Serious Games for the Therapy of the Posttraumatic Stress Disorder of Children and Adolescents

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Abstract. The posttraumatic stress disorder (PTSD) is a mental-health problem that can emerge after a delayed reaction of a person to a traumatic incident. A common therapy is the so-called exposure therapy. However, children and adolescent cannot be treated with a common therapy. In this paper we describe a serious game for the therapy of a PTSD by children and adolescent. Objective of this paper is to introduce a concept for the game development and a method to balance the game. It is based on a so-called impulse hierarchy. The game prototype respectively the utilized concept and methods have been tested with healthy test persons. The results are a strong indication for the effective of the developed game concept and the usefulness of the key principles.

1 Introduction

The posttraumatic stress disorder (PTSD) is a mental health problem that can emerge after a delayed reaction of a person to a traumatic incident. This incident leads to an exceeding threat of the relevant person. It arouses a sense of deep desperation, strong fear, and helplessness. A traffic accident is such an incident. Involved people are not able to manage their life anymore on their own. They avoid the traumatic situation, retire themselves from their social environment, suffer sleeplessness, great nervousness, and other mental disorders. A behavior therapy can help the involved people. A common therapy is the so-called exposure therapy. This therapy confronts the patient with his / her individual trauma. It includes a repeated relive of the traumatic situation. Normally, the repeated relive is done narrative or in-vivo; at the place where the trauma occurs. This therapy enforces an emotional rehabilitation and leads to a systematic desensitization.

Beside the classical therapy, virtual reality exposure therapies (VRET), game-like applications and serious games are explored for several years. These therapies displace the patient into a virtual world and confront the patient with virtual stimuli. Games add a story that enhances the reflection of complex mental health problems. Altogether, the research in this field demonstrates the effectiveness of this therapy method.

However, children and adolescents cannot be treated in the same way. They have a different comprehension of the PTSD and a lack of insight into the difficulties that the

mental disorder cause. In all, they need to be motivated for the therapy. However, serious games are in the focus of research for this target group in order to treat mental health problems [1], [2]. In our definition, serious games are computer games that impart knowledge, train capabilities as well as enable them to apply this knowledge meaningful. The knowledge is transferable into the "real world", the player becomes more capable of acting. During the therapy the children and adolescents play the serious game. Thus, they become part of a metaphorical adventure. Indirectly, they deal with different important questions regarding their mental health problem.

In this paper we describe key principles for the design of a serious game for the therapy of PTSD. Furthermore, we introduce a method to keep the game in balance between fun and fear. Both methods facilitate third persons to develop a serious game for the desired purpose. The paper is structured as following. First, the related work is described. Then the key principles and our game concept are introduced, followed by the explanation of the developed method. Afterwards, the tests are presented. The paper closes with a conclusion and an outlook.

2   Related Work

Serious games, commercial games, and game-like applications have found their way into the focus of therapists. Commercial computer games were the first games therapists used in therapy (e.g. [3], [4], [5]). The games have been used to treat different mental health problems. A patient, child or adolescent, played a game during a therapy session. The therapist observes his/her patient while he/she is playing and notes the patient his/hers behavior. The game serves as a context for discussion between therapist and patient. It provides a structure for a therapy session and supports the building of an effective patient-therapist working relationship [6].

A major concern regarding commercial computer games is their content, which limited its use in psychotherapy [7]. Commercial computer games, their graphical interface, the sound, and the game play are designed to evoke specific emotions such as fear, excitement, and humor [8]. These emotions interfere with the emotions a therapist needs to evoke for treatment [1].

To face this concern serious games for the treatment of mental health problems get into academic focus. An advantage of serious games is their motivating effect to children and adolescents. It makes fun to play a game. Serious games exploit this fun factor for therapy purpose: The treatment of PTBS and other mental health problems based on learning theories. And fun advances the learning process.

Different serious games have been designed for different mental health problems and for different therapy methods. But the main principle of all games is similar: The player, normally the patient, assumes the role of a virtual character and needs to handle different quests. The patient experiences a metaphorical story in the game. Thereby s/he deals with different questions and problems regarding the certain mental health problem. In detail the mechanisms differ that cause a therapeutic effect.

One of the first serious games in this field is the game Personal Investigator (PI) [9], [10]. PI has been developed for the treatment of emotional disorders. The patient assumes the role of a detective. Objective of the game is to become a master detective. During the game the player encounters different challenges and problems.

The solution of these problems helps the patient to reflect his/her problems. The game is in a clinical trial.

A second game is Treasure Hunt [11]. It is a game for the behavior therapy of children and adolescents with anxieties or depressions. The patient assumes the role of a child and needs to help the captain of a treasure ship reading a treasury map. For this purpose the patient has to solve different tasks that allow a reflection of the mental health problem.

Virtual Classroom is a game for children with an attention deficit disorder [12]. The game presents a virtual classroom including tables, chairs, a blackboard, virtual classmates, and a virtual teacher. The patient himself/herself is a scholar. During the game nuisance-causing effects like sound are brought in. The reactions of the patient are recognized and reflected.

There are still a few further games, which become effective utilizing the same major principle. Earthquake in Zipland is a serious game that should help children to elaborate the divorce of their parents [13]. A patient assumes the role of a moose and has to solve different quests. In 2010 the German game "Zappeliz zaubert" (Zappeliz perform magic) was released [14]. The game has been designed for the treatment of an attention deficit disorder.

In summary, several results have been presented:

- Serious games facilitate the treatment of mental health problems. The shown studies are a strong indication for their effectiveness.
- Serious games help the therapist to develop a working relationship to a patient. Many children have a problem to talk to a therapist due to several prejudices.
- Finally, serious games motivate children and adolescents. There are strong indications that this effect supports the therapy: Therapy is learning and motivation improves learning [15].

However, the serious games have not been developed for the treatment of a post-traumatic stress disorder (PTSD). Applications for the treatment of PTSD have been developed for adults ([16], [17], [18], [19]). Unfortunately, these applications are not designed as games. Thus, the results cannot be transferred without any further evaluation due to the fact that children and adolescents have a different understanding of the therapy. Finally, they need games to be motivated for therapy.

3   Game Concept and Principles

A serious game for the treatment of a PTSD needs to follow different principles than serious game for other mental health problems. The difference is: to treat a PTSD the patient must be confronted with his/her trauma, with a trigger stimulus that causes anxiety and unease. On the other side the serious game is used to evoke fun and gratification; both facilitate the treatment. If to much anxiety arise, the game causes the opposite effect. To face this challenge a set of key principles and an effective hierarchy are introduced. Both allow keeping balance between fear and fun.

3.1   Game Design and Key Principles

During the collaborative work on the serious game, a set of key principles occurs that guided the creation of a virtual game environment. We define a key principle (KP) as a design rule that directs the structure and layout of the virtual environment as well as the usage of trigger stimuli and their virtual presentation. The key principles have been founded after the observation and discussion of many therapy sessions and the development of a game prototype. **Fig. 1** shows a screenshot of the players view on the virtual game environment of this prototype.
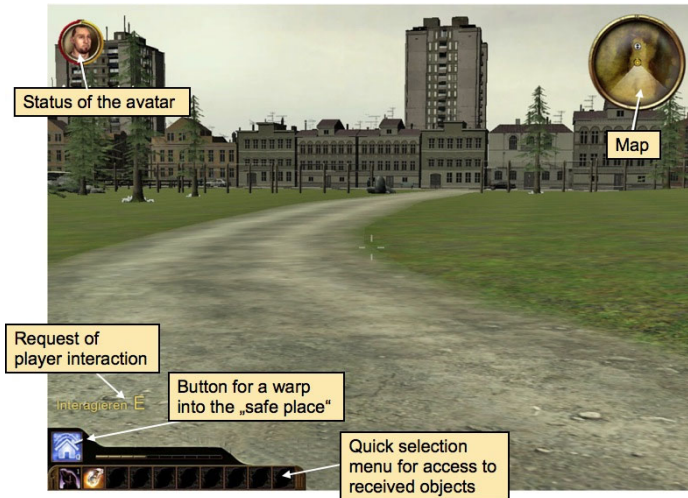

Fig. 1. The players view on the virtual game environment

The patient controls a virtual avatar that s/he plays from a first person view. The entire game is created like a normal computer game. On the main screen the player founds a status display of the avatar, a small map indicating the position of the avatar. A quick selection menu gives access to different objects, which the player receives as gratification during the game. The game is controlled by mouse and keyboard.

The basic game design needs to correlate with the individual experienced trauma. Everybody who suffers on a PTSD has experienced an individual event like a car accident. Thus, the trigger stimulus, the entire situation is individual and has to be designed individually. For instance, if a child has been involved in an accident at a crossroad inside a town and the car was red (this can be a trigger), the virtual world also needs to show a virtual crossroad and a red car. This is our major key principle for an effective serious game. Of course, the challenge is to identify the trigger stimuli. Mostly, also the children and adolescents do not know all trigger stimuli at the beginning of a treatment. To face this problem the game design, respectively the design of the virtual world needs to be adapted during the therapy.

In addition to this major principle, the further key principles define guidelines for the entire structure and setup of the virtual environment.

KP1 - The virtual environment needs to be separated into a mediation zone and a confrontation zone. Fig. 2 (left) shows an overview of the current virtual world realized in our prototype. On the top of the figure a red border indicates a so-called confrontation zone. In this zone only, the patient is confronted with his/her trigger stimuli. Beyond this zone the green border indicates a mediation zone. In this zone, the patient can talk to other non-player characters, etc. The separation into zones needs to communicate to the patient. The zones allow the patient to control the therapy, one important factor for its effectiveness. If the patient is ready to face a stimulus, s/he can walk into the confrontation zone. By all means, this requires an action of the patient (walk) that allows control.
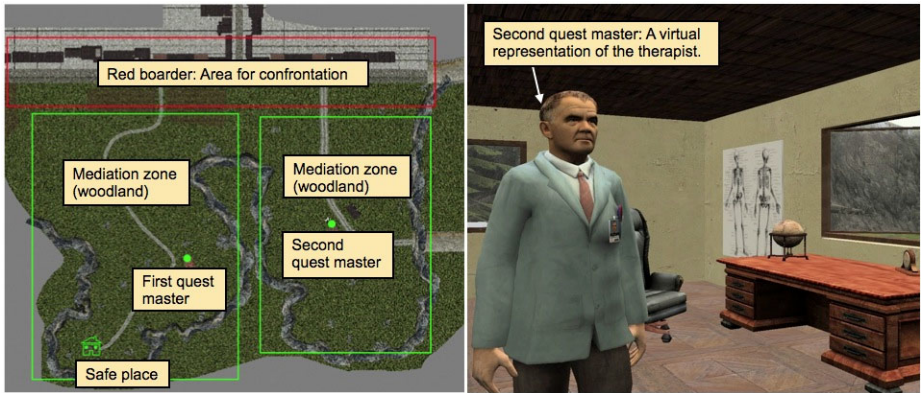

Fig. 2. An overview of the current virtual world (left), a quest master offers the player a set of quests: tasks that force the player to deal with his / her problem (right)

KP2 - Free choice of quests. The patient determines the "speed" of the therapy and not the therapist. Thus, s/he also has to choice between several quests. A quest is a task inside the game that the player has to perform. Most of them are search & collection quests as well as protecting quests. In each quest, the player deals with different aspects regarding the PTSD. For instance: "Why is it impossible to avoid the emotion of fear?", or "What trigger stimuli are to avoid?". However, the patient has to get the feeling of choosing the quest. S/he has to decide when s/he is ready to deal with a certain topic.

KP 3 – Gradual increase of stress. At the beginning of the game, in the first therapy session, the player should get the choice between "easy" quests. Each quest results in an increase of stress. The first task should result in a marginal increase of stress. With progressing therapy, the quests have to become more challenging. A practical solution to keep this under control is to establish a central point inside the virtual world and to assign quests with respect to the distance to that place. **Fig. 2**, left, shows this principle: The player starts at the so-called "safe place". The first quest master assigns

only simple quests to the player. The second quest master assigns the challenging quests. Finally, the therapist should activate the last stimuli manually. In the case of a car accident, the patient has to see a virtual accident (Fig. 3, right).

KP4 - Individualization facilitates a central point. The central point inside the virtual world should be the so-called "safe place". The "safe place" is a psychological metaphor for a state of safety. The common therapy utilizes pictures, photos, or thoughts as safe place. In the game it has to be a 3D model at least. Fig. 3, left, shows our interpretation of this place. It is a building inside the game environment. To establish this place as a central point of the game, as a safe place, the player needs a strong relation to this place. This is possible by individualization. The player needs the possibility to design this place as s/he wish. Furniture, pictures, the design of the wall, and everything else has to meet the expectations of the player. This results in an emotional relation and causes a feeling of safeness.
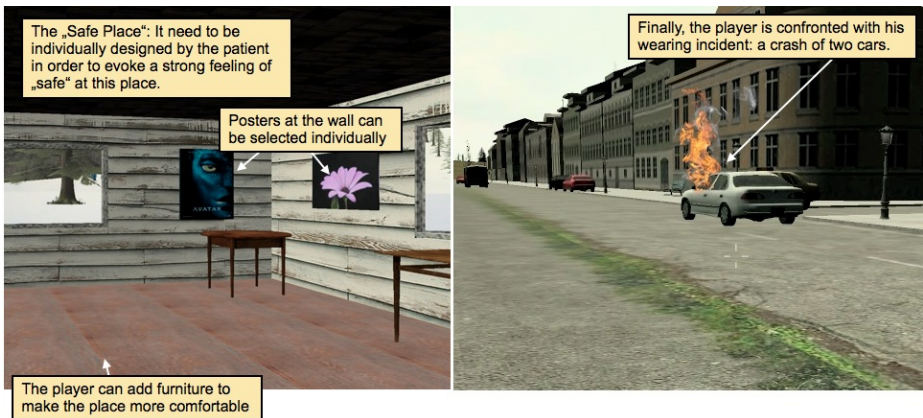

Fig. 3. The "safe place" (left), and a crash of two cars as final trigger stimulus (right)

KP3 - Gratifications have to be objects the patient can use immediately. After passing a quest the player must receive a gratification immediately. The children and adolescents need this gratification to evoke a feeling of satisfaction. This enhances the therapy. However, to realize this effect an object has to be deliver that can be used immediately in the game. An armor, a protective shield, and other things. Its effect is mitigates when game points or collectibles are rewarded.

3.2 Effective Hierarchy

To keep balance between anxiety and fun in the game an effective hierarchy has been developed. The effective hierarchy allows to keep track of the different stimuli in the virtual world and to balance the challenges in the game, caused by the quests. Figure 4 shows a section of the suggested effective hierarchy and its utilization.
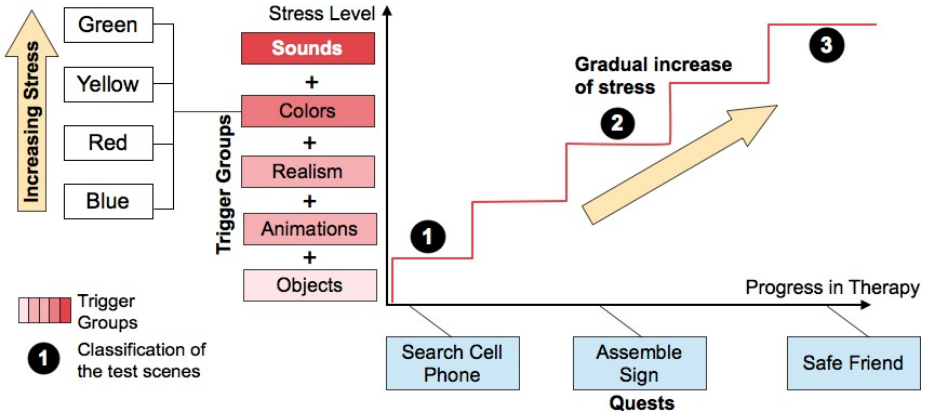
Fig. 4. Schematic overview of the effective hierarchy and its utilization

The basic of this effective hierarchy are a group of trigger elements, which are sorted by their ability to cause stress. The series is: objects (streets, houses, persons, trees, etc.), animations, realism, colors, and finally sounds. Basic elements are objects. To get a relaxing world, it has to be created using static virtual objects only. To increase the stress level animations have to be added. Then the realism of the scene should be increased by including details. The last two trigger groups are colors and sounds. If a scene contains all triggers, it becomes a stressful scene.

Each trigger group includes a set of graphical attributes that realize this trigger group. For instance, the trigger group color includes the colors blue, red, yellow, and green. The triggers are ordered by its ability to cause stress.

The order of the graphical attributes and sounds depends on the experiences of every patient. Thus, the therapist has to adapt this series for each patient. The therapist starts with a predefined template. During his/her talks with a patient s/he has to determine trigger stimuli (The therapist has to do this during a common therapy, too) and to reorder the stimuli / graphical attributes of the trigger groups.

In order to utilize this hierarchy it is linked to the different quests. In figure 4 the quests are indicated on the abscissa. From the left to the right the quests become more challenging. After a quest is designed, the included trigger stimuli (objects, animations, realism, color, and sound) need to be analyzed and their level of stress has to be rated. By this rating they can be assigned on the abscissa.

In the game a gradual increase of stress has to be realized. By the use of the effective hierarchy, we have an indication for the mental challenges a quest causes and are able to offer the patient a set of adequate quests.

4   User Tests

The key principles and the effective hierarchy need to be tested to get an indication for their effectiveness. Therefore, a test with healthy children (8 children) has been carried out. To compare this group, a group of adults (6 adults) has also been tested.

4.1   Test Setup

Fig. 5 (left) shows an image of the test setup. A test person observes three different, pre-defined scenes of the game on a large powerwall. The selection of test scenes is indicated in figure 4 by the numbers in the chart. The tests should increase the stress level of the test persons. Thus, scenes on a lower, an average, and a high-assumed stress level have been defined. We have assumed that the stress level of the test persons should increase, while observing the scenes.

To measure the stress of a test person and his/her "fear" the State-Trait Anxiety Inventory (STAI) has been used [20]. STAI provides a questionnaire with questions for 20 different items. The analysis of this questionnaire allows determining a stress level as quantitative value. The stress level has been determinate after each scene. A test person has observed in scene. After each scene the person has been asked for an appraisal of his/her current state.

In addition to the questionnaire, the pulse rate of each person has been measured. For this purpose a Polar pulse watch have been utilized.
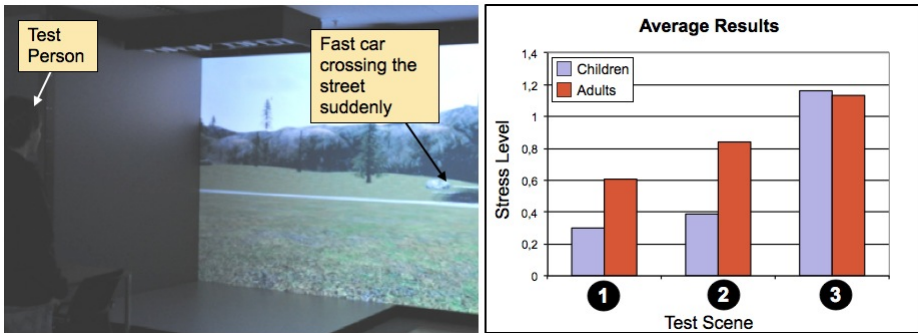

Fig. 5. An image of the test setup (left), the received results (right)

4.2   Results and Discussion

Fig. 5 (right) shows the results. The ordinate shows the stress level. The abscissa presents the three tests and the results. The bars show the average stress level of the three tests, calculated due to the STAI proceeding. The results are separated. The results of the children are colored mauve, the results of the adults are colored orange. The numbers (1 to 3) indicate the tests.

As expected the stress level increases due to the predicted stress level. The addition of trigger stimuli, according to the effective hierarchy, causes the expected behavior: From scene one to scene three the stress level increases. There are differences between the stress level of the adults and the stress level of children. Finally, both incline to the higher stress level. The lower stress level of the children at the scene one may base upon their familiarization with computer games. The pulse measurement supports these results in general. However, the gradient of the pulse rate is not as high as the gradient shown in figure 5.

5   Conclusion and Outlook

The contribution introduces the use of serious game for the treatment of a PTSD by children and adolescents. To design a virtual environment for this type of game, we introduce a set of key principles. In addition, to keep the challenges of the game in balance, an effective hierarchy was introduced. This effective hierarchy should make the scenes and their effect predictable.

To determine their usefulness a user test has been carried out. This test and the developed prototype enable three statements:

First, the key principles are practicable for game design. They provide a guideline for the arrangement of composition of 3D models like streets, buildings, woodlands, and quests, respectively the quest objects. The key principles are not fix but they are a good starting point.

Second, the effective hierarchy and the ordered trigger elements are a useable method to design a concrete therapy. However, they are not finally evaluated. But the results of the test are a strong indication that they facilitate the generation of virtual scenes with a controllable and predictable stress level.

Third, it is possible to design a serious game that keeps balance between anxiety and fun. Thus, in future the game will facilitate the therapy of PTSD.

Our next step is to extend the game. More levels and a larger map are necessary in order to keep a child busy for a several hours. Furthermore, we prepare a controlled study with children that show pre-clinical symptoms of a PTSD.

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