The Games for Health Prototype

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ABSTRACT

In this paper we present a prototype developed to explore the application of game design and technology to the treatment of Post Traumatic Stress Disorder (PTSD). We describe the design process that led to the development of the prototype and the included aspects of game design and game technology, how the approach and the prototype differ from previous work in using virtual environments in the treatment of PTSD, and we outline the first clinical trials of the prototype.

Demo and video links:
`http://itu.dk/people/holmgard/gfh/gfh.html`
`http://www.gamesforhealth.dk`

1. INTRODUCTION

Post Traumatic Stress Disorder (PTSD) is a psychiatric diagnosis describing an often severely disabling syndrome that is sometimes developed after being exposed to highly stressful situations. Veterans from military operations are a high-risk group for developing this syndrome [17]. With the Games for Health project we set out to investigate the usefulness of game design and technology to support the psychiatric treatment of PTSD with veteran soldiers from the currently ongoing Danish military engagement in the conflict in Afghanistan. One treatment approach for PTSD, favored because of strong evidence for its therapeutic efficacy, is the *cognitive behavioral therapy* technique of *exposure therapy*. In exposure therapy, the therapist confronts the patient with anxiety provoking stimuli in a controlled setting in order to extinguish reactions to said stimuli and/or allow the patient to reprocess the memories cued by the stimuli. Three common variations are the use of real life stimuli i.e. *in vivo*, representing stimuli via media i.e. *mediated*, or having the patient imagine the stress provoking situations and thus self-generate the stimuli i.e. *imaginal* [6, 9]. With the help of a multidisciplinary team, we designed and implemented a novel game that expands upon the principles of exposure therapy with simple game mechanics and uses detection mechanisms to infer the user's responses to in-game events.

2. BACKGROUND

Prior research has demonstrated the usefulness of virtual environments for treating veterans' PTSD with *virtual reality therapy* [10]. The developed systems often focus on outfitting the therapist with a sand-box type environment for the patient to explore that the therapist manually configures during the therapeutic session. The interaction is centered on the conversation between the user and the therapist, and the user's primary role is to explore and perceive the virtual environment, rather than directly interact with it. The approach also typically seeks a high degree of verisimilitude and employs specialized equipment such as head mounted displays or custom-built interfaces like e.g. vibrating platforms. Finally, virtual reality therapy most often focuses on exposing the patient to the original stressful, traumatizing situation. Notable examples are the *Virtual Iraq* and *Virtual Afghanistan* applications that show promising results in clinical testing [14, 15, 16]. No approaches for virtual reality therapy have yet, to the knowledge of the authors, combined exposure therapy with affective computing [12]. Various physiological phenomena have been demonstrated to allow for the measurement of emotional states, finding use in everything from the measurement and modeling of players' reactions to veterans' stress levels [11, 13, 19, 20]. Additionally, studies have shown that veterans suffering from PTSD exhibit response patterns significantly different from those of non patients. It has been suggested that these differences could be used to support diagnostic differentiation [4].

3. GAME DESIGN CONSIDERATIONS

The design of the Games for Health prototype was guided by the joint design efforts of a multidisciplinary team consisting of researchers and practitioners from the fields of psychotraumatology and digital games. We set out to address the PTSD condition in a manner that differed from the prior work outlined above in a number of ways:

Ease of use was an overarching design goal. We aimed to create a tool that would fit into most psychological or psychiatric clinical practices with a minimum of technical expertise needed from the mental health practitioner. Hence, it was decided to develop a tool that could run on any reasonably modern consumer computer equipment. To this end the prototype was developed using the game engine Unity [1]. We did, however, deviate from this design goal

Figure 1: The supermarket. A man is walking rapidly and angrily down the aisle.

Figure 2: A flashback scene presented immediately after the game state of Figure 1. The angrily walking man bled into a vision of a man running towards the player.

to the extent that is was necessary to enable the physiological readings for the affective computing component of the prototype, but only employed consumer-grade psychophysiological measurement equipment [3].

Exposure to everyday life situations was central to the design of the prototype. Whereas existing solutions [14, 15, 16] focus on addressing the memory of the traumatizing situation, the mental health professionals on the design team stressed the potential value of being able to expose patients to mundane, but stressful situations. We hypothesized that this approach could help PTSD patients improve their functioning in everyday tasks with direct benefits to their quality of life as a form of *systematic desensitization* [6]. The task of going shopping in a supermarket was quickly identified as a common situation that is severely challenging to many veterans suffering from PTSD. Supermarkets are highly stimulating environments with many social interactions and unpredictable auditive and visual experiences, which PTSD patients find stressful; some to the extent that they avoid going shopping or only do so with a helper present for emotional support. Consequently, we built our prototype to take place in a virtual supermarket and focused on reproducing the experience of the stressfulness of shopping in a supermarket. Since many veterans suffering from PTSD report re-experiencing memories of the originally traumatizing situation when cued by elements in the environment, we also included short *flashbacks*. These momentarily change the environment of the game to an Afghan theater of operations, before changing back into the supermarket. The two modes of the game are depicted in Figure 1 and Figure 2.

Goal driven interaction with the virtual environment was determined to be a priority area where game design could support the use of virtual environments for treating PTSD. The underlying idea was informed by research in presence and immersion [8] suggesting that the user's involvement with the diegetic aspects of a virtual environment has a high impact on the level of immersion the user feels which we, in turn, hypothesized to influence the stressfulness of the experience. Additionally, adding a mission to the patient's interaction with the prototype would quite simply provide a reason for interacting with as much of the virtual environment as possible, allowing us to expose the patient to as many different stimuli as possible. Hence, we added the very basic mission of having to gather a number of items indicated on a shopping list, before proceeding to the register, standing in line and paying the store clerk before leaving. The patients were asked to complete this task within a set time frame and were shown a timer counting down while they were completing the mission.

Tracking responses through affective computing was included for a number of reasons. As noted above, earlier studies [7] have shown that patients suffering from PTSD have autonomic responses to stressful events that differ from those of control individuals. Consequently, the autonomic responses would allow us to investigate whether veterans did indeed respond differently to the prototype than a control group, which would indicate that the prototype had a specific relevance to the patients. Conversely, once a baseline dataset had been established, it could also potentially allow the prototype to function as a diagnostic support tool, by using autonomic responses to distinguish between patients and non-patients. Finally, the ability to track and evaluate patients' responses to individual events in the virtual environment could allow for the construction of individual models of stress reactivity, which in turn could allow for the tailoring of event-configurations at the individual level.

4. PLAYING THE GAME

Below, we briefly describe how the game was played by the participants in the study. Since the game is specifically constructed to elicit stress responses with the player an experimenter and trained psychologist, capable of intervening, is present in the room with the player throughout the session to minimize the risk of subjecting the player to any excessive stress. Before initiating the first round of play, the severity

of the patient's PTSD symptoms is assessed using a structured interview and a questionnaire: The PTSD Module of the Structured Clinical Interview for the DSM (SCID) [5] and the PTSD Checklist [18].

4.1 The Game Environment

As noted above, we assume that the player's level of immersion into the game environment will influence the extent to which he responds to the stressors in the game. To support immersion, the simulation is presented from a first-person-perspective, inviting the player to identify himself onto the unseen avatar of the game. The player starts at the entrance of the supermarket, navigates through the supermarket collecting items on the list and concludes the mission by standing in line and paying at the cash register. The player can move freely around the supermarket and collects or activates goods or items by centering the view on them and clicking. In order to ensure that the player experiences as much of the supermarket as possible, the object of the game is to collect a number of goods presented on an on-screen shopping list within a given time frame. The items to collect and the remaining time are displayed on screen during the game. The goods are placed in locations that make it probable that the player will be exposed to all sections of the supermarket if he manages to collect all items. The supermarket environment includes a number of stressors that aim at eliciting stress in the player. These are designed around three typical symptoms of PTSD, namely agoraphobia, hyper-arousal/heightened startle response, and the re-experiencing of traumatic events upon cueing by an outside stimulus or general stress [6].

Stressors targeting agoraphobia include the following design elements: The layout of the supermarket is designed to include hidden angles and preventing the player from attaining a full overview of the location. An aisle is blocked by a shopping cart making it difficult for the player to pass. *Non-Player-Characters* (NPCs), adults as well as children, wander around the supermarket, sometimes blocking the way of the player. Two NPCs, engaged in conversation, will stop talking and stare at the player if he approaches. An NPC walks angrily down the aisle toward the player, expressing aggression through his body-language. A family of NPCs are engaged in a discussion, the father scolding the child aggressively. An NPC pockets goods from the shelves of the supermarket.

Stressors targeting hyper-arousal include a dog barking at the entrance to the supermarket and the sound of crashes and glass breaking suddenly playing at random locations in the supermarket.

Finally, stressors targeting re-experiencing are included in the form of three different flashbacks. The purpose of these is to elicit the feeling of recalling and re-experiencing a traumatic memory. Only one is shown per mission. In the first flashback the player is walking on a foot patrol in a typical Afghan theater of operations. In the second flashback the player sees a man running directly toward him, possibly with hostile intentions. In the third flashback the player sees a fellow soldier hit by an explosion, clutching the remains of his leg.

The game features three different configurations of missions assumed to elicit stress to different degrees. The missions vary in terms of the number of items the player must collect within the time limit and the apparent threat in the presented flashback. We assume that increasing the number of items the player has to collect within the same time frame and increasing the degree of threatening content in the flashbacks will increase the stressfulness of the experience accordingly. The missions are played consecutively from the least stressful to the most stressful.

4.2 Hardware and Setup

For continuous measurement of *skin conductance* (SC) and *blood volume pulse* (BVP) the IOM biofeedback device [3] is used. The IOM biofeedback device samples these two signals at a rate of 300 Hz and downsamples them to 30 Hz in firmware before transmitting them to the recording computer [2]. The device is attached to the distal phalanges of the little, ring, and middle fingers of the player's non-dominant hand. To ensure maximum exposure to the content, while still using typical consumer-grade hardware, the game is presented on a 25" LCD monitor placed roughly 35 cm from the face of the player. For providing auditive stimulation, while still allowing the player to communicate with the experimenter, supra-aural headphones are used to deliver the sounds of the game. The audio level is adjusted to be experienced subjectively as loud, but pleasant. Since frustration with the control scheme of the game might introduce unwanted variation into the results of the experiment [21] the game is configured to use what we consider to be standard controls for first-person-perspective computer games which should be familiar to most players. The mouse, operated with the player's dominant hand, controls the perspective and the keyboard controls movement. In order to minimize the risk of movement artifacts in the physiological readings, participants operate the keyboard (W, A, S, D or arrow keys) with only the index finger of their non-dominant hand, keeping the other fingers still.

5. CLINICAL TRIALS

Clinical trials were completed in December 2012. A total of 15 veterans suffering from PTSD and 20 comparable veterans, who were screened for but not diagnosed with PTSD, played the game three to six times over one to two sessions (three rounds per session), with a fourteen day break between sessions. The analysis of the collected data is currently ongoing, however, preliminary findings indicate that the prototype has a strong potential for stimulating stress in veterans suffering from PTSD, based on both qualitative data gathered from observation and interviewing, as well as subjective ratings of experienced stress levels collected from the participants. Preliminary analyses of physiological responses support this observation. Several patients commented that the experience of playing through the prototype made them aware what elements of the supermarket they found particularly stressful and that this provided them with insight into their everyday challenges of going shopping.

6. FUTURE WORK

The first analysis of the collected data material is expected to be completed during January 2013. If the collected data supports the hypothesis that physiological responses to the

prototype can be used to differentiate between those veterans who qualify for the PTSD diagnosis and those who do not, further testing is planned to expand the body of evidence. The next step for the prototype will be the inclusion of adaptive functionality, enabling it to identify the most potent stimuli at the personal level. The assumption is that this will allow sessions to be increasingly customized to the individual patient, based on the individual's previous responses to the game.

7. CONCLUSION

This paper has given a short introduction to the Games for Health prototype and the key considerations that went into its design and development. The developed prototype advances the areas of game design and technology applied for health purposes. Preliminary results indicate that there is indeed a value in this alternative approach of simulating everyday situations to provide PTSD patients with a tool that allows them to train their coping skills for these situations in collaboration with their therapist. Furthermore, preliminary analyses suggest that the bodily responses of PTSD patients are substantially different from the responses of non-patients. This in turn makes it plausible that a virtual environment featuring affective detection functionalities could have potential as a future diagnostic tool supporting psychiatric practice.

8. ACKNOWLEDGMENTS

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