

# Annual Review of Cybertherapy and Telemedicine

Volume 3 Year 2005 ISSN: 1554-8716

## Interactive Media in Training and Therapeutic Intervention

Editors:

Brenda K. Wiederhold, PhD, MBA, BCIA  
Giuseppe Riva, PhD, MS, MA  
Alex H. Bullinger, MD, MBA



Interactive Media Institute

## Treating Acrophobia in a Virtual Environment

A. H. Bullinger<sup>1</sup>, I. Angehrn<sup>1</sup>, B. K. Wiederhold<sup>2,3</sup>, F. Mueller-Spahn<sup>1</sup>, R. Mager<sup>1</sup>

<sup>1</sup> COAT-Basel / UPK (Center of Applied Technologies in Neuroscience), University of Basel, Switzerland

<sup>2</sup> Interactive Media Institute, San Diego, USA

<sup>3</sup> Virtual Reality Medical Center, San Diego, USA

**Abstract:** *Specific phobias are one of the most frequent mental health problems and can lead to years of personal suffering. The most effective treatment is exposure therapy. Our aim was to proof the feasibility and efficacy of virtual environments in treating acrophobia patients using a manually guided exposure therapy. Our pilot study was designed as a crossover intervention with a waiting list condition as a control group. After treatment, our results show that exposure in virtual environments is a feasible technique can provoke anxiety, and leads to a therapeutic effect.*

### INTRODUCTION

Anxiety disorders appear with a lifetime prevalence of about 25% (12). Chronic processes have been observed up to a percentage of 50% in agoraphobic, specifically phobic and socio-phobic cases (24). Among these, specific phobias are the most widespread disorders (11, 16). Currently, the internationally accepted treatment strategy is behavior therapy with exposure (20, 21). Many trials have been conducted to substitute situations of exposure using computer-based simulations. Today one can say that the attempts to develop computer-based psychotherapy programs have not been very successful.

But, the early 1990s saw a change, brought about by the introduction of virtual reality (VR) systems in research at universities. Three-dimensional virtual environments are computer-generated interactive visualizations, in which the user is able to experience spatial and temporal correlations. Data helmets or specially designed presentation media, based on function units composed of screens and appropriate projectors, are used to produce the three-dimensional effects. In the last years, virtual environments have often been used by several research teams in Europe and the USA, to research, for example, acrophobia (3, 8), claustrophobia (4), arachnophobia (5) and fear of flying (9,26,27,28). This technique is also used to study addictions (cue exposure) (15). Furthermore, expectations are raised that by apply-

ing virtual environments as an exposure platform there will also be a great success in the investigation of the biological basis of specific phobias: Because the environments generated by the computer are always represented completely unmodified and exactly corresponding to the preceding and succeeding sequences, they are very suitable for studying the psychophysiological stimulus-reaction conditions and for examining the therapeutic effects on these psychophysiological reactions (23).

### PILOT STUDY

#### METHODS

##### *Study Design*

At first, three test persons were exposed to altitude in VR while the other three test persons were supervised in a waiting list condition (WLC). WLC means that the test persons could perform self-selected computer games concurrently to the exposure therapy. After a break of three months the test persons in the WLC did the VR exposure, and the group that had already been exposed to altitude played on the computer.

In a preliminary talk the therapeutic rationale was discussed with the test persons. All of the six treatments (each with three exposures) were carried out by a therapist with many years

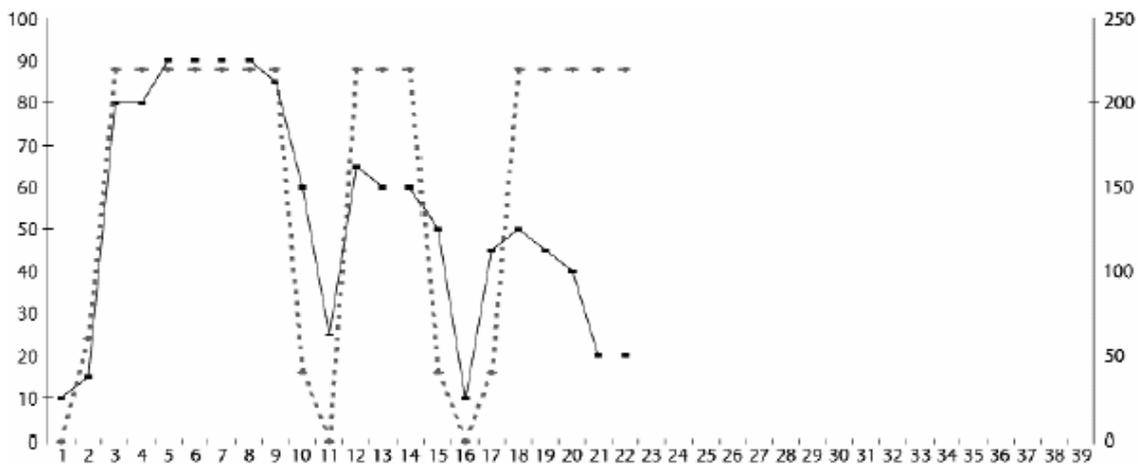
of clinical experience in psychiatry and training in cognitive behavior therapy. On the basis of empirical and theoretical models the origin, triggering factors and the perpetuating factors of the specific phobia were explained. Also the correlation of cognitive, affective and vegetative symptoms of anxiety with situational characteristics was described. The model of a dysfunctional interaction (also known as “vicious circle”) of intrapersonal and external stimuli was well understood by the concerned people because of their own experience. Besides, the negative impact of anxiety-avoidance on the process of the disorder was emphasized. The program sequence and the expectations of the test person were clarified. The expectations were, at first, very skeptical and affected by frustration of many years, but after the medical education the attitude changed regularly into a rather hopeful one. The test persons were encouraged to frequent autonomously, in the period between the sessions, situations which they had avoided so far. All test persons were physically examined by a medical doctor. Therefore, somatic diseases sometimes related to anxiety syndromes could be excluded. In doing so, a psychiatric and medical anamnesis was made.

The diagnosis of a specific phobia (acrophobia) was made by the Composite International Diagnostic Interview (CIDI (25)). Other phobias or comorbid disorders according to ICD-10 and

DSM IV (1) were excluded. Especially any psychotic disorder, suicide attempts in the anamnesis, disorders caused by using psychotropic substances like addiction, delirium and apparent physical disorders (especially considerably impaired vision or defective hearing) were criteria for exclusion.

The therapeutic effect was measured by means of self-evaluation on a 4-point-scale at 5 points in time: 4 of them were before and after exposure/waiting list (respectively waiting list/exposure) and one interview was conducted 6 months later (figure 1a). We asked the test persons about the subjective evaluation of their discomfort (scale “comfort/discomfort”) and their contentment (scale “contentment”) and also about the dimension of phobic avoidance (scale “avoidance”). These 3 scales measured from “I feel very good” (point 1) to “I feel very bad” (point 4).

Furthermore, the concept of the Subjective Units of Discomfort (SUD (7)) was explained to the test persons. It refers to an individually “calibrated” rating of the actual anxiety and stress on a scale of 0-100. During the later exposure, the test person was asked, in intervals of 5 min, about the level of his anxiety/stress on a scale of 0 (conveniently balanced feeling) to 100 (maximal anxiety). The purpose of that was, on the one hand, to identify potential cognitive avoidance-strategies and on the other



**Figure 1.** First exposure treatment of test person No. 5. The horizontal axis shows 39 intervals of 5 minutes. The left vertical axis indicates the dimension of anxiety (black line with squares) between 0 and 100, the right vertical axis indicates the altitude of the elevator in meters (maximal 220m, dashed line with lozenges)

hand to survey the impact of the virtual environment on the stress of the test persons. Furthermore, the test persons were asked to give their subjective evaluation regarding the dimension of the “worst” anxiety situation. The scale “maximal anxiety” was divided in 10 stages to simplify an adaptation to the 100 scale points of the SUDs.

#### *The Virtual Environment*

The computer-based program is generated by True Space, TCL (the software can be bought) and by Lightning (virtual interaction- and animation software especially created for our application, ICIDO Ltd., Stuttgart, Deutschland). The virtual environment is visualized by a Silicon Graphics (SGI) Onyx<sup>2</sup> Deskside System. For data transfer a Head Mounted Display (V8, Virtual Research), a Tracking System (Flock of Birds, Ascension) and an interaction medium (Space Mike, ICIDO Ltd.), also especially created for our application, were used.

#### *The Exposure*

The gradual exposure in VR was made by means of the aforementioned technique, altitude “situations” generated by the computer served to elicit anxiety. A manual was used and (13) served to assure standardization of the therapy process; the virtual environment was always generated homogeneously by the computer.

The manual consisted of an introduction to the technique and information about specific phobias as well as a therapy schedule.

- In session 1, in addition to the diagnosis via the CIDI and the medical examination, a behavioral analyses (problem definition, analyses of condition and function, developing an individual phobia hierarchy) was made. The identification of further problem areas completed the data acquisition.
- In the second session the therapy rationale, the schedule and the expectations were discussed. The test person received instructions for practicing in-between the sessions.
- In session 3 to 5, the test person was confronted with the virtual environment. In a final session the experience of the test per-

son made during the therapy was discussed. The person was again encouraged to continue confronting himself with situations he had avoided so far.

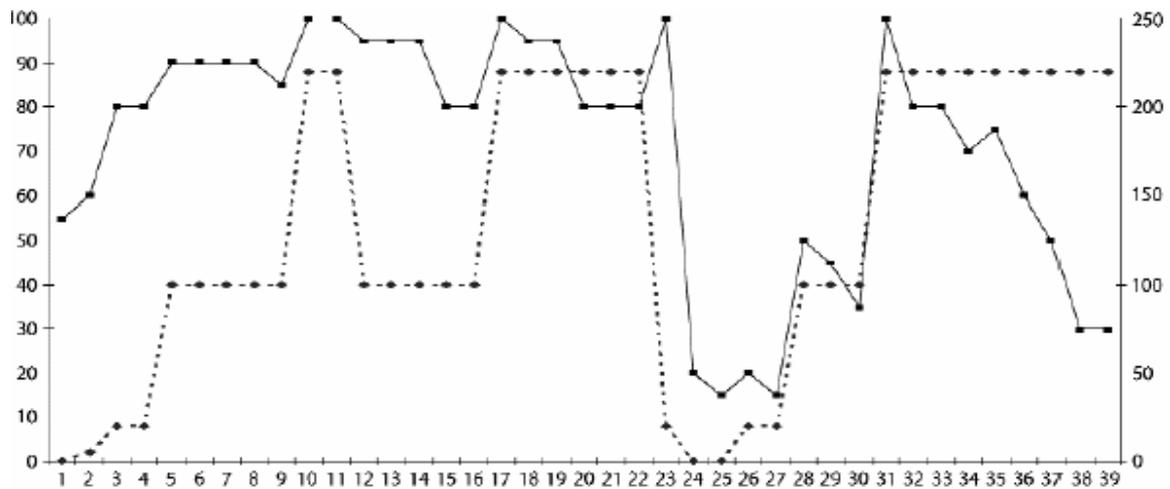
The first of three confrontations was dominated by the cognition of anxiety. The test person should, if possible, experience maximal occurrence of anxiety cognitions, anxiety feelings and anxiety physiology. Every session lasted 2-4 hours. During the exposure the test person was asked every 5 min about the level of his anxiety/stress measured on a scale ranging from 0-100 (SUDs). After having surpassed the point of culmination of the emotional-vegetative reaction, the exposure continued until the test person showed a significant subjective ease (scale: <30).

The test person was instructed to verbalize clearly his perception. The therapist was empathic-supporting and motivated the test person to endure the situation. In principle, the decision to drop out or to continue the exposure was not made by the therapist. If the test person wanted to drop out, the therapist was supposed to encourage him to continue. An “emergency-stop procedure” has been arranged individually (i.e. verbal signs as “Stop, it is enough”).

#### *Test Persons*

The test persons were people from the German-speaking area around Basel. There was an advertisement in the newspaper and in the period from February 2000 to January 2001, 38 persons answered the advertisement. Twenty of them could be excluded already on the phone, because either they did not have acrophobia or they had some other symptoms as i.e. eating disorders, alcohol addiction, and agoraphobia. Eighteen people were invited to a preliminary talk, but 4 of them cancelled it beforehand. After the 14 preliminary talks, 2 persons withdrew their consent for the treatment. 6 of the remained 12 persons were selected via a random generator and were accepted for the pilot study.

All 6 test persons were male and did not suffer from a further somatic mental disorder. They were socially well-integrated and employed. The mean age was 37.8 years.



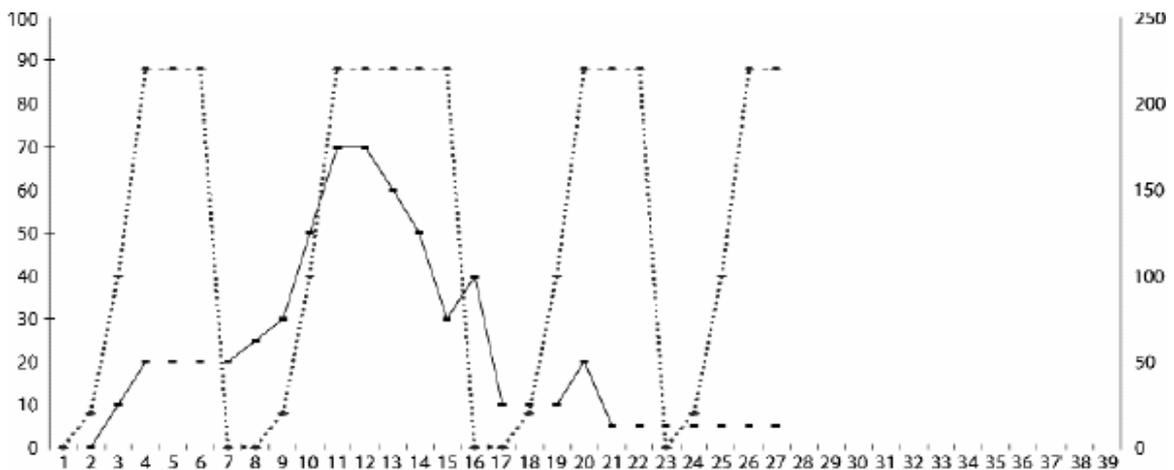
**Figure 2.** First exposure treatment of test person No. 6. The horizontal axis shows 39 intervals of 5 minutes. The left vertical axis indicates the dimension of anxiety (black line with squares) between 0 and 100, the right vertical axis indicates the altitude of the elevator in meters (maximal 220m, dashed line with lozenges)

**RESULTS**

The object of this pilot study was to examine the feasibility and the efficacy of virtual environments in treating acrophobia patients. The exposure was without any relevant incidents and the individually arranged “emergency-stop” was never used.

Positive effects of the exposure in the virtual environment could be observed for all test per-

sons. Exemplary results of the 18 exposures are graphically illustrated in figure 1, 2 and 3. Figure 1 represents a “classical” exposure process within 105 min: At the beginning the anxiety increased synchronously with the altitude. In the subsequent 2 confrontations, the amplitude of the subjectively experienced anxiety decreased significantly and ends after 105 min with less than 30 SUDs. In the second case (figure 2), the anxiety was already at the beginning very distinct. The exposure was slow and

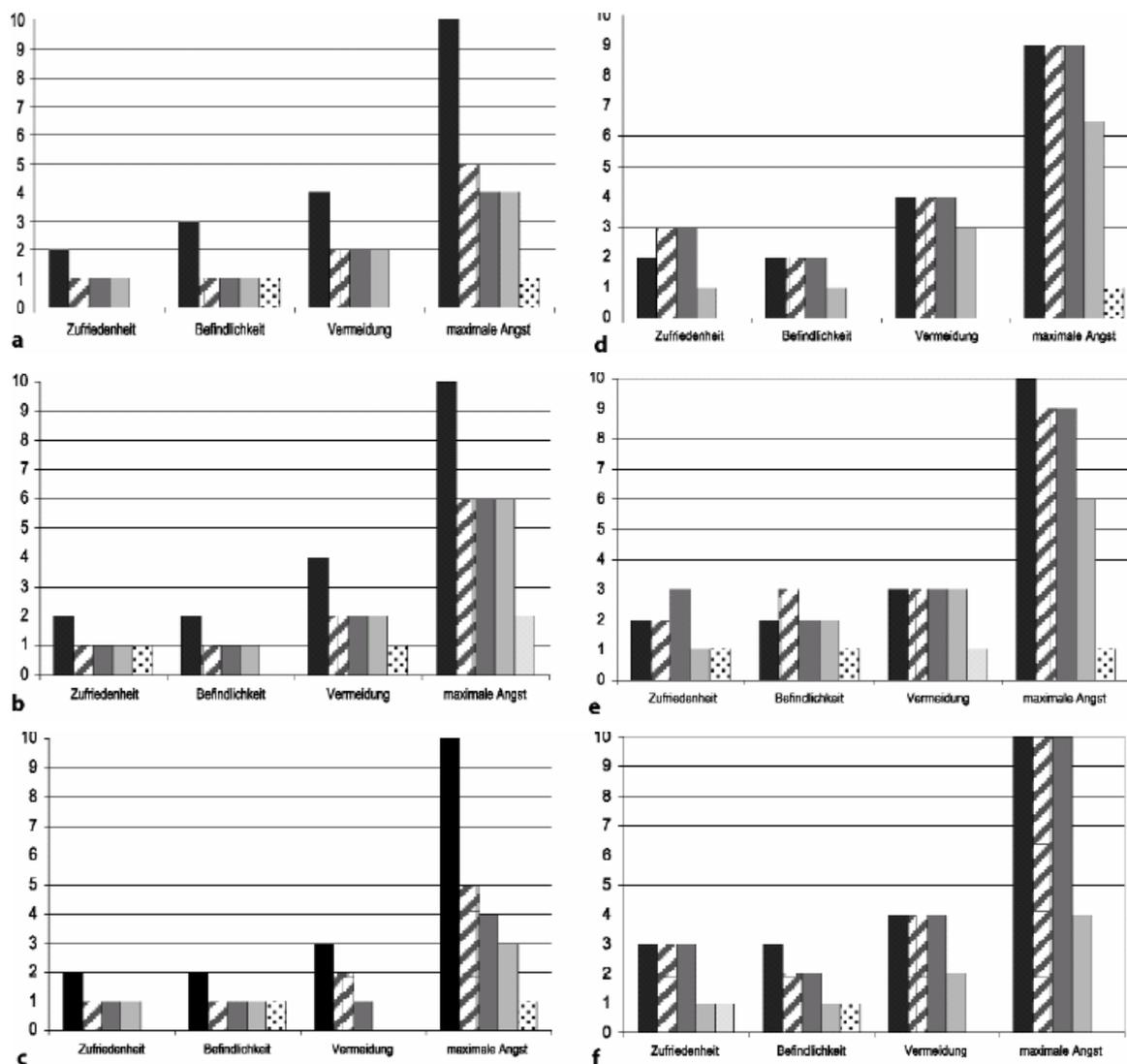


**Figure 3.** First exposure treatment of test person No. 4. The horizontal axis shows 39 intervals of 5 minutes. The left vertical axis indicates the dimension of anxiety (black line with squares) between 0 and 100, the right vertical axis indicates the altitude of the elevator in meters (maximal 220m,

gradual and reached only after approximately 50 min the maximal altitude. The anxiety became almost insupportable for the test person and a reduction of altitude implicated almost no release. After about 100 min the anxiety diminished in spite of subsequent maximal altitude-exposure. The fast virtual downward trip by the elevator resulted firstly in an increase of anxiety but finally in a great release. After 160 min a reduction of anxiety can be observed ending after almost 200 min with a SUD of approxi-

mately 30. Figure 3 shows a prolonged rise of anxiety. Only at the second time of maximal altitude the stress level had a relevant value of about 70 SUDs. The release occurred soon and was maintained also after new confrontation. After 145 min the exposure was stopped having a stable SUDs of less than 10.

Figure 4 shows, resuming all 5 measurements, the test persons' self-evaluation concerning "contentment", "discomfort", "avoidance" and



**Figure 4a-f.** Illustration of therapy effects concerning "contentment" [Zufriedenheit], "comfort/discomfort" [Befindlichkeit], "avoidance" [Vermeidung] and "maximal anxiety" [maximale Angst]: **a-c** represents test person no. 1-3; **d-f** represents test person no. 4-6. Time of enquiry: measuring 1 (black), measuring 2 (diagonally striped), measuring 3 (dark grey), measuring 4 (medium grey), in-

maximal anxiety in single situations. One can see that all test persons experienced the therapy as successful. This estimation was stable for 6 months: The subjectively felt comfort increased and previously avoided situations were frequented more and more and were experienced with decreasing anxiety. Discontent, discomfort and the degree of avoidance were evaluated by the test persons on a scale ranging from 0 (no problem) to 4 (every altitude with more than 5 m was avoided). The evaluations were to be explicitly subjective and general. In terms of "discontent" the test person was asked to what extent he was discontent because of his phobia. With regard to "comfort/discomfort" he was asked how much the phobia affects his physical and mental orientation. An occurrence of 2 and 3 improved to 0-1. "Avoidance" meant the avoidance of being in altitude. This avoidance was at the beginning 3-4 and after 6 months only 0-1. The occurrence of anxiety was also quantified by a 0-100-scale. All test persons experienced values of 90 or even more before they underwent the therapy. After 6 months the Subjective Units of Discomfort were only around 10.

## DISCUSSION

The pilot study shows that an exposure in a virtual environment is possible and evokes anxiety among patients suffering from a specific phobia and has therapeutic effects. It has not been clarified so far to what extent habituation-processes and to what extent cognitive restructurings took place.

Possible side effects of virtual environments are sickness in the simulator (2) or impaired vision after the exposure (18). According to our inquiry none of the 6 test persons experienced such or other side effects. The experience was dominated by anxiety symptoms as i.e. sweating, gastrospasms, nervousness and sometimes even "panic" anxiety. The pressure of the data helmet on the head, vertigo, sickness or further disturbances were not said to be disagreeable. It can be supposed that because of the subjective threat of the virtual altitude such further disagreeable feeling have been suppressed. Compared to exposures in vivo, the test persons showed –in vitro- very similar reaction patterns. It is remarkable that nobody used the emer-

gency-stop even if they often talked about doing it. In a real exposure such moments are very critical because the avoidance is easy to do. Drop-out is known as a common strategy and is almost automated. The very different way of the virtual environment could be a cesura in this automation. These experiences have to be interpreted with caution. The test persons were typical for specific phobic disorders insofar as the beginning of the disorder was in early adulthood and was chronically restricting. Among all the healing attempts there were psychotherapeutic treatments of "school psychology", so-called alternative intervention and even esoteric practices. Some of our test persons also tried sporadically to reduce their anxiety in taking "benzodiazepines" or alcohol.

Because of using self-evaluation-scales there is another limitation of the data. This process is common in therapeutic terms, but leads to difficulties in the evaluation of the data and in its comparability. The technique of the VR could be a great advantage because of its standardization. During exposure, additional physiological parameters (23) could be measured forming the objective of the so far only subjective aspect of anxiety. In this case, the investigation of the biological basis of the specific phobias is auspicious by means of using virtual environments as an exposure platform. Because the computer-generated environments are always represented completely unmodified compared to the preceding and succeeding processes, they are suitable for the study of the psychophysiological stimulus-reaction conditions and for the examination of the therapeutic effects resulting from these psycho-physiological reactions.

## CONCLUSION

Our pilot study showed an improvement in all the measured domains (contentment, comfort/discomfort, anxiety occurrence, avoidance). The occurrence of the test person's anxiety diminished significantly during exposure. Situations previously avoided were frequented. General life-contentment and comfort rose. The improvement after the therapy is very evident among the test persons. The waiting condition "computer games" changed nothing. After 6 months the positive results could still be ob-

served and they even continued to improve. These results correspond to our own therapeutic experience as well as to other published studies (8, 9, 10, 17, 19, 20, 22, 26, 27, 28).

## REFERENCES

1. American Psychiatric Association (1994), Diagnostic and Statistical Manual of Mental Disorders (DSM 4th edn). Washington, DC
2. Baltzley DR, Kennedy RS, Berbaum KS, Lilienthal MG (1989), The time course of post-flight simulator sickness symptoms. *Aviation Space Environm Med* 60(11):043–1048
3. Bullinger A, Roessler A, Mueller-Spahn F (1998), 3D-Virtual Reality as a Tool in Behavioral Therapy of Claustrophobia. *CyberPsychol Behav* 1(2):139–145
4. Bullinger A, Roessler A, Mueller-Spahn F (1998), From Toy to Tool: the Development of Immersive Virtual Reality Environments for Psychotherapy of Specific Phobias. *Stud Health Technol Inform* 58:103–111
5. Carlin AS, Hoffman HG, Weghorst S (1997), Virtual reality and tactile augmentation in the treatment of spider phobia: A case report. *Behav Res Ther* 35(2):153–158
6. Cartwright GF (1994), Virtual or real? The mind in cyberspace. *Futurist* 22–26
7. Foa EB, Rothbaum BO (1998), Treating the trauma of rape. Cognitive-behavioral therapy for PTSD. Guilford Press, New York
8. Hodges LF, Kooper R, Rothbaum BO, Opdyke D, de Graaff JJ, Williford JS, North MM (1995), Virtual environments for treating the fear of heights. *Comput Innov Technol Comput Profess* 28(7):27–34
9. Hodges LF, Rothbaum BO, Watson BA, Kessler GD, Opdyke D (1996), Virtually conquering fear of flying. *IEEE Comput Graph Applic* 16(6):42–49
10. Jacobs M, Christensen A, Huber A, Polterock A (1995), Computer-assisted individual therapy vs. standard brief individual therapy. In: Jacobs M (chair) Computer-psychotherapy: Wave of the future? Symposium conducted at the meeting of the Western Psychological Association, Los Angeles
11. Kaplan HI, Sadock BJ, Grebb JA (1994), Synopsis of Psychiatry – Behavioral Sciences – Clinical Psychiatry (7th edn). Williams & Wilkins, Baltimore
12. Katschnig H, Stolk JM, Klerman GL, Ballenger, JC (1992), Discontinuation and long-term followup of participants in a clinical drug trial for panic disorder. *Biol Psychiatry* 1:657–660
13. Kuntze M (2000), Therapiemanual zur graduierten Expositionstherapie in „Virtueller Realität“ zur Behandlung der spezifischen Phobie. COAT, Basel
14. Kuntze M, Mueller-Spahn F, Mager R, Stoermer R, Bullinger AH (2002), Ethics and Values in a Virtual Environment. 10th Medicine Meets Virtual Reality Conference, Newport Beach CA, USA
15. Kuntze MF, Stoermer R, Mager R, Roessler A, Mueller-Spahn F, Bullinger AH (2001), Immersive Virtual Environments in Cue Exposure. *CyberPsychol Behav* 4(4) 497–501
16. Margraf J (1996), Lehrbuch der Verhaltenstherapie, Bd 1, 2. Springer, Berlin Heidelberg New York
17. Margraf J, Schneider S (1990), Panik – Angstanfälle und ihre Behandlung. Springer, Berlin Heidelberg New York
18. Mon-Williams M, Wann JP, Rushton S (1993), Binocular vision in a virtual world: Visual deficits following the wearing of a head-mounted display. *Ophthal Physiol Optics* 13 (4):387–391
19. North MM, North SM, Coble JR (1996), Virtual reality therapy. IPI Press, Colorado Springs
20. Oest LG (1996), Spezifische Phobien. In: Margraf J (Hrsg) Lehrbuch der Verhaltenstherapie, Band 2. Springer, Berlin Heidelberg New York
21. Rachman S, Taylor S (1993), Analyses of claustrophobia. *J Anx Disord* 7(4):281–291
22. Rothbaum BO, Hodges LF, Kooper R, Opdyke D, Williford JS, North M (1995), Effectiveness of computer-generated (virtual reality) graded exposure in the treatment of acrophobia. *Am J Psychiatry* 152:626–628
23. Stoermer R, Mager R, Roessler A, Mueller-Spahn F, Bullinger A (2000), Monitoring Human-Virtual Reality-Interaction: a Time Series Analysis Approach. *CyberPsychol Behav* 3 (3):401–406
24. Wittchen HU (1991), Der Langzeitverlauf unbehandelte Angststörungen: Wie häufig sind Spontanremissionen. *Verhaltenstherapie* 1:273–283
25. Wittchen HU, Semler G (1991), Composite International Diagnostic Interview (CIDI). Beltz Test, Weinheim

26. Wiederhold, B.K. (1999). "A comparison of imaginal exposure and virtual reality exposure for the treatment of fear of flying" [doctoral dissertation]. California School of Professional Psychology.
27. Wiederhold, B.K. & Wiederhold, M.D. (2000). "Lessons Learned From 600 Virtual Reality Sessions." CyberPsychology & Behavior. 3 (3): 393-400.
28. Wiederhold, B.K., Wiederhold, M.D., (2005). Virtual Reality Therapy for Anxiety Disorders- Advances in Evaluation and Treatment. Washington, DC: American Psychological Association.

**Contact:**

Alex H. Bullinger  
COAT-Basel / UPK  
Wilhelm Klein – Str- 27  
4025 Basel, Switzerland  
[bua@coat-basel.com](mailto:bua@coat-basel.com)