Research Assignment

Virtual Reality and the treatment of patients with a PTSD

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TUDelft VRET
Virtual Reality Exposure Therapy

Research assignment

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1.1 Introduction

Whether people go to work, study, or plan their holidays, there is most likely something out there that puts them in an inevitable stressful situation. Despite the fact that most people want to avoid such situations, they can often handle them without any problems or complications. However, it is a whole different story when someone is exposed to a traumatic event beyond the bounds of common, everyday human experiences. In such cases a person can develop a 'Post-Traumatic Stress Disorder' (PTSD) (Paul M. G. Emmelkamp, Bouman, & Scholing, 1995). This type of anxiety disorder is often linked to military soldiers who have witnessed a stressful event, but it can also affect people who have, for example, been in a motor accident or people who were confronted with a personal assault.

A wide range of possible options for treatment include therapies such as 'prolonged imaginal exposure therapy', 'in vivo exposure' and 'eye movement desensitization and reprocessing' (EMDR). Alternatively, various medicines are available to help patients cope with their disorder.

With the emergence of better and faster technology, various new approaches have been proposed. One such approach is the use of 'Virtual Reality' (Harvey, Bryant, & Tarrier, 2003). This technique enables the patient to interact in a virtual representation of the world. 'Virtual Reality Exposure Therapy' (VRET) (Harvey, et al., 2003) is one particular way of treatment and is already being used in practice to help people suffering from several different phobias other than a PTSD, such as, but not limited to, acrophobia and agoraphobia. In these worlds a variety of anxiety-provoking stimuli can be triggered at any time. Because the level of these stimuli can be changed, it is possible to gradually expose the patient to various levels of intensity. Studies (Bush, 2008) have shown promising results. However, is 'VRET' or virtual reality in general also a good way to treat patients suffering from a PTSD? Key aspects related to 'Virtual Reality' (such as 'presence') may be of importance, but what about other elements, if any?

A study (Difede, et al., 2007) has shown that when a therapy lacks to engage the patient emotionally, it will often lead to poor, undesirable results. The same study states that facts about both the patient and the whole ordeal need to be present in order to evoke emotions. Due to certain patients either avoiding specific moments of the event, or not being able to express themselves thoroughly, it is often very difficult to gather all of the facts and link them together. It is also said that in some cases the patient even has an unrealistic view of what might have happened.

Traditional treatment for patients with a PTSD poses several problems while trying to engage the patient emotionally, whereas the use of 'Virtual Reality' makes it possible to accomplish this gradually with the help of a set of pre-defined stimuli. It is essential to look at traditional treatment first and see if, for example, 'VRET' or 'Virtual Reality' in general can be used to enhance the effects which are currently obtained without the help of these new techniques. This research assignment will therefore not only include research on how 'Virtual Reality' can be used to help people with a PTSD, but also traditional treatments and their important aspects will be taken into account.

1.2
Goal of this research assignment

The main goal of this research assignment is to acquire answers to the following questions:

- Which features contribute towards a reduction of symptoms of a patient with a PTSD?
    - Which steps are taken in traditional treatment?
    - What are the limitations or difficulties?

- How can Virtual Reality help people with a PTSD?
    - Do current aspects used for the treatment of other phobias (such as presence) contribute?
    - Can VR or VRET enhance the steps and effects currently provided by traditional treatment?

These questions can only be answered by doing research on PTSD, various treatments without the use of Virtual Reality, Virtual Reality itself and VRET in combination with current phobias, including those which cover PTSD. Eventually, the answers and the remaining part of the research will also contribute to the final theses project.

1.3
Research approach and outline

Before these questions can be answered an extensive literature study is needed. This involves reading and collecting papers, articles and books. The literature must cover at least one of the following subjects:

- PTSD
- Traditional treatment of people suffering from a PTSD
- Virtual Reality and PTSD
- Virtual Reality and/or VRET

Because of the variety of subjects and the amount of literature involved, a list will be created featuring details, such as the title of the paper, the authors, relevance and, if applicable, experiment details. The (printed) papers will be tagged with a number for quick reference. If papers contain relevant and useful information, extra keywords and details will be added to the list.

While reading, advantages and disadvantages of methods will be kept. Comparisons and links to related papers will also be created for future reference.

In short, the following subjects will be discussed in further detail:
- Post-traumatic stress disorder
- Traditional methods for treating people with a PTSD
- Virtual Reality and VRET
- Current research on VR and PTSD

2.1 Post-Traumatic Stress Disorder

A 'Post-Traumatic Stress Disorder' is considered one of the twelve different types of anxiety disorders. Hence, before giving the definition of a PTSD, it is useful to look at the characteristics of an 'anxiety disorder' first.

According to DSM-IV (*Diagnostic and Statistical Manual of Mental Disorders IV*, 1995) a generalized anxiety disorder is characterized by:
- anxiety occurring persistently
- excessive and hard to control worry
- feelings of uneasiness.

Anxiety and feelings of uneasiness are normal human reactions when someone is in a stressful situation. Sometimes anxiety even results in better performance (Raudis & Yustitskis, 2008), as seen in the Yerkes-Dodson law graph in figure 1. However, when this feeling becomes excessive and influences a person's lifestyle, it is, like most other mental disturbances, considered a disorder. A very noticeable change in one's lifestyle is the avoidance of certain activities, people and places (*Diagnostic and Statistical Manual of Mental Disorders IV*, 1995).
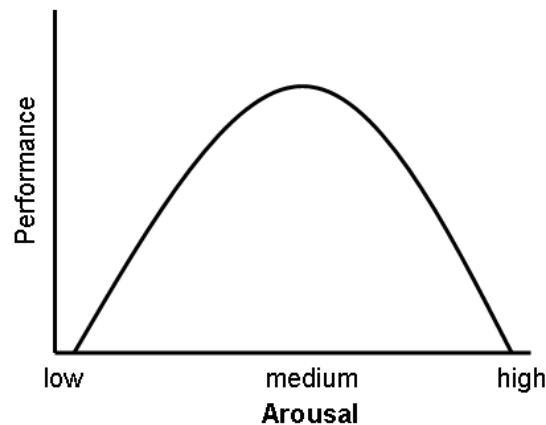

Figure 1 - Yerkes-Dodson law (Raudis & Yustitskis, 2008)

This definition covers anxiety disorders in general. DSM-IV provides the following description for a PTSD:

"Posttraumatic Stress disorder is characterized by the re-experiencing of an extremely traumatic event accompanied by symptoms of increased arousal and by avoidance of stimuli associated with the trauma." (Diagnostic and Statistical Manual of Mental Disorders IV, 1995)

This definition already specifies certain symptoms which make a PTSD different compared to other (anxiety) disorders. Symptoms of a PTSD can be distinguished by three different symptom clusters (Paul M. G. Emmelkamp, et al., 1995). Each cluster is related to one of the following:

- Re-experiencing,
- Avoidance
- Arousal

These symptoms occur after the person has been exposed to a specific kind of stressor. However, not everyone will experience these symptoms immediately after the event. In many cases the symptoms occur days or even months after the stressor. What are the criteria for these symptoms and what is considered a traumatic event? Also, in which ways does the person re-experience these events over and over again?

2.2

Criteria

The traumatic event or 'stressor' has to be of an extreme nature (Paul M. G. Emmelkamp, et al., 1995). Of course this statement is somewhat subjective, as one person is able to handle a specific stressor while others can not. Also, not everybody who experiences a traumatic event will react the same way (*Diagnostic and Statistical Manual of Mental Disorders IV*, 1995; Paul M. G. Emmelkamp, et al., 1995). The stressor is usually of human design (kidnapping, terrorist attack, personal assault, etc.), but also exposure to natural disasters (volcano eruption, tsunami) can result in a PTSD. In both cases it is clear that these kinds of events are outside the bounds of "normal", everyday experiences. The stressors mentioned here all have one thing in common: they can pose a serious threat to one's life or environment. DSM-IV (*Diagnostic and Statistical Manual of Mental Disorders IV*, 1995) specifies these traumatic stressors as one of the criterion of PTSD. The stressor must suit at least one of the following:

- Experience of an event which involves a serious injury or actual or threatened death.
- Witnessing an event involving death or injury of other persons.
- Learning or hearing about unexpected or violent death, harm, threat of death or injury by a family member or close relative.

This criterion is only concerned with the possible cause of a PTSD. Not everyone will develop a PTSD when confronted with one of the above mentioned stressors. Therefore more criteria are needed to cover the response and possible symptoms following a traumatic event.

DSM-IV (*Diagnostic and Statistical Manual of Mental Disorders IV*, 1995) states that a person's response to a stressor must involve fear, helplessness or horror. Next to this response, people who have developed a PTSD also experience certain symptoms related to the trauma. One such a symptom is the persistent re-experiencing of the stressor, as mentioned in the definition of a PTSD. There are various ways this symptom can occur. DSM-IV describes these as a new criterion:

- Recurrent recollections of the event. This includes thoughts, perceptions and images. Not only when the person is awake, but also when the person is asleep.
- The person feels or thinks as if the traumatic event recurs.
- The person is distressed when exposed to various stimuli related to the traumatic event.
- Physiological reactivity on exposure to the stimuli mentioned in the previous criterion.

Strongly related to this symptom is the persistent avoidance of specific stimuli. Of course the avoidance must occur after the exposure of the stressor. DSM-IV (*Diagnostic and Statistical Manual of Mental Disorders IV*, 1995) states that avoidance is one of the criteria related to PTSD and that at least three of the following indicators should be true.

- Avoidance of feelings, thoughts or conversations associated to the trauma
- Avoidance of activities, places or people which may trigger recollections of the trauma
- The inability to recall an important part of the traumatic event
- Lost interest in certain activities
- Feelings of detachment from friends or family members
- Limited experience of feeling or emotion
- Only thinking about the near future

Another important symptom and criterion is the increase of arousal of a person. This may lead to difficulties sleeping and concentrating. The increased arousal can also lead to sudden outbursts of anger and hyper vigilance (*Diagnostic and Statistical Manual of Mental Disorders IV*, 1995). The duration of these symptoms, including the re-experiencing and avoidance of the stressor, must be longer than one month.

2.3

Fear structure and emotional processing theory

Some of the treatments which will be described in the next chapter, such as imaginal exposure, are strongly related to the emotional processing theory by Foa and Kozak (E. B. Foa & Kozak, 1986). This theory states that patients with a PTSD have developed so-called 'fear structures' consisting of information about:

- Stimuli associated with a traumatic event
- (Their) behavioural responses
- Meaning representations

The stimuli were already mentioned in the previous paragraph. People exposed to a stressor will remember facts about associated stimuli. For example a vehicle that exploded after it hits another car or seeing a comrade die by a mine.

Not only information about the stimuli is remembered but also facts about the behavioural response of the person at that time. For example a racing heart beat and perspiration.

And the last aspect is information about the meaning representation of the traumatic event. The meaning representation of a certain event can, of course, differ from person to person. The representation is strongly related to the stressors and criteria mentioned in the first part of the previous paragraph. One can, for example, associate an explosion to death or death of relatives.

Some treatments are based on activation of this fear structure using repeated exposure and adding new learning elements while anxiety is reduced (E. B. Foa & Kozak, 1986; E. B. Foa, Riggs, Massie, & Yarczower, 1995). Studies (E. B. Foa, et al., 1995) have shown that there is a correlation between activation of this fear structure and improvement in treatment. The treatments related to this theory will be discussed in detail in the next chapter.

2.4
Problems and statistics

Avoiding certain places or people to circumvent stimuli associated to a traumatic event can change the way a person lives. Not only changes in situations which can occur in public, but also the lack of concentration, sleep and the lost of interest may pose problems. It is possible that a traumatic event can cause feelings of guilt, which can lead to, for example, a depression disorder. Also various other disorders can take place as an effect of the different lifestyle. An example is the development of a social phobia or panic disorder (*Diagnostic and Statistical Manual of Mental Disorders IV*, 1995; Paul M. G. Emmelkamp, et al., 1995).

War is known for its high rates of potential traumatic events. Fire fights, terrorist attacks, losing comrades and taking care of dead bodies are only some of the events a soldier can experience during war. A study (Hoge, et al., 2004) among 'Operation Iraqi Freedom' veterans showed that PTSD symptoms affected up to 18% of the returning soldiers. Another study (Milliken, Auchterlonie, & Hoge, 2007), also concerned with returning soldiers from Iraq, has shown that over 66% of the soldiers were at least exposed to potential stressors. In the same study it is said that almost 17% of active duty soldiers and over 24% of reserve soldiers screened positive for PTSD. When soldiers or other military personnel get deployed multiple times, the chances of developing a PTSD even get 1.5 times higher (Mental Health Advisory Team, 2006).

Currently 18% of the American (adult) population suffers from some form of anxiety disorder (Health, 2006). Of this group about 8% has a particular PTSD. Studies (Garcia-Palacios, Hoffman, Carlin, Furness, & Botella, 2002) have shown that a huge amount of people do not seek treatment. Unless the disorder causes drastic changes in their lifestyle such that it causes huge amounts of hardship, people tend to rather avoid the various stimuli than seek for appropriate treatment (Paul M. G. Emmelkamp, et al., 1995).

One of the reasons mentioned in a study among Iraqi veterans (Hoge, et al., 2004) is the stigmatization attached to the treatment. People may be afraid to lose their jobs when their boss finds out about their problems, or they are afraid others might think different of them.

Several new methods to treat people with a PTSD are being developed to deal with these kinds of problems. The previous mentioned paper states that the use of Virtual Reality as a post-combat exercise can be a good option for returning soldiers. The attitude among soldiers towards Virtual Reality exposure is different compared to other more standard types of treatment. Virtual Reality through a network or letting patients finish (writing) assignments or exercises at home through the internet may be other possible options for treatment.

3.1 Treatment of PTSD

Traditional treatment methods

There are many ways to treat patients suffering from a PTSD. But before going into details, it is important to note that the way of treatment depends on the traumatic event the person was exposed to. A clear example is the distinction in approach between the treatment of a victim of rape and a person with a war trauma (Paul M. G. Emmelkamp, et al., 1995). Flooding techniques, imaginal exposure and in vivo exposure proved to be effective for treating people with a war trauma (Paul M. G. Emmelkamp, et al., 1995). However, stress inoculation, followed by exposure treatment, was found to be very effective in studies (Paul M. G. Emmelkamp, et al., 1995) concerning rape victims while flooding techniques have been criticized.

Because of the different kinds of trauma types, it is not allowed to generalise a PTSD treatment based on results of one specific trauma type (Harvey, et al., 2003). At the end of this chapter several trauma types are reviewed with respect to Cognitive Behaviour Therapy (CBT).

Throughout the years various options and combinations of methods have been taken place on how to treat people suffering from a PTSD. Empirical evidence and various reviews (Bradley, 2005) have shown that Cognitive Behaviour Therapy is the most effective treatment for PTSD. However, CBT is not the only way of treatment. This chapter will cover several well-known CBT components as well as other accepted methods of treatment currently being used by therapists all over the world.

3.2

Cognitive behaviour therapy for PTSD

Cognitive Behaviour Therapy aims to change patients' patterns of thinking and to make them prepared to face their fears (Harvey, et al., 2003). Patients will be exposed to various stimuli associated with the traumatic event. This can be done in vivo or with imaginal exposure. These two exposure treatments will be described in more detail after an overview of the general principles of CBT.

Psycho-education
During the first treatment session the therapist explains and gives information about the symptoms which can occur after a traumatic event. Afterwards a discussion will take place to tell the patient how the core symptoms will be treated.

Aims (Harvey, et al., 2003):
- Making sure that the patient is aware of the trauma reaction

- Let the patients be able to formulate their own symptoms (in detail)
- Creating and understanding of the main rationale of the entire treatment

Exposure
Prolonged exposure is based on the emotional processing theory (E. B. Foa & Kozak, 1986). Repeated exposure allows the activation of the earlier mentioned fear structure.

Engaging emotionally by letting the patients talk about their emotions and thoughts are very important steps for activating the fear structure (E. B. Foa & Kozak, 1986; E. B. Foa, et al., 1995). However, Foa and Kozak also note that solely the activation of the fear structure may not be sufficient. Habituation within and across sessions is also essential to correct the underlying cognitive structure (E. B. Foa, et al., 1995).

With exposure therapy new learning can take place as well as reduction of a person's anxiety. Patients being able to gain access to their memories associated to the traumatic event are now able to change unhealthy and often faulty thought patterns. This is done with the help of new perspectives and information regarding the stimuli, behavioural responses and meaning representations.

Possible benefits are (Harvey, et al., 2003):
- Promotes habituation and thus reduces anxiety
- Promotes correction of a patient's belief that an anxiety remains unless avoidance takes place
- Promotes the inclusion of corrective information about the trauma into the memory
- Obstructs the progress of negativity which is associated with fear reduction
- Patient will see the trauma as one discrete event
- Options for self-mastery

Cognitive restructuring
This principle is concerned with teaching patients to evaluate, after identification of, negative automatic thoughts associated with a traumatic event. It also teaches patients to evaluate their thoughts about the trauma itself, the world in general and the future (Harvey, et al., 2003).

A controlled study by Marks et al. (Marks, Lovell, Noshirvani, & Livanou, 1998) has shown that exposure, as well as cognitive restructuring, were both therapeutically on their own, but not mutually enhancing when combined. In this same case study it was found that both principles were superior compared to relaxation.

Anxiety management training
This type of management training allows patients to (partially) master their fears, reduce levels of arousal and give them assistance when being exposed to their fears.

Sessions and duration
Sessions usually take 60 to 90 minutes. Depending on the type of trauma, patients have to enrol in 9 to 12 separate session.

3.3
Exposure in detail

Exposure can be established in several ways, two well-known CBT methods are: imaginal exposure and in vivo exposure. Variants to these exposure methods are therapy through the internet, exposure by writing down the traumatic experience and listening to audiotapes with various related stimuli.

3.3.1
Imaginal exposure

Prolonged imaginal exposure uses the imagination of the patient to recreate (and re-experience the patient to) the feared situation. The patient has to tell the therapist what happened before, during and after the traumatic event. In order to maximise the experience, the patient is asked to tell the story in the present tense. The patients should not only tell what they have seen, but also state other sensory cues and their responses.

Imaginal exposure relies heavily on the memorial and imaginative capabilities of the patient. This can pose a problem, especially because the patient must feel as anxious as they would in a real, physical, situation. However, Foa, Hembree and Rothbaum (E.B. Foa, Hembree, & Rothbaum, 2007) proposed techniques to enhance these capabilities and, in effect, improve activation of the fear structure:

- During treatment questions regarding emotion-producing content are asked, such as sounds and smells.
- Certain stimuli or memories can put the patient in a highly distressed state. If this is the case, there is a possibility that the patient is not possible to learn anything new. Opening their eyes during the treatment or letting them talk in the past tense is one of the proposed solutions.

The generated images of the patient are important in this kind of therapy. The affective intensity and the vividness of the images determine the success of the therapy (Lang, 1977).

Vividness has to do with the degree of completeness of a situation. Patients describing highly vivid images are able to determine many factors associated with, for example, the stimuli and their response. Affective intensity has to do with the amplitude of verbal, visceral and somatic muscle responses related to the traumatic event.

3.3.2
In vivo exposure

In vivo exposure does not rely on the memorial and imaginative capabilities, at least, not heavily. Instead, a physical recreation is needed in order to put the patient in a feared situation. Harvey, Bryant and Tarrier (Harvey, et al., 2003) describe in their review that most

exposure treatments use in vivo exposure as only a supplement to imaginal exposure and do not mention in vivo exposure as a stand alone treatment for PTSD. However in vivo exposure is often used as treatment option in various other anxiety disorders.

3.3.3

Summary of the two exposure methods

Both of these methods of exposure have their advantages as well as their disadvantages. Of course, as mentioned earlier, treatments can vary depending on the nature of the traumatic event. A chaotic terrorist attack may be harder to remember than a road incident. Creating physical representations of the situations can be simple for certain trauma types, while it might be very costly or even impossible for other types of trauma.

However, general remarks can be given for both methods without comparing the two with each other. These are listed in Table 2.

Imaginal exposure		In vivo exposure	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
- Private setting - Safe - Not expensive - Not embarrassing	- Limitations therapist control - Success rate rather low - Depends on patient's capabilities	- Anxiety response is easy to achieve - High success rate	- Can be public: high risk of embarrassment - Limitations therapist control - Expensive - Can be unappealing

Table 2 – Advantages and disadvantages Imaginal and In Vivo exposure (Bush, 2008; P. M. G. Emmelkamp, et al., 2002; Riva, Molinari, & Vincelli, 2002)

The (office) setting used for imaginal exposure is very attractive as it is both private and safe for the patient (Riva, et al., 2002). As mentioned earlier, a major disadvantage is that imaginal exposure relies heavily on the capabilities of the patient.

The major advantage gained when choosing in vivo exposure is the huge success rate (P. M. G. Emmelkamp, et al., 2002). Unfortunately, in some cases, it is difficult or impossible to create a physical representation of the feared situation in private. This means that patients must be exposed to their fears in public. This means there is a risk of embarrassment, this can pose a problem especially if the patient's disorder is not only limited to PTSD.

In both cases the control of the therapist is poor, especially compared to exposure using virtual reality (Bush, 2008).

3.3.4

Other variants

There are also other exposure variants currently being used. One such a method is **repeatedly writing down descriptions** and aspects of the stressor and the associated experience (Resick, Nishith, Weaver, Astin, & Feuer, 2002). Resick and Schnicke say that if someone writes about their trauma, more details will be given than when the same person talks about his or her experience. And this, in return, will eventually decrease the amount of strong negative emotions.

Strongly related to this approach is the concept of writing assignments with the help of the internet, a trial by Lange, Ven, Schrieken and Emmelkamp (Lange, van de Ven, Schrieken, & Emmelkamp, 2001). An experiment was set up to see if therapy using the internet could help people with trauma-related symptoms.

This approach has a couple of advantages over face-to-face therapy. The most obvious one is of course mobility; sessions can be performed while sitting behind a computer connected to the internet. This form of online therapy can also encourage people, who were once afraid or too anxious of going into therapy, to seek treatment or help. Compared to face-to-face therapy, the step someone has to make towards treatment is much smaller.

This type of internet therapy is based on two important mechanisms in overcoming traumatic events (Ehlers & Clark, 2000; Jaycox, Foa, & Morral, 1996; Lange, et al., 2001):
- Habituation to the frightening stimuli
- Cognitive reappraisal of the traumatic experiences

Vaughan and Tarrier (Vaughan & Tarrier, 1992) describe a somewhat different kind of approach. This time audiotapes of stimulus cues are used. This self-directed exposure has, like internet therapy, one major advantage; mobility and the elimination of possible anxiety caused by going to the therapist.

The ability of sharing essays and assignments with a therapist is a great feature; studies (Rime, Mesquita, Philippot, & Boca, 1991) have shown that sharing of traumatic experiences with trusted people or parties can be of great importance. It is also stated that especially victims of rape could benefit from this in the distant future.

Self-confrontation in the assignments is another element which is present in these variants. This aspect of treatment was shown to be effective in several studies e.g.(Schoutrop, Lange, Hanewald, Duurland, & Bermond, 1997). In those studies, participants were required to write in the present tense. They were not only supposed to write about what has happened, but also describe their emotions and thoughts. This shows great similarities with imaginal exposure therapy.

3.4

CBT and the various types of PTSD

According to Harvey et al. (Harvey, et al., 2003) there are several different trauma types. They range from assault to terrorism to motorcycle accidents. Each type differs in the degree of violation of a person's assumptions of safety, trauma recovery and duration. Table 3 is a summary of the different types of trauma types covered in Harvey's paper.

Trauma type	Remarks and findings
Assault	In vivo exposure exercises after systematic desensitisation • reduced fear and improved social adjustment • different study showed that systematic desensitisation led only to modest reduction Study comparing prolonged exposure, stress inoculation, counseling and wait list • stress inoculation training showed great results over counselling and wait list • prolonged exposure led to greater reduction at follow-up after stress inoculation
Mixed trauma	Study comparing prolonged exposure alone, cognitive restructuring alone, a combination of the two and just relaxation (Marks, et al., 1998) • exposure alone, restructuring alone and the combination showed similar results • all 3 superior to relaxation techniques Different study comparing imaginal exposure alone, exposure with reconstructing and counceling • exposure and the combination superior to counceling • more reductions in PTSD symptoms when the combination was used
Terrorism	Cognitive therapy program that focused on imaginal and in vivo exposure. Plus reappraising the event and aftermath, reducing unhelpful behavioural and cognitive strategies • slightly different approach, but showed an impressive effect
Road traffic accidents	CBT, supportive psychotherapy or wait list • CBT included education, muscle relaxation, imaginal and in vivo exposure, positive event scheduling and anger management. • This CBT program led to greater reducations than the other two options. • Reductions in PTSD symptoms, comorbid depression and generalised anxiety disorder
Combat veterans	Early study compared imaginal exposure with "standard" treatment and standard treatment alone • imaginal exposure showed reductions of of anxiety, hypersensitivity to soun and sleep disturbance

	Same as above, but now outcomes measured by a structural interview • Experiment showed that also the re-experiencing symptoms have been reduced
	Study which compared exposure therapy and family therapy to waiting list • exposure therapy combined with family therapy superior to waiting list • family therapy no added effect
Refugees	One study compared CBT and imaginal exposure only • both showed improvements • the review mentions that it is likely that the study was insufficiently powered
Childhood abuse	Skills training and CBT treatment compared to a wait list • the combination of skills training and CBT showed improvements over the waiting list group • still not sure if the skills training was needed

Table 3 – Trauma types and findings (Harvey, et al., 2003)

The review shows that CBT is the best option among the various different trauma types. However, some experiments were not put together very well. This review states that assault victims benefit from CBT after stress inoculation training. This is also confirmed (Paul M. G. Emmelkamp, et al., 1995) in the practitioner's guide of Emmelkamp.

3.5

Other forms of treatment: EMDR, medicines and combinations

Another way for patients to reduce symptoms related to PTSD is by undergoing a treatment called 'Eye Movement Desensitisation and Reprocessing' (EMDR). The basic idea is that patients need to focus their attention on the traumatic event while tracking the moving finger of the therapist.

One disadvantage of 'Cognitive Behaviour Therapy' is that sessions can be too stressful for specific patients, depending on the stressors. This might cause patients to stop the treatment early.

Although EMDR also asks the patient to bring back memories of the stressor, the patient now has to focus on something else as well. A review done by Cahill (Cahill, Carrigan, & Frueh, 1999) describes the procedure in more detail and states that this type of treatment does indeed work.

First the patient needs to bring back memories and thoughts associated with the traumatic event. The patient also has to focus on the physical sensation and the negative thoughts associated with the stressor. At the same time the patient has to track the therapist's finger. This is done several times, sometimes by adding additional information provided by the patient. Every time the Subjective Units of Distress (SUD) is measured and sessions continue until the SUD reaches a certain score.

Just like with other forms of treatment, reprocessing is an essential part of this treatment as well. New perspective is given and faulty or incomplete thought patterns will be (partially) eliminated.

Besides therapy, medications are also an option to treat patients with a PTSD. Although medications reduce some of the symptoms of this disorder, in most cases it does not eliminate all symptoms permanently. Medicines can also be taken into account in combination with other forms of treatment.

4.1 Virtual Reality and VRET

This chapter will start with a brief explanation of Virtual Reality. Afterwards Virtual Reality Exposure Therapy (VRET) will be explained, together with its advantages and disadvantages over standard, traditional treatment.

Virtual Reality (VR) is a technology that allows someone to enter a virtual, real-time generated 3D environment. Interaction and immersion can take place with the help of devices such as a Head Mounted Display (HMD) and tracking devices.

Two kinds of Virtual reality systems can be distinguished:

- Non-Immersive VR
- Immersive VR

The two different types are self-explanatory. With immersive VR, a person becomes fully immerged into the virtual world. They see, hear and, in some cases, smell artificially created aspects of the computer generated world. Advanced cases also speak of haptic interaction. In contrast to immersive VR, non-immersive VR displays the 3D environment on one or multiple (desktop) displays. Instead of using a HMD or any other tracking sensors to move and interact in the 3D world, the user has to use a keyboard, mouse or joystick.

4.2

Virtual Reality is effective in exposure treatment of a variety of anxiety disorders (Cahill, et al., 1999; Garcia-Palacios, et al., 2002; Parsons & Rizzo, 2008; Scheumie & Mast, 2000) included, but not limited to:

- Acrophobia
- Fear of flying
- Spider phobia
- Agoraphobia
- Fear of public speaking

A meta-analysis (Parsons & Rizzo, 2008), found that exposure therapy using Virtual Reality had a significant effects on a variety of different anxiety disorders.

Multiple anxiety-provoking stimuli can be triggered in the virtual world at any time. Unlike imaginal exposure therapy, patients can now be engaged by several of their senses. Gradual exposure is possible in real time thanks to the possibility of changing the intensity of the stimuli.

Virtual Reality Exposure therapy (VRET) blends features of both imaginal exposure and in vivo exposure together, but eliminating several disadvantages of the two.

Schuemie and Van der Mast (Scheumie & Mast, 2000) specify the following advantages:

- **Perception of VR/threshold**
  The threshold of VRET is lower compared to standard, traditional treatment. Also people perceive VRET different. Especially among soldiers treatment is usually a taboo.

- **Safety**
  Complete therapist control, unlike imaginal and in vivo exposure. This means that the exposure can be stopped or changed immediately at any given time.

- **Variety of worlds**
  The therapist can choose the appropriate world according to the patient's needs. Unlike in vivo exposure situations (for example a plane) this does not have to be expensive. Changes in a virtual can also be made whereas in the real world it would not always be possible.

- **Physiological measurement**
  Everything can be measured in the therapist's office. The measurements can also be registered and checked during the exposure. A racing heart beat or anxiety response can immediately be seen together with the 3D view of the patient.

- **Privacy/low risk of embarrassment**
  Unlike in vivo exposure, a patient does not have to perform tasks in public. Instead, everything can be performed in the therapist's office.

- **Time**
  This advantage is strongly related to the previous one. Because the patient can be treated in the therapist's office, both patient and therapist do not have to travel elsewhere. No complicated schedule or worrying about appropriate places.

Other, although somewhat related, advantages are (Bush, 2008):
- Easy anxietal response
- Treatment cost for the patient is low

Schuemie and Van der Mast (Scheumie & Mast, 2000) mention one disadvantage, which is 'simulator sickness'. A well-known symptom caused by the minor lag in the HMD.

Other disadvantages are (Bush, 2008):
- Initial setup cost
- Unfamiliar to therapists

The same paper also states that a potential risk of patient dropout can occur when 'presence' is missing or when 'presence' is badly implemented.

Picture 3 – Virtual Reality Exposure Therapy setup (Mast, 2009)

5.1 VRET and PTSD

Using VRET for PTSD patients

As mentioned briefly in the previous chapter, studies have shown that VRET is effective for a variety of anxiety disorders. However, that does not mean Virtual Reality will also be helpful to reduce PTSD symptoms.

This chapter will give more insight into Virtual Reality and exposure using VR in combination with PTSD patients. First more details and ideas about this phenomenon are given, followed by a wide range of previously conducted studies.

5.2

Ideas and findings

In this paragraph several ideas and findings will be presented originating from papers and studies involved with Virtual Reality and PTSD.

One of the disadvantages of imaginal exposure mentioned in the third chapter was that it heavily relied on a patient's imaginative and memorial capacities. Virtual reality can do what imaginal exposure can, such as modifying a patient's memory, but also augments the patient with visual, auditory and also haptic computer-generated capacities (Hoffman, Garcia-Palacios, Carlin, Furness, & Botella-Arbona, 2003; Hoffman & Ieee Comp, 1998). Better yet, the treatment can be done gradually.

Virtual Reality helps patients who are reluctant to engage in recollections of feared memories. Hardware, such as tracking devices and other sensors, can help the user to emerge into the world, encouraging the patient emotionally. Engaging patients emotionally is key to activate their fear structure.

The pace of a session can be adjusted to the patient. This is usually not the case with traditional treatment where the therapist has limited control. Foa et al. (E. B. Foa, Steketee, & Rothbaum, 1989) mention that a firm distinction can be created between remembering and reliving. Remembering is related to a person staying in control, whereas reliving is associated with a person becoming overwhelmed by the re-experience. With VR it is possible to let the patient relive the event.

The VR world does not involve the same risks as going to a (similar) feared location which is the case with in vivo exposure. Especially for PTSD patients this can be a benefit. Next to the advantages discussed in chapter 4, patients can feel supported knowing the therapist is there and watching the exact same thing they are seeing. The patients are sharing their experiences (Difede, et al., 2007).

Rothbaum and colleagues (Rothbaum, et al., 1999; Rothbaum, Hodges, Ready, Graap, & Alarcon, 2001) introduced VR therapy for PTSD. They proposed that the illusion of being present in the virtual 3D world facilitates emotional processing of the memories associated to the traumatic event. They also showed that VR therapy reduced PTSD symptoms of Vietnam veterans.

A case report (Difede, et al., 2007) says that gradual exposure using VR was successful for reducing acute PTSD symptoms. In this case a patient suffered from acute PTSD symptoms after September 11th (WTC). During gradual VR treatment the patient eventually started telling the story in more and more detail. The patient could remember events she could not remember at first. During treatment she also was very emotional. This was not the case with other treatments she applied to.
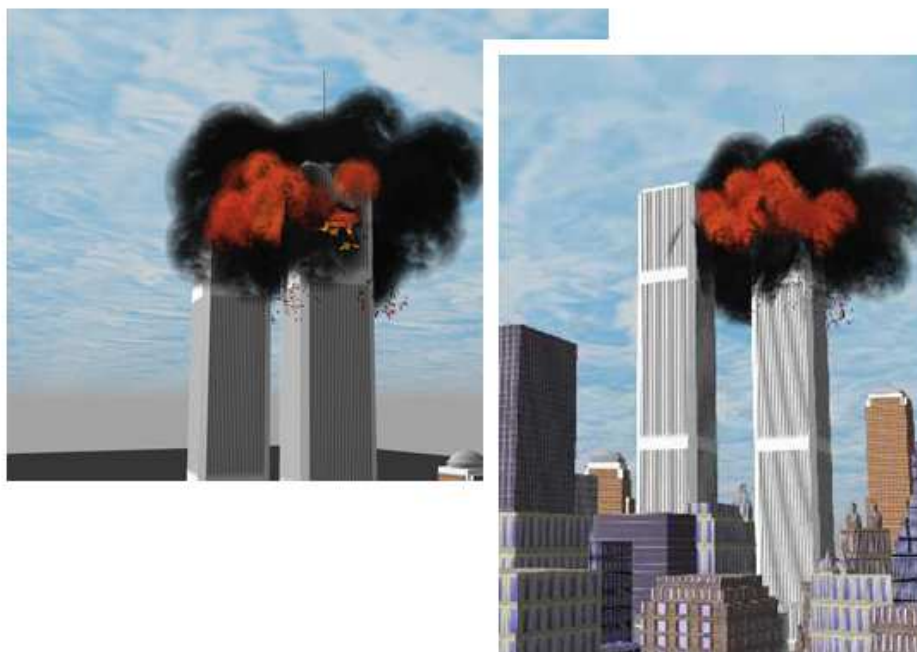
Picture 4 – Virtual September 11th (Difede, et al., 2007)

Further results of (case) studies will be given in the next paragraph.

Another paper states that presence is very important. Not only presence, but also should the virtual world resemble the natural environment as best as possible to "ensure generalization of fear reduction" (Beck, Palyo, Winer, Schwagler, & Ang, 2007). This paper also mentions that, in contrast to in vivo exposure, the therapist is more in control. In this case the authors wanted to see the effects of VRET for people suffering from a PTSD after a road accident. With VRET they were able to make sudden changes in real time, such as the direction of the car and the view of the patient. A recurring advantage is that the virtual world is less threatening compared to the real world, in this case a real driving situation.

In this case the virtual world did not resemble the actual traumatic event. The virtual world had all the elements, such as cars, trucks and road, but it did not resemble the environment where the stressor(s) took place. The world did, however, simulate a driving experience.

The notion of therapist control has also been mentioned in several other papers, e.g. (Reger & Gahm, 2008) as an important feature for therapy of PTSD patients. Therapists can modulate the emotional engagement of the patient by controlling the set of stimuli. This, among other features, enhances the activation of the fear structure and the incorporation of new information.

Emotional detachment among soldiers with traditional treatment is still a problem (Reger & Gahm, 2008). This can occur due to high rates of trauma experiences a soldier may have faced. Imaginal exposure may not be sufficient in these cases.

Virtual reality can deliver specific stimulus environments which do not rely on the hidden world of the patient (Rizzo, et al., 2007).

Many aspects discussed in this paragraph are not only important for reducing PTSD related symptoms, but also for anxiety disorders in general. Virtual Reality exposure uses elements of both imaginal exposure as well as in vivo exposure. Advantages over traditional treatment were discussed in the previous chapter, but looking solely at PTSD it is clear that this disorder also benefits from these advantages.

5.3

Experiments, pilot tests and case studies

This paragraph features some case studies, pilot tests and experiments which involve both PTSD and Virtual Reality Exposure Therapy. Results will be given together with a small explanation on how the experiment was conducted.

5.3.1

BusWorld (Rizzo, 2007; Bradley, 2005)

BusWorld is a simulation which represents a terrorist suicide bus-bombing. It was created to treat civilians in Israel with a PTSD related to this stressor.

Although no paper could be found about an actual experiment involving PTSD patients using this particular simulation, the pilot test and an associated paper give some insight in developing a virtual environment for potential PTSD patients. The pilot study's objective was to see if the amount of anxiety among the participants grew (subjective units of discomfort scores – SUDS) when the intensity of the bus simulation grew.

For this study 30 participants were included. All of them have not witnessed a terrorist attack before and they also have not been treated for any kind of psychological illness. Basically, all participants were considered healthy.

There were four levels of intensity programmed into the simulation. Level 1 starts with a quiet street while the last level shows a suicide bomb attack with screaming and other sound effects included.

The participants showed significant increase in anxiety levels as the intensity inside the environment increased. This means that even healthy people were able to feel different, increasing anxious levels within the simulation.

Picture 5 – BusWorld (Rizzo, 2007; Bradley, 2005)

The eventual goal of BusWorld, as described in their pilot test, is to change unhealthy thought patterns, gradually habituate anxiety and reduce the intensity of associated emotions. Unfortunately not everything could be tested with the setup of this (simple) pilot test. However, the expectations the authors had about the SUD ratings and the increase of intensity proposed in their virtual world were correct.

5.3.2

Virtual Reality exposure therapy for active duty soldiers (Reger & Gahm, 2008)

This paper describes a case of an army infantryman which has been exposed to numerous traumatic exposures during his lifetime in the army. The exposures include events such as witnessing a friend's death, the death of an enemy combatant and several body recovery operations.

For this case two different virtual worlds were available; a convoy scenario and a dismounted patrol. The convoy scenario was chosen as it resembled the patient's stressor environment. A summary of the experiment is given in Table 4.

Screening	• PTSD checklist-Military version, score 58 • PTSD related symptoms according to DSM-IV
Sessions	• 90-minute sessions • 6 sessions in total • 4 weeks duration • Each session involving VR lasted 35 minutes on average • Convoy environment used
Results	• Two outcome measures used • PTSD checklist-Military version after VR exposure: 29 • BASIS-24 scores showed a downward trend • Self report: decrease in symptoms and increased socialization and functioning

<div align="right">**Table 4 – Infantryman case**</div>

The PTSD checklist (Military version) score before the treatment was 59, with 50 being the score therapists use to conclude that a patient has symptoms of PTSD. After the VR sessions this score was halved. The patient also reported decrease in various symptoms related to PTSD.

5.3.3

Virtual Iraq: Initial case reports from a VR exposure therapy application for combat-related post traumatic stress disorder (Rizzo, et al., 2007)

Two cases were described in this paper:
• 22 year old female Army private
• 29 year old male U.S. Marine

Both patients were exposed to the same virtual environment, namely Virtual Iraq. This virtual world uses graphics and models from 'Full Spectrum Warrior', an army-funded tactical Xbox game partially funded by the army.

Scenarios were customizable to situations which resembled real life events in the Middle East. This way a wide range of situations could be simulated.

Table 5 shows a summary of the experiment done with the 22 year old Army private, Table 6 shows the other case.

Screening	• PTSD checklist-Military version, score 42 • Patient Health Questionnaire (PHQ), score 20 • Beck Anxiety Inventory (BAI), score 12 • In Iraq she evaluated scenes right after a suicide or IED bombing took place. Exposed to human carnage. • PTSD related symptoms and recurrent Major Depressive disorder according to DSM-IV
Sessions	• 10 sessions in total • Includes not only VR, but also psycho-education, exposure-based homework and initial imaginal exposure

Results	• PTSD checklist-Military version after treatment: 22
	• Patient Health Questionnaire after treatment, score 3
	• Beck Anxiety Inventory after treatment, score 0
	• Self report: signs of habituation
	• SUD ratings reduced after sessions

Table 5 – Army private case

Screening	• PTSD checklist-Military version, score 62
	• Patient Health Questionnaire, score 16
	• Beck Anxiety Inventory, score 28
	• Deployed in Iraq for 7 months
	• Suicide attempt patient before treatment took place
	• Diagnosed with chronic PTSD, later tests confirmed this
Sessions	• 6 bi-weekly 90-120 minute sessions
	• One supportive therapy session by phone
Results	• PTSD checklist-Military version after treatment: 37
	• Patient Health Questionnaire after treatment, score 5
	• Beck Anxiety Inventory after treatment, score 22
	• Self report: Not suicidal anymore, habituation effect during sessions. Little distress.
	• Follow-up treatment showed even better improvements. PTSD checklist score reduced to 22, PHQ to 4 and BAI to 15

Table 6 – U.S. Marine case

Both results look promising. However, the previous paper (Reger & Gahm, 2008) mentions a PTSD checklist (Military version) norm of 50. This is not the case with the Army private. The score does decrease though and a variety of symptoms seem to have disappeared.

The second case showed great reductions in scores, especially after the second, follow-up treatment. Between these two measurements the patient started working again and received treatment from his unit's psychiatrist. It is not stated that these factors helped towards the end result.

5.3.4

ARGAMAN: Rapid Deployment Virtual Reality System for PTSD Rehabilitation (Dayan, 2006)

This paper explains a Virtual Reality system slightly different from the systems discussed earlier. The main difference is that the patient can now see a projected image of the therapist in the virtual world. According to the authors this will highly improve the overall impact of the treatment. Unfortunately no experiment was done to compare this system to other, currently existing, systems.

Another difference is that this system does not use 3D models. Instead, the system uses pre-rendered video fragments and puts these on the screen. This way complex human animations and facial expressions can just be extracted from recorded material of real people, cut out and uploaded to the system.

Patients using VR for treatment are preferably immerged into the 3D environment. This means that the patient is isolated from the real world. Adding the therapist to the 3D world may improve the treatment.

If this feature works or if it interferes with the 'presence' of the patient is not known.

The system comes with a virtual world editor to create virtual worlds which correspond to the problems of the patients. This editor is what makes ARGAMAN especially suitable for PTSD patients. Unlike other disorders, customizable virtual worlds need to be created in a short amount of time.

Picture 7 – Pre-rendered persons "PolyClips" (Dayan, 2006)

6.1 Conclusion

The questions from the first chapter were:

- Which features contribute towards a reduction of symptoms of a patient with a PTSD?
    - Which steps are taken in traditional treatment?
    - What are the limitations or difficulties?

- How can Virtual Reality help people with a PTSD?
    - Do current aspects used for the treatment of other phobias (such as presence) contribute?
    - Can VR or VRET enhance the steps and effects currently provided by traditional treatment?

Looking at traditional treatment, Cognitive Behaviour Therapy has proven to have positive effects treating people with a PTSD. It is important to note that there are a variety of different kinds of trauma types and it is wrong to think that one generalised procedure will work for all of them.

Table 3 summarizes several studies associated with seven different trauma types. The studies show that either a combination of CBT components or one component alone can greatly reduce PTSD symptoms.

The steps taken in traditional treatment, CBT in this case, are based on the emotional processing theory. In order to reduce PTSD symptoms the 'fear structure' must be activated and unhealthy or wrong thought patterns must be changed with new learning.

A 'fear structure' "generated" by a person exposed to a traumatic event consists of information about stimuli associated with a traumatic event, their behavioural response(s) and meaning representations. Talking with the patient about each aspect and asking about their emotional state and thoughts seem to be important steps towards recovery. Although studies mention that the activation of the 'fear structure' is essential, gradually habituating anxiety is considered to be important as well.

These steps are taken into account with exposure therapy. However there are **limitations**.

Imaginal exposure relies on the patient's abilities to remember or imagine situations. Treatment will be hard, if not impossible, if patients are having trouble accessing their memory.

In vivo exposure also has its limitations; looking for a suitable place can be very hard and maybe very expensive. Putting the patient directly in such an environment, sometimes in public, may not be a good idea either.

Virtual Reality blends features of the two exposures together. Many disadvantages present in 'in vivo' and 'imaginal exposure' are gone with VR exposure. The advantages listed in chapter 4 are for therapies in general. However some of the proposed advantages are especially useful for PTSD patients.

To prevent poor results, a patient has to be emotionally engaged. Studies, such as the WTC simulation, showed that VR techniques can be used to accomplish this. With VR, in contrast to in vivo, this can even be done gradually.

Current aspects used for other disorders are useful for PTSD as well. As mentioned earlier, just the activation of the fear structure is not sufficient. Habituation is needed as well. Studies have shown that the SUD ratings decline when people are repeatedly being exposed to increasing intensity levels.

One aspect which is especially useful for PTSD is that the therapist has more control. With imaginal and in vivo exposure this is not the case. Also, the patients share their experience with the therapist, another aspect which is said to be useful to reduce PTSD symptoms.

6.2

Discussion

Virtual Reality has shown to be a useful technique for helping people suffering from a wide range of anxiety disorders. As stated in the previous paragraph and throughout this research assignment, Virtual Reality can have a positive effect on PTSD treatment as well.

A huge difference between this kind of disorder and other anxiety disorders is the memory element. Creating a virtual world for people with a spider phobia is not too difficult. One generalized world (featuring several stimuli to change the level of exposure) may already be sufficient to treat a group of people. This is not the case with PTSD. The virtual worlds need to correspond to the stories of the patients, or at least, the virtual worlds have to engage the patient emotionally. Elements associated to the patient's 'fear structure' are needed. So far nothing is known about how exact the virtual world should resemble the patient's memory. However, even if the virtual worlds do not need to be very exact, it will still be a cumbersome task to create virtual worlds for each and every patient. Especially if only a short amount of time is given.

Creating a virtual environment for a group of people who have faced the same stressor(s) or were present at the same location is more sufficient. Parts can be reused and a toolset can be developed to customize the more general virtual world according to the patient's needs.

As seen with traditional methods, sharing and self-confrontation can also benefit patients suffering from a PTSD. This can be done by, for example, letting patients write down their emotions and feeling at the time the trauma took place. However, it can be very difficult for patients to write about their emotions or to remember specific events. Similar problems arise with other exposure variants. The use of images or 3D objects may trigger a patient's memory or emotion.

One possible way to combine several elements discussed in this research assignment is to let the patient create its own virtual world. Creating a world from scratch may be impossible, but letting the patient, with the help of the therapist, add buildings, people and actions to a specific unfinished world sounds more within reach. In some situations the patient's notion of

time can be wrong. Together with the option of viewing the environment from different angles new learning, self-confrontation and reappraisal can take place. Objects within the environment can trigger a patient's memory and emotion, allowing habituation of the stressor(s). Because the patient has to create the virtual world together with the therapist, the aspect of sharing is included as well.

7

<div align="right">References</div>

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