrative selector we propose will be responsible for presenting a base story to the player, assign-

ing homework to the player in each story session over a long period of time, and reacting to player homework performance using adherence maximization and engagement maintenance techniques as described above.

Algorithm 1: Assign-Homework(all-homework, all-persuasion-techniques, player-soc, homework-history, persuasion-history)

Initialization: Let homework-set = Ø, H = Ø, P = Ø.

1. Refine homework set: For h' in all-homework, if player-soc = *stage of change* associated with h', let homework-set = homework-set + h'.

2. Choose homework: If player failed or rejected previous homework, for h in homework-set, if *process of change* of h has highest homework success rate, let H = h; Else for h in homework-set, if player has rejected or failed h before, let H = h.

3. Adopt persuasion technique: For p in all-persuasion-techniques, if p has highest success rate, let P = p.

4. Check persuasion frequency: If P was used twice in a row prior to this session, for p in all-persuasion-techniques, if p has second highest success rate, let P = p.

5. Present homework: R = user input when given <H, P>.

6. Update history: If R = 'accepted', update homework-history, letting status of H = 'accepted', update persuasion-history, letting rating of P = (rating of P) +1, return; Else update persuasion-history, letting rating of P = (rating of P) -1.

7. Adopt different persuasion technique: For p in all-persuasion-techniques, if success rate of p is immediately lower than P, let P = p.

8. Present homework with new persuasion: R = user input when given <H, P>.

9. Update history: If R = 'accepted', update homework-history, letting status of H = 'accepted', update persuasion-history, letting rating of P = (rating of P) +1, return; Else update persuasion-history, letting rating of P = (rating of P) -1.

When the narrative selector assigns new homework, it will follow the procedure described in Algorithm 1. The narrative selector maintains homework and persuasion technique history to inform homework assignment processes in future sessions. Such content is stored in XML trees with homework ID, corresponding *stage of change*, persuasion technique type and applicable situations recorded as attributes.

In the session that follows a previous one, usually one or more days after the previous homework is assigned, the narrative selector updates the story following Algorithm 2, using a collection of satellite stories as well as B, the base story for the session. The narrative selector first checks whether the homework has been performed, and if yes, the narrative selector presents a transition story that provides immediate positive reinforcement, and traverses the rest of the story in the current session to insert satellite stories that expedite the transition of a character in places where requirements are met for these stories. If the homework has not been performed, the narrative selector adopts a similar procedure, using foreshadowing stories instead of transition stories.

Algorithm 2: Update-Story(B, satellite-stories, H, homework-history)

Initialization: Let S = Ø, B' = B.

1. Check previous homework: If player completed previous homework, let R = 'success', else let R = 'failure'. Update homework-history, letting status of H = R.

2. Immediate response: If R = 'success', for s in satellite-stories, if s is a transition story and can occur immediately, insert s in B' as next story; Else for s in satellite-stories, if s is a foreshadowing story and can occur immediately, insert s in B' as next story. Let satellite-stories = satellite-stories – s, break.

3. Additional satellite stories: For s' in satellite-stories, if s' can occur after s and s' is the same type (transition or foreshadowing) as s, insert s' in B' where the type is acceptable, let satellite-stories = satellite-stories – s', break.

4. Check conflict with base story: While $\exists$ c_1 in (B' – B) that conflicts $\forall$ c in B where $c \neq c_1$, let S = S + c_1, x = the location of c_1 in B', remove c_1 from B', let c_2 = find a story in satellite-stories that can be inserted at x. If $c_2 \neq$ Ø, insert c_2 at x in B'.

5. Check conflict between satellite stories: While $\exists$ s_1 and s_2 that conflict each other, where s_1 in (B' – B) and s_2 in (B' – B) and s_1 occurs earlier than s_2 in B', let S = S + s_2, remove s_2 from B'.

6. Present story: Let satellite-stories = satellite-stories + S. Return B'.

After inserting satellite stories, the narrative selector checks for conflicts in the story. If the introduction of a satellite story conflicts the main story, the narrative selector may pick an alternative satellite story instead. If two satellite stories conflict each other, the narrative selector will resolve the conflict by removing the satellite story farther away from when the previous homework is checked, as immediate feedback is preferred over a delayed one.

Prototyping

We designed a prototype containing two sessions of game play to promote physical activity. A narrative selector as described above is implemented in the prototype and adapted to the genre of the game. We describe the prototype and the choices we made in the adaptation.

The Story

Because we are interested in developing a framework that can be used with existing stories to enable developers of games for health to quickly develop interventions in the future, we have chosen to use an existing story available from the public domain for this prototype. The story we are working with is a Golden Age comic book, *Commander Battle and the Atomic Sub*, which contains seven issues completely available in the public domain. The comic book was created in 1954 in the context of the Cold War, featuring fictional World War II hero *Bill Battle* and his crew of atomic submarine commandos fighting against aliens and battling espionage against the United States.

We made two major changes to the story before using it for health intervention. First, because the original story's premise is limited to the context of its times, we assigned a new premise to the story: The future is pictured by technology, but defined by man. We added satellite stories indicating this premise in the prototype and plan to continue doing so in the finished game. Second, the original story has no connection to physical activity. We have decided to relate physical activity to the story's new premise, indicating the atomic submarine is partially powered by the physical and mental status of the commandos onboard. The story will involve the player as an additional commando in the team, whose primary job is to perform exercise related missions and recover from a devastating injury, to power the atomic sub and find his or her lost memories.

The Game Interface

We've chosen to develop the game using *Ren'Py* (http://www.renpy.org/), a game engine commonly used for developing visual novels, because it is one of the simplest tools that fulfill our purposes.

Because we have chosen to adopt the story from a comic book, we created the prototype simulating the experience of reading an online comic book. Specifically, we modeled the experience after *Marvel Entertainment*'s online comic book reader, with slight modifications to allow the player to make choices regarding their homework. The comic book is originally 7 to 12 pages per issue, and 5 to 7 frames per page. Each frame may contain several dialogue boxes. A narrator text may be present on top of a frame. When converting the comic book to a game, we removed all hand-written texts from the pages and turned them into scripted texts that the game can position in text bubbles (if it is a dialogue turn) or at the bottom of the screen (if it is a narrator text). The game displays the comic book to the player one page at a time. Inside the page, the game displays one frame at a time, zooming in to show the entire frame with a close shot (Figure 1). While presenting a frame, the game will also display dialogue text and narrator texts one at a time. Each transition between texts, frames and pages can be triggered by a left-click by the player.

Functions are created in the game to present multiple choice menus to the player and prompt free input from the player. Menus are presented when the player is asked to accept or reject a homework assignment, and when the player must indicate whether they have completed a previous homework assignment or not. Player input is required to report their findings from completing a homework assignment, or to explain why they can't finish a homework assignment.

Narrative Selector Adaptation

Because we are using a comic book to present the story, we performed a series of adaptations for the narrative selector described in our framework.

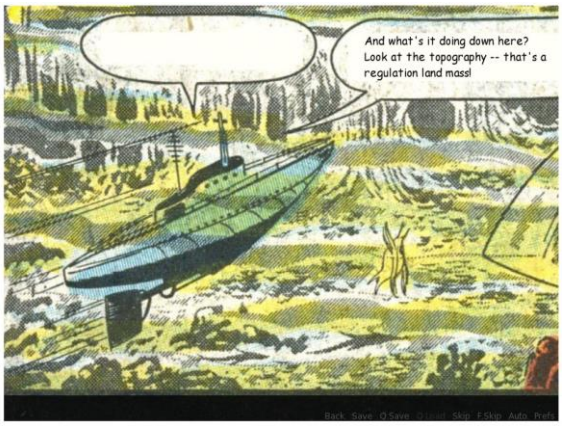

Figure 1. A screenshot of the prototype.

The current prototype contains homework assignments in three *processes of change* that cover all five *stages of change*. In the finished game, we plan to develop 52 homework assignments for the ten *processes of change*. Each homework assignment belongs to a single *process of change*, and each *process of change* can be used for players across multiple *stages of change*. The narrative selector uses the player's *stage of change* to identify a *process of change* that contains the proper homework assignments, and presents one of these assignments to the player.

In the completed game, each session will begin with a set character checking on the player's previous homework assignment. At the end of the session, a different character will assign the player a new homework assignment following Algorithm 1. The current prototype presents Bill Battle, the protagonist in the original comic book, who will assign the player a homework exercise at the end of the first session and check on the progress in the second session. After the homework checking, the narrative selector updates the story following Algorithm 2. The system retrieves utter-

ances regarding each homework assignment from an XML file. An example is as follows:

<hw id="1">

<assign>Search for articles on the Internet about the pros and cons of physical exercise. Write down your key findings next time.</assign>

<report>Have you read through articles about the pros and cons of physical exercise?</report>

<success>What are the pros and cons you've found? Write down a few simple words.</success>

<failure>What prevented you from finding out the pros and cons of physical exercise?</failure>

</hw>

The base stories, satellite stories, and persuasion techniques are also indexed in XML. The story index will contain information including the type of the current story piece, the type of story that can follow the current one, and the variables that are changed after this story piece is run, if any. Motivation techniques include utterances unique to each non-player character. Bill Battle's motivation utterances, for example, are stored in the following format:

<char name="bill">

<consistency id="1">Let's all do our work, yeah? You came down here telling me you will help us. C'mon, do your part and let me do mine. Just give it a try, OK?</consistency>

<liking id="1">I hope I'm not pressuring you. Look, I want to trust you. I want you to cover my back. And for that I need you. You hear me? Give it a try, and I won't blame you if you fail.</liking>

...

</char>

The prototype contains one transition satellite story and one foreshadowing satellite story. The transition satellite story describes *Doc*, one of the atomic sub commandos, checking on the helicopter onboard the atomic submarine while he commends the player for their first homework completion. The foreshadowing satellite story features the President telling the player he is worried whether *Bill Battle* will be able to hold the team together. These satellite stories can both be added to the story when the team is preparing for their first mission in the second session. When new satellite stories have been developed, the narrative selector will have more choices for each session based on constraints of the location of the commandos, the status of their mission, and the availability of certain characters. A screenshot of the prototype can be found in Figure 1. Figure 2 demonstrates the possible paths of the two sessions under the guidance of the narrative selector.

Discussions and Future Work

Some researchers have been concerned about the fixation of intelligent narrative research on classical drama (Horswill 2012). The work presented in this paper is inspired by these concerns and aims to combine the principles of drama with theory of health behavior change. By using this hybrid approach, we intend to explore new horizons for intelligent narrative research and use narrative technologies to benefit the research in behavioral medicine.

In this work, we have chosen to work with a medium that differs from most existing research in the field. Compared to text-based interactive narrative, platform games, and games that allow free player input such as Façade, converting a comic book to a game is faced with a different set of constraints and challenges. Future work may explore means to increase interactivity of this genre and create narrative systems using art and drama principles unique to comic books, such as discussed in (Auter and Davis 1991).

Intelligent narrative systems hold the potential to reduce cost and improve the efficacy of health interventions. Applying intelligent narrative systems to health interventions may yield to important research questions in connection with both domains. Future research may identify such cross-domain problems and investigate the potential of intelligent narrative systems that bestow health benefits.

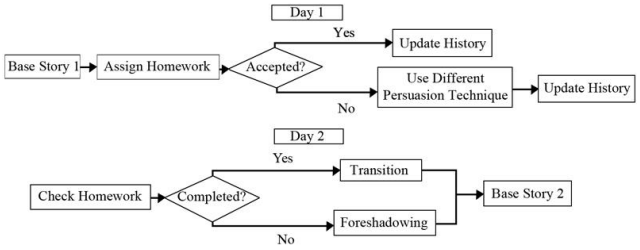

Figure 2. Flow of the two developed sessions.

As future work, we intend to evaluate how well our narrative selector improves adherence, maintains engagement, and promotes health behavior change. We plan to continue with our efforts in creating 21 sessions of game play, featuring the entire story of *Commander Battle and the Atomic Sub*. We plan to recruit subjects to play the game in their homes up to one session per day over the course of three weeks, and use a between-subject experiment design to compare the results to a homework-only health behavior change intervention as well as other common games for health approaches. We intend to discuss the study design and results in a future publication.

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