Treatment of Acrophobia in Virtual Reality: a Pilot Study

Article · January 2000
Source: CiteSeer

4 authors, including:

Some of the authors of this publication are also working on these related projects:

Virtual reality View project

Computer Support for Anxiety Disorder Treatment at Home (CATCH) View project

Treatment of Acrophobia in Virtual Reality: a Pilot Study

M.J.Schuemie[1], M. Bruynzeel[2], L. Drost[2], M. Brinckman[1], G. de Haan[1], P.M.G Emmelkamp[2], C.A.P.G. van der Mast[1]

[1]Delft University of Technology, faculty of Information Technology and Systems
[2] University of Amsterdam, faculty of Psychology

Introduction

Phobia treatment

According to the DSM-IV (American Psychiatric Association, 1995), simple phobias consist of persistent fear of a circumscribed stimulus and consequent avoidance of that stimulus, where the person having this fear knows it is excessive or unreasonable. If the feared stimulus is heights, the person is said to suffer from acrophobia, or fear of heights.

The most common and most successful treatment for acrophobia is graded exposure in-vivo. Here, the avoidance behavior is broken by exposing the patient to a hierarchy of feared stimuli, whereby the fear will first increase, after which habituation will occur and the fear will gradually diminish (Bouman, Scholing & Emmelkamp, 1992).

In in-vivo treatment the patient is exposed to real stimuli. A promising alternative is graded exposure in Virtual Reality, where the patient can be treated in the safety and privacy of the therapist's office and situations can be recreated which are hard to find or costly to reach.

At this moment, research is being conducted at the Delft University of Technology and the University of Amsterdam aimed at developing a virtual reality system to be used by therapists for such VR Exposure Therapy (VRET). This article describes the results of a pilot study undertaken to explore the possibilities and characteristics of VRET and determine requirements for a system to support therapists

Previous research

Already some research has been done concerning treatment of phobias in VR. The first studies were undertaken at the end of 1993 (Rothbaum, Hodges, Kooper, Opdyke, Williford & North, 1995). In a controlled experiment 7 persons were assigned to a control group and 10 persons were exposed in seven weekly VR sessions. The results of this experiment, as well as of the case study that followed, were very promising and started a series of research initiatives around the world. In case studies people were treated for spider phobia (Carlin, Hoffman, & Weghorst ,1997), fear of public speaking (Hodges, North, Strickland, Weghorst, 1997), fear of driving and claustrophobia (Alcaniz et al.,1998). One other controlled experiment was concerned with the treatment of agoraphobia (Coble, et al.,1995).

Goals of the research

The research described in the previous paragraph was mostly of an explorative nature: is it possible to treat people in virtual reality? In our pilot study we attempted to look more deeply at certain aspects of VRET. Our goal was to find out more about the necessary characteristics of the virtual reality system. Until now, all research concerning VRET had been done using expensive VR hardware and software developed almost from scratch by the researchers. Can simple, off-the-shelve and relative cheap VR equipment also be used?

Another question we would like to ask is what a virtual world should look like for the treatment of acrophobia; which factors play a roll in provoking a phobic response to heights?

A second goal of this experiment was to develop a validated system to be used in a second experiment. This last experiment was aimed at measuring the effectiveness of VR therapy and will be described in detail in another report (by Emmelkamp et al.).

Method

Design

Three virtual worlds were constructed using a popular high-level VR development tool. These worlds were evaluated by the subjects. Each subject was immersed in the worlds two times: the first time the subject was led through the world and was not specifically asked to make any comments. The second time comments were encouraged and at the end the presence and fear experienced during the VR were measured using questionnaires.

The world best suited for generating fear of heights was improved based on these evaluations and used for the second experiment. In this experiment it was proven that the VR system was effective in reducing

acrophobia. Although the full details of this experiment are not discussed here, some results concerning the necessity of certain characteristics of the VE have also been included in this article.

Subjects

Six subjects participated in the evaluation of the virtual worlds: 3 male, 3 female. Two of these had strong acrophobia, 4 only mild acrophobia.
In the second experiment 10 subjects participated, none of these took part in the first experiment.

Measurements

Measurements used in the experiment, which were relevant for the research questions posed are:

- Acrophobia Questionnaire (AQ) (Cohen, 1977)
- Attitude Towards Heights Questionnaire (ATHQ) (Abelson & Curtis, 1989)
- Fear and presence questionnaires (Slater, Usah and Steed, 1994)

This last questionnaire consisted of the following questions, which, in the rest of this article, will be referred to as realism, immersion, interaction and presence, respectively:

1. How real did the virtual world seem to you? (1 = about as real as an imagined world, 7 = indistinguishable from the real world)
2. To what extent were there times when you felt that the virtual world became 'reality' for you, and you almost forgot about the real world outside? (1= at no time, 7 = almost all the time)
3. Did the virtual world seem more like something you saw, or some place you visited? (1 = something I saw, 7 = some place I visited)
4. In the virtual world, I felt more like... (1 = I was standing in the laboratory wearing a helmet, 7 = I was in the virtual room)

Equipment

The virtual worlds were generated using an ordinary Pentium Pro 200 MHz computer with 64 Mb RAM and a Matrox Mystique 220 graphics card, running Windows 95. The software used was Superscape VRT 5.0, a commonly used VR modeling and visualization toolkit. This toolkit allows designers to develop 3D worlds with sounds and simple interactions through a graphical user-interface. It also includes a simple scripting-language for designing more complex interactions.
In all the system was able to generate the display at a rate of about 10 frames per second. This means the update was visible but not too disturbing.
The worlds were displayed using the I-glasses from Virtual-IO. This Head Mounted Display (HMD) has an integrated 3-degrees-of-freedom tracker (rotation only). The HMD has a very narrow field of view, only

30 degrees, and displays in a low resolution of 180.000 pixels. It does support stereographic projection through a method known as interlacing. Hereby the two viewpoints generated by Superscape VRT are interlaced on the VGA output. Odd horizontal lines are projected on the left eye and even horizontal lines projected on the right eye by the HMD, allowing the user to see depth. The author would like to comment that interlacing is not supported by the current version of Direct3D, and since Direct3D is the only 3D-acceleration API supported by Superscape VRT, it is not possible to use interlacing together with 3D-acceleration when using Super-scape VRT.
When wearing the HMD, the wearer could still see a lot of the real environment. To remedy this, a piece of cloth was placed over the visor blinding the subjects to all but the virtual world.
To give the user an enhanced feeling of height, a construction was used where the user is standing on a metal grid suspended a few inches above the ground, surrounded by a railing the user could hold on to. The setup is shown in figure 1.

Figure 1: Setup used for the experiments. The subject is wearing the HMD with a piece of cloth to mask the real environment and is standing on a metal grid suspended a few inches above the ground, clutching the railing.

Three worlds were used: a roller coaster, a swimming pool with diving tower and a glass elevator.

In the first world subjects were placed in a small mining car running on a track containing loopings and barrel rolls (see figure 2) and they could use the HMD to look around. The VR also included sounds of a real roller coaster.

Figure 2: Roller coaster world. Subjects could look around while the car followed the tracks.

The second world contained a swimming pool with a bridge over it and two opposing diving- towers. The third world contained a glass elevator. The second and third world allowed the therapist to control the movement of the subject using a joystick.
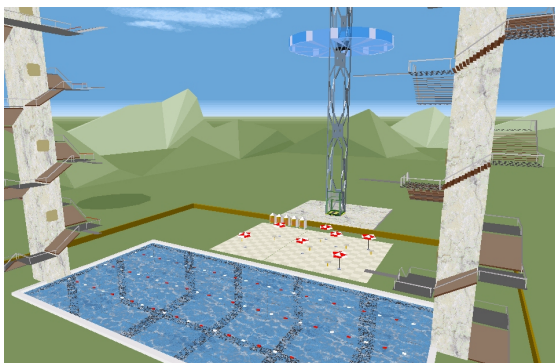

Figure 3: Swimming pool with glass elevator. On the left and right the two diving towers are visible and in the back is the glass elevator with a glass platform. The autopilot would take the patient up the left diving tower, stopping at each diving board.

The evaluations showed the second world to be most effective. For the second experiment the bridge was removed and a glass elevator was added as shown in figure 3. The sound of people talking and of wind was made variable over height; the higher one climbed the louder the sound of the wind and the lower the sound of people. Also an autopilot was included for the convenience of the therapist. With one push of a button the subject started on a pre-defined path, stopping at certain points.

Results

Evaluation of virtual worlds

Table 1 shows the results on the fear and presence questionnaires of the evaluation of the first world. The little fear the subjects experienced were mostly caused by the feeling of loss of control instead of fear of heights. The loopings were not high enough to trigger an anxiety response and possibly the idea of a mining car going through brown mountains did not fit the subjects idea of reality enough to invoke a high level of presence.

	Fear	Realism	Immersion	Interaction	Presence
Subject 1	1	3	2	2	2
Subject 2	3	2	5	5	5
Subject 3	2	2	2	2	1

Table 1: Scores on fear and presence in roller coaster on a scale of 1-7 where 1 is a low score and 7 a high one.

Table 2 shows a better response to world 2. Subject comments indicated that reference-points nearby are very important for generating a feeling of height, such as being able to see the other levels of the diving tower through the floor-grid. The bridge over the swimming pool was considered to be very disturbing because this was not according to what subjects considered a real swimming pool. The volume of the sound of people talking was the same at every height and this also was remarked as being unrealistic. The thought that they could fall of the diving-board was very scary for most subjects.

	Fear	Realism	Immersion	Interaction	Presence
Subject 1	2	3	3	3	3
Subject 2	3	4	4	5	5
Subject 3	6	6	6	7	6
Subject 4	4	5	5	5	4
Subject 5	2	2	2	2	2
Subject 6	2	2	3	3	2

Table 2: Scores on fear and presence in pool . Scale is 1-7

Table 3 shows that world 3 was considered to be very scary only by one person and was not further considered. The glass elevator was incorporated into the swimming pool world.

	Fear	Realism	Immersion	Interaction	Presence
Subject 2	2	4	2	5	5
Subject 3	6	6	6	6	6
Subject 4	3	3	4	5	4
Subject 5	3	4	4	3	3
Subject 6	1	1	1	1	1

Table 3: Scores on fear and presence in elevator. Scale is 1-7

Effectiveness of VE characteristics

The effectiveness of the VE was measured in the second experiment as the reduction in acrophobia reported on the Acrophobia Questionnaire. This was compared to the realism, immersion, interaction and presence induced by the VE.

The correlation between the fear and presence induced by the VE and the reduction in acrophobia is shown in table 4.

	Fear	Realism	Immersion	Interaction	Presence
AQ	0.078	0.119	0.022	-0.051	-0.325

Table 4: Correlation between the reduction in AQ and the fear and presence questionnaire

Interestingly, no significant correlation was found between the fear experienced during the session and the reduction in acrophobia. Also, no significant relation was found between presence and a reduction in fear of heights. Table 5 shows there was a significant correlation between the fear experienced in the VR and the general level of presence experienced by the subjects.

	Realism	Immersion	Interaction	Presence
Fear	0,6837	0,6977	0,7691	0,4461

Table 5: Correlation between fear and presence

Discussion

The evaluations showed that VR can be effective in treating fear of height even thought the virtual worlds do not contain a lot of details. It seems that subjects fill in the missing details themselves. It is very important though that the details that are present are consistent with reality. To provoke a fear of heights the virtual world should contain reference points nearby (see figure 4).
A higher fear of heights could also be achieved by creating situations which look like the patient can fall down a long way. An interesting result of this study is that no relationship was found between the level of presence experienced in the VE and the effectiveness of the therapy. Creating a sense of presence often takes a lot of effort in terms of expensive equipment and extensive design and if it could be shown that it is of minor importance to the effectiveness of the application than VRET systems could be created more efficiently. Hodges et al. (Hodges et al., 1994) discussed the necessity of presence for effective phobia treatment. Other researchers, in treating fear of spiders, also stated that "Although not conclusive, our data is consistent with that claim." (Carlin, Hoffman, & Weghorst ,1997). An explanation for the lack of correlation between the effectiveness of the therapy and the fear and presence experienced in the VR in our experiment could be the limited population in this experiment. Another explanation could be that the subjects had too little acrophobia to begin with. Future research is needed to investigate this.
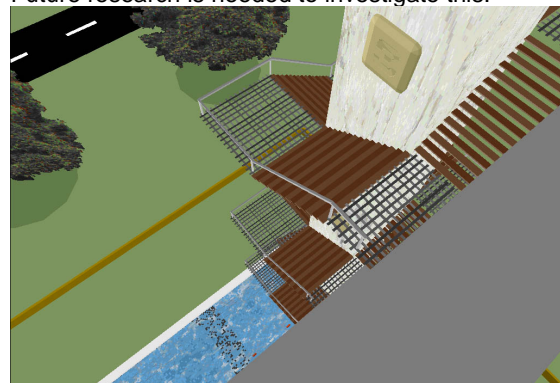

Figure 4: Especially reference-points nearby, such as seeing lower levels on the diving tower, can give a sense of height.

Our results do show a relationship between presence and fear in a VR, which is consistent with earlier research (Friedman, Regenbrecht, Schubert, 1998). People will only feel afraid in a VR when they experience a high level of presence.
Apparently a state of the art VR system is not necessary for exposure therapy. The hardware used would cost less than $2000 on today's market and the virtual worlds were created by computer science students using a high-level tool. However, at this moment it is not possible to say anything about the relative effectiveness of more expensive equipment. The experiments described in this article mark the start of a research project aimed at bringing VRET from the experimenter's lab into the therapist's office. It has been shown that making VRET a part of daily therapeutic practice could be feasible, although many questions still remain to be answered. What design should the human-computer interaction in VRET systems follow? How effective is the VR therapy really and what are its consequences for therapist and patient? What are the key elements needed in a VR systems to make it effective for each specific phobia?

References

Abelson, J.L., Curtis, G.C. (1989), Cardiac and Neuroenddocrine responses to exposure therapy in height phobics: Desynchrony with the "physiological response system.", *Behavior Research & Therapy*, 27, 556-561

Alcaniz, M. Banos, R.M. Botella, C. Perpina, C., Rey, A. Villa, H. (1998), Virtual Reality Treatment of Claustropobia, , '*Behaviour Research & Therapy*', 36(2):239-246, Februari

American Psychiatric Association (1995), *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.), Washington D.C.

Bouman, K., Scholing, A., Emmelkamp, P.M.G. (1992), *Anxiety Disorders: A Practitioners Guide*, John Wiley & Sons

Carlin, A.S., Hoffman, H.G., Weghorst, S. (1997), Virtual Reality and Tactile Augmentation in the treatment of spider phobia: a case report, *Behaviour Research & Therapy,* 35,153-158

Coble, J.R. North, M.M. North, S.M. (1995),Effectiveness of virtual reality environment desensitization in the treatment of agoraphobia, '*International Journal of Virtual Reality*', vol.1,no.2, p25-34

Cohen, D.C. (1977), Comparison of Self-Report and Behavioral Procedures for Assessing Acrophobia, *Behavioral Therapy*, 8, 17-23

Friedman, F., Regenbrecht, H,T., Schubert, T.W. (1998), Measuring the Sense of Presence and its Relation to Fear of Heights in Virtual Environments, *International Journal of Human-Computer Interaction*, 10(3), pp 233-249

Hodges, L. ,Graaf, de, J.J., Kooper, R., Meyer, T., Opdyke, D. ,Rothbaum, B.O, Williford, J.S. (1994), Presence as the defining factor in a VR application, Technical report GIT-GVU-94-5

Hodges, L., North, M.M., Strickland, D., Weghorst, (1997), Overcoming phobias by virtual exposure**,** *Communications of the ACM*, vol 40, No. 8, August

Rothbaum, B.O., Hodges, L., Kooper, R. Opdyke, D., Williford, J. & North, M.M. (1995), Effectiveness of Virtual Graded Exposure in the Treatment of Acrophobia, *American Journal of Psychiatry*, april, 152, 626-628

Slater, M., Usah, M., Steed, A. (1994), Depth of Presence in Virtual Environments, *Presence: Teleoperators and Virtual Environments*, 3, 130-144