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Application of "Virtual Realities" in Psychotherapy: Possibilities, Limitations and Effectiveness

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1. Introduction

In numerous projects, the Internet has proven to be a useful enhancement and a helpful support to psychosocial and psychotherapeutic methods. Key words such as online-therapy, e-therapy, and e-mental health are frequently used in this context (for an overview, see Bauer & Kordy, 2008; Eichenberg, 2008; Eichenberg & Ott, in press; Ott & Eichenberg, 2003; Bauer & Kordy, 2008). Another tool considered useful is mobile media, which can effectively be applied to the entire spectrum of clinical-psychological interventions (Döring & Eichenberg, 2007). Virtual Reality (VR) technologies go one step further by enabling the creation of computer-based models of the real world that can be interacted via man-machine interfaces. VR applications can also be accessed via the Internet, but only singular and stationary programs exist so far. The observation that virtual stimuli trigger real anxiety, often accompanied by physiological symptoms (elevated blood pressure, sweating and nausea), has led to the integration of these modern applications into the spectrum of therapeutic intervention techniques.

Two conditions are necessary in order for people to experience virtual environments as "real" and thus render the environments therapeutically useful. These two conditions are referred to as "immersion" and "presence".

An individual's involvement with the virtual environment due to objective, stimulating conditions is referred to as immersion. On the one hand, the virtual environment's visual, auditory, and tactile designs create the three-dimensional perception that the VR model is the real world. On the other hand, the perception of the virtual environment is facilitated by specific output devices (e.g. data-goggles, monitor) and special input devices (e.g. data gloves, voice recognition software, geolocation systems, and line-of-sight trackers). These special devices and systems enable synchronous activity and communication with the computer generated model using gestures, mimicry, language, body position, etc.

The subjective experience of physically being in a virtual environment and that this environment is real is referred to as presence. Characteristics of presence are the perception of the environment being real, blanking out real-world stimuli as well as involuntary and objectively meaningless body movements. For example, a person might crouch to feel his feet firmly planted on the real floor while crossing a virtual bridge over a virtual abyss.

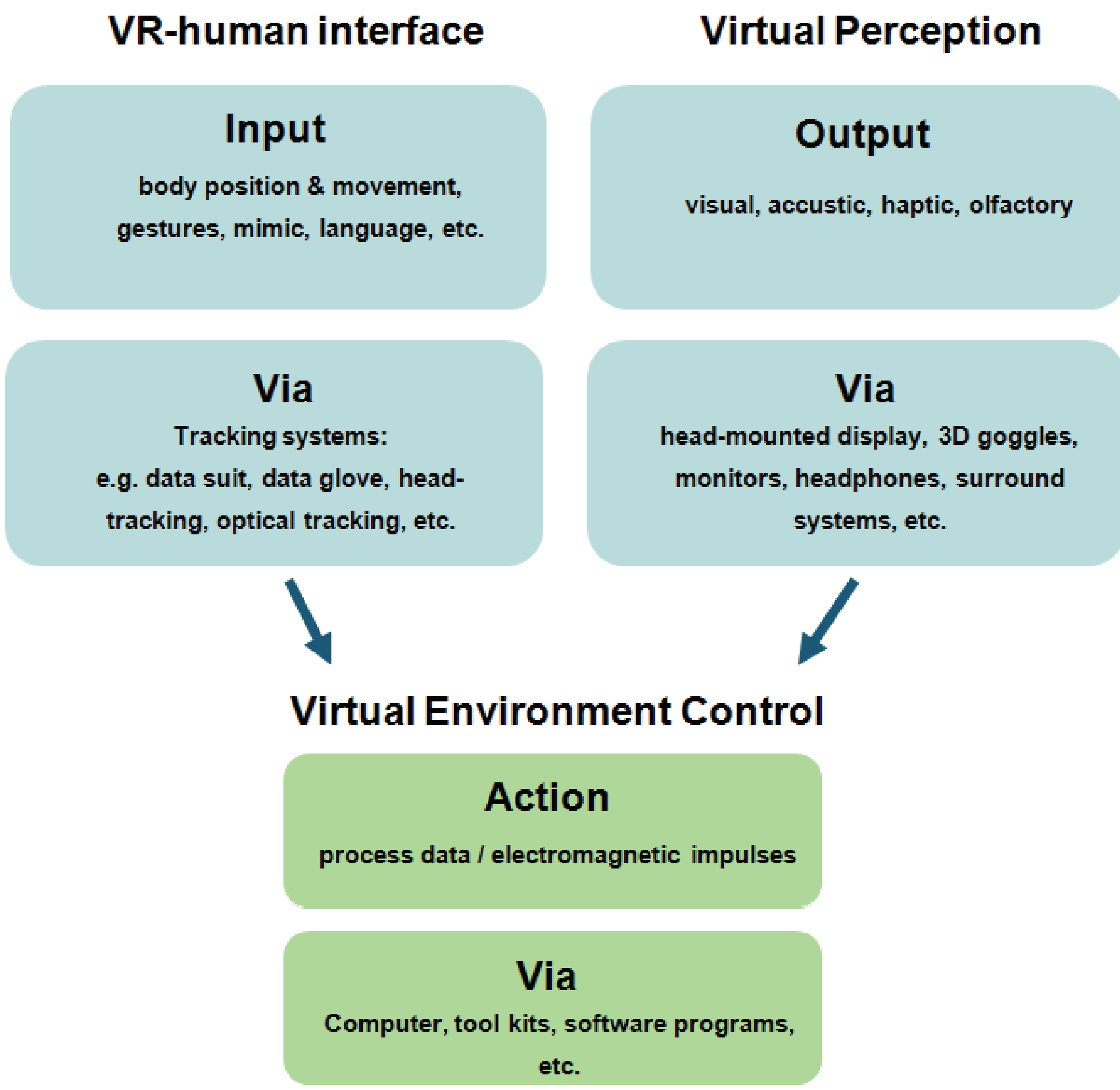

Fig. 1. Technical requirements of VR applications (source: proprietary graphic)

2. Use in psychotherapy

Initially, VR technologies were applied in various areas of medicine (comp. Kaltenborn, 1994). The development of a three-dimensional visualization system facilitated laparoscopic surgery. In the field of rehabilitation of physically disabled patients, carrying out everyday tasks was simplified with the aid of VR devices. Mute patients, for example, could carry on verbal conversations using a data glove that captures gestures, which are interpreted by the computer and forwarded to a language system. The language system then translates the gestures into a synthetic language.

Since 2000, VR applications have been systematically tested in the field of psychotherapy, particularly in behavior therapy and proven to be effective in the treatment of various specific phobias, as first studies show. According to the theories of behavior therapy, in order to treat phobias the anxiety provoking situation must be sought, avoidance amplifies

the notion that the stimulus is dangerous and thus prevents corrective experiences. Being able to experience and tolerate anxiety is an essential part of the therapy. The aim of the treatment is to revise maladjusted concepts and to learn new behavior. There are two different forms of exposure therapy. Immediate exposure to the feared situation or object in reality is referred to as "in vivo" exposure. Exposure to the situation or object in imagination only is referred to as "imaginal" exposure. Both methods involve incremental, i.e. graduated exposure. Starting with stimuli that trigger only low levels of fear, the exposure is incrementally or massively increased. In the latter case, patients are exposed to their most extreme fear ("flooding" or, in imaginal exposure, "implosion").
Consequently, exposure treatments that employ VR applications go one step further than imaginal confrontation because they present a three-dimensional and interactively explorable environment. As a medium between imaginal and in-vivo exposure to anxiety-provoking stimuli, the effectiveness of these methods is outlined in the following article.

3. Empirical evidence of the effectiveness of exposures using VR

Most studies of the effectiveness of VR applications have examined their use in treating specific phobias such as fear of heights, fear of flying, fear of animals, and social phobias. A few studies have been made using VR to treat other disorders, though some of these applications are questionable not only ethically but also by current psychotherapeutic standards.
Firstly, two current meta analyses regarding the effectiveness of VR environments in treating anxiety disorders are summarily presented. Subsequently, exemplary studies of the treatment of anxiety disorders, including posttraumatic stress disorder, and the therapeutic VR components used in the treatments are introduced.

3.1 Meta analyses

There are currently two meta analyses that analyze and document the present state of research on the effectiveness of VR-based exposure treatments for anxiety disorders.
N=21 evaluation studies (N=300 subjects) substantiating the effectiveness of VR-based exposure therapy were evaluated by Parsons and Rizzo (2008). All studies with pre-post measurements were included in this study; using a controlled study design was not a prerequisite for admission to the analysis. Regarding the reduction of symptoms by using VR therapies, the authors found an average effect size of d=.95 (SD=.02). Aside from fear of flying (d=1.5; SD=.05), the effect size was largest for the treatment of panic disorder with agoraphobia (d=1.79; SD=.02). The effect size was nearly identical for the treatment of social phobia (d=.96; SD=.10), acrophobia (d=.93; SD=.06) as well as arachnophobia (d=.92; SD=.12), with that of PTSD being the smallest (d=.87, SD=.01). The authors assumed a series of determining factors (e.g. degree of immersion and presence, duration of the disorder, socio-demographic aspects), but were unable to make empirically funded statements based on the data at hand, because too few studies provided information about these aspects.
Powers and Emmelkamp (2008) chose a more rigid design and used only 13 controlled studies (with N=397 subjects) as a basis. They surmised that VR treatment for anxiety disorder is highly effective (in comparison to the waiting control group: median d=1.11) and at least as effective as in-vivo therapy (median d=.34).
Overall, the findings at hand show that VR treatment for anxiety disorders is highly effective, although it seemed more effective in treating diffuse phobias (e.g. fear of flying)

than more complex anxiety disorders (e.g. social phobia, PTSD). However, the weaknesses common to meta analyses (e.g. publication bias, as studies with insignificant results are less frequently published, with the consequence that effects tend to be overestimated) need to be considered. Conversely, the limitations of the studies involved need to be taken into account in particular (e.g. sample sizes that are too small, partially missing data about the time of the follow-up ratings and the conjunctive lastingness of a successful treatment). Introducing varied levels of immersion (e.g. head-mounted display or VR-cave) as independent variables and generally ensuring that no measurement instruments are used that might favor one treatment environment over the other (e.g. imaginal vs. VR) is an important consideration for future studies.

3.2 Exemplary studies of various syndromes

The meta studies on hand reveal that the effectiveness of VR has been studied mainly in behavior therapy for patients with anxiety disorders. Anxiety disorders are among the most frequently diagnosed psychological disorders. In the federal health survey of 1998/99, a 12-month prevalence was established among 14.5% of the adult German population (Jacobi et al., 2004). Consequently, comprehensive research efforts to optimize existing treatment methods come as no surprise. Anxiety disorders lie within the traditional treatment range of behavioral procedures and lend themselves well to the VR setting due to their concept of exposure (as opposed to psychodynamic therapy procedures, which center on the relationship aspect). Thus, anxiety disorders present the first syndrome category for which the use of modern media such as the Internet or VR technology as a setting for interventions was scientifically evaluated (Eichenberg & Portz, 2005).
The two major diagnostic classification systems differ in their definition of anxiety disorders. While the DSM-IV (the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders; Saß et al., 1998) contains an individual chapter named „Anxiety Disorders", they are included in the chapter „Neurotic, Stress and Somatoform Disorders" in the ICD-10 (the World Health Organizations' International Classification of Diseases, 1991). The ICD-10 distinguishes between the subgroups of *phobic* disorders (agoraphobia, social anxiety disorder, as well as specific phobias) and other *anxiety disorders* (panic disorder, generalized anxiety disorders). *Posttraumatic stress disorder* is consequently dealt with in the same chapter as anxiety disorders.

Fear of heights

The fear of situations involving heights (acrophobia) is frequently reported among the public. In a survey of over 8000 adults, 20% admitted to having experienced an exaggerated fear of heights at least once in their lifetime, but not to the extent that would meet the clinical criteria of acrophobia (Curtis et al., 1998). In the cited study, acrophobia ranks immediately behind the fear of animals, which was reported most often (22%). 5.3% of those surveyed met the criteria for diagnosis of acrophobia. Contrary to the common observation that women develop a specific phobia more frequently than men, this is not distinctively the case with acrophobia. While 55-70% of acrophobia sufferers are female, 75-90% of adults suffering from fear of animals are women (comp. DSM-IV, Saß et al., 1998).
Empirical research of VR-based exposure therapy began with individual case studies of patients suffering from acrophobia. Rothbaum et al. (1995) described an acrophobic student who had five therapy sessions after being shown anxiety reducing relaxation techniques. During these sessions, he was exposed to several virtual environments within which he

could gradually move up to increasingly higher planes. On each plane, the student used relaxation techniques to habituate himself to the height. Standardized instruments (e.g. Avoidance Scale, Attitude Towards Heights) measured an improvement of his symptoms in a pre-post comparison. Even if these first studies show methodical deficits (effects of relaxation techniques were not distinguished from effects of exposure techniques), they do illustrate the fundamental advantages of imaginal confrontation. On the one hand, actual locations, in this case high bridges, can often only be reached with great effort and pedestrians can disturb the intervention. On the other hand, the stimulus can be applied in measured doses and the anxiety-provoking situation can be accessed in a safe and individually remodelable environment.

The therapeutic potential of VR exposure as part of behavior therapy to treat acrophobic patients was confirmed in a study series by Emmelkamp et al. (2001). In the first study, a within-subjects design was used. Ten acrophobic patients were gradually exposed to heights in VR during sessions and then went in-vivo to heights in the company of the therapist. The extent of their acrophobia was measured before treatment, after VR exposure, and after in-vivo exposure. Various scales indicated significant improvement after VR exposure, while only one variable (Fear of Heights, Cohen) registered additional improvement after in-vivo exposure. The authors assumed that a blanket effect had happened in the sense that VR treatment was so effective that no further significant improvement could be achieved after repeated in-vivo exposures. In a second study (Emmelkamp et al., 2002), VR and in-vivo exposure were compared in a between-subject design. *N*=33 acrophobic patients with an average age of 44 (*SD*=9.3) and having suffered from the disorder for an average of 31.5 years (*SD*=11.3) were randomly exposed to both VR and real settings. Each exposure was

Fig. 2. VR-environment used to treat fear of flying (source: A. Mühlberger)

graduated over the course of three sessions. In order to increase the comparability of the two scenarios, the real environment used for in-vivo exposures was replicated in the virtual environment. Thus, three environments – virtual or real – had to be visited: A shopping mall in Amsterdam with four floors, escalators, and bridge railings, a 50 meter high fire escape, and the roof garden on a university's grounds (65 feet high). The patients rated their anxiety levels on the SUDS-scale (Subjective Units of Disturbance) at specified points in time. Each time patients had habituated themselves to a particular situation, they were encouraged to switch to a more challenging exercise. The evaluation results demonstrated that both forms of treatment were equally effective. VR as well as the in-vivo variant lead to equally significant improvements that continued to last after six months. Krijn et al. (2004) found no differences in effectiveness regarding the dependence upon different levels of presence, i.e. operationalized with VR via Cave (high degree of presence) or head-mounted-display (low degree of presence).

Fear of flying

According to references, phobic *fear of flying* affects approximately 10% of the population (e.g. Nordlund, 1983). Another 20% fly with considerable unease (Institute of Demoscopy Allensbach, 2003). There is a frequent comorbidity with other disorders: According to Kinnunen (1996), 43% of those suffering from fear of flying also suffer from claustrophobia, while another 53% suffer from acrophobia. The situations that trigger fear in individuals suffering from fear of flying differ greatly. In a study with 144 subjects suffering from fear of flying (Mühlberger & Hermann, 1997), 5% of subjects reported fear of an accident happening, 29% fear of heights, 26% fear of enclosed rooms, 25% fear of an anxiety attack, 14% fear they might not receive medical attention, 12% fear of being subjected to fear itself, and just as many were afraid of their fear being noticed by others.

Schubert and Regenbrecht (2002) refer to some of these anxiety-specific characteristics that, on a conceptual basis alone, support using VR in regard to treating fear of flying. In particular, they highlight the logistical and financial expenditure that is far lower in comparison to in-vivo exposure. They also emphasize the privacy and familiarity of the treatment setting compared to the public exposure during a regular commercial flight. Mühlberger et al. (2008) add the ease of repeating VR exposure. Rothbaum et al. (2000) introduced a controlled study comparing VR supported therapy to in-vivo exposure. Forty-five subjects with fear of flying were randomly assigned to either VR or in-vivo therapy. Both treatment environments resembled each other in the first four sessions (cognitive intervention, breathing exercises, and thought stopping training). In the next four sessions of VR treatment, patients were seated in a virtual airplane that they visualized using data goggles. The visualization was supplemented with realistic airplane ambiance noises or the simulation of turbulent weather. The patients were gradually exposed to increasingly anxiety-provoking situations (from simply sitting in a parked airplane to turbulence during takeoff, to actual flying or landing). In the in-vivo environment the subjects spent two double sessions at an airport. First they took part in flight preparation training, then they entered parked airplanes and visualized takeoff, flight and landing of the plane (combination of in-vivo and imaginal treatment). A pre-post comparison using several standardized measuring instruments showed significant improvement of symptoms in both treatment groups. No significant differences were apparent between the two treatment groups, even after the follow up rating after six months, and the improvements remained consistent. The subjects in the waiting condition showed no reduction in symptoms; however, it should be critically mentioned that the stimuli were not identical in the two

Fig. 3. Fear of flying: simulator (source: A. Mühlberger)

treatment environments, because an actual flight was not part of the therapy. A further study conducted by Wiederhold et al. (2003) revealed that graduated VR treatment combined with the feedback of physiological parameters (breathing, heart frequency, skin resistance) was most effective in comparison to pure VR therapy and imaginal exposure using the same graduated exposure to fear. In a randomized study, the authors found that 20% of the patients in the imaginal environment, 80% of the patients in the VR treatment and 100% of the patients who received VR exposure with additional feedback of biological parameters were able to fly again after eight weeks of therapy. Study series by German scientists from the University of Würzburg also substantiated the effectiveness of VR: Even short-term VR exposure therapy in only one session is useful for treating fear of flying in the long run. The authors demonstrated the participation in a completion flight is important for long-term therapy success, while the attendance of a therapist during this flight has little influence (Mühlberger et al., 2006). The following pictures show the simulator as well as a section of the VR (inside of the airplane) the way they were used in the Würzburg studies.

Fear of spiders

In the ICD-10, fear of spiders (arachnophobia) is assigned to the category of zoophobias, subgroup of specific phobias. Zoophobias are the most common specific phobias, the exaggerated fear of small, crawling, scuttling animals like spiders, snakes and rats being predominant. According to references, the prevalence of arachnophobia is 3.5-6.1% of the population, a large percentile of them women (Schmitt et al., 2009). A person suffering from arachnophobia will experience intense fear paired with physical reactions as well as avoidance and flight behavior when exposed to a spider. This can impede a person’s daily life, such as being limited when choosing an apartment or needing help when confronted with a spider (comp. casuistic). Since spontaneous recovery is rare, behavior therapy is the preferred method in treating this disorder.

Single case studies (Carlin et al., 1997) as well as controlled studies have documented successful treatments of arachnophobia with VR.

Fig. 4. VR-environment used for exposure treatment of arachnophobia (source: www.hitl.washington.edu)

Case example (from Carlin et al., 1997)

Mrs. M. (37 years old) had suffered from arachnophobia that severely affected her daily life for 20 years. Before she drove to work in the mornings, she would search her car for spiders, spray pesticide, and leave a burning cigarette in the ashtray with the car windows closed, because she had heard that spiders do not like smoke. She routinely sealed the bedroom windows with tape and the door with towels before she went to bed to make sure no spiders could enter the room. After washing her clothes, she would put each piece of clothing into an individual plastic bags, sealing the bags to make sure the clothing stayed free of spiders.

Mrs. M. took part in 12 VR sessions of 60 minutes each over the course of three months. Before the first session, she was exposed to photos and later to plastic models of spiders over the course of several hours. Despite these preparative exposures, she remained extremely phobic. The therapist saw the advantage of using VR exposure because it enabled him to control the anxiety-provoking stimulus. Virtual spiders obey commands and can be touched without risk and brought to a desired position.

During the first VR sessions, Mrs. M. was exposed to two virtual spiders in a simulated kitchen – one large brown spider and one smaller black one. One month later (5th session), the visual simulation of one of the spiders was interfaced with a furry toy spider. This spider carried a sensor so that movement of the toy resulted in the movement of the virtual spider ("tactile augmentation"). The addition of a tactile stimulus was supposed to add to a maximum degree of presence and maximum transfer to the "real world".

The combination of tactile and visual stimuli triggered intense fear responses in Mrs. M. She experienced physical symptoms such as dry mouth, uncontrollable shaking of her hands and legs, and profuse sweating.

After completion of therapy, however, she showed a visible reduction in fear towards spiders.

While her self-rating of experienced fear during the visual-tactile exposure was 7.9 on a scale of 1-10, she rated her fear at a level of 3 by the end of therapy and showed no more physical symptoms. Off the 280 students who, like Mrs. M., completed a self-rating scale of arachnophobia, 29% were just as afraid or even more afraid of spiders than Mrs. M.
Mrs. M.’s improvement is so profound that she is now able to go camping.
The success of the treatment described above was also confirmed in follow-up studies (comp. Garcia-Palacios et al., 2002). At the same time, these studies revealed that VR treatments that combine the use of tactile and visual elements are more effective than purely visual VR exposures (Hoffmann et al., 2003).

Social Phobia

The fear of being critically observed by others, leading to avoidance of social situations, is referred to as social phobia. More extensive social phobias usually occur in combination with low self-esteem and fear of criticism. Social phobias symptomatically escalate in form of blushing, shortness of breath, cramping, speech impediment and frequent slips of the tongue, shaky hands, nausea, the urge to urinate, and even panic attacks. Typically, those affected fear that their nervousness or fear could be noticed, which only increases their anxiety. In an attempt to avoid all of this from happening, individuals with social phobias often avoid situations that could expose them to being observed by others to begin with. This can have a negative impact on a person’s private and career life and lead to social isolation. About 11% of the male and 15% of female population suffer from social phobia at least once in their lifetime (Maggee et al., 1996).
Studies using clinical random samples also exist for the treatment of social phobia using VR settings. In a randomized design, Klinger et al. (2005) studied the effectiveness of VR supported therapy in comparison to cognitive behavior therapy with 36 patients who had, on average, been suffering from social phobia for 15 years. Various rating scales as well as therapist ratings were used to measure the effectiveness of the treatment after 12 sessions. Both VR and cognitive behavior therapies were found to be highly effective treatment forms for this specific phobia as well, successfully reducing fear and avoidance. Distinctions between the two forms of treatment were insignificant (comp. also Roy et al. 2003). Specific VR environments have also been developed to treat public speaking fear, a potential characteristic of social phobia (e.g. Anderson et al., 2003; Herbelin et al., 2002; Pertaub et al., 2001).
The use of VR in therapy to treat further anxiety disorders (e.g. claustrophobia: see single case study by Botella, 1998) and other psychological disorders (eating disorders: see Riva et al., 2001, alcoholism: see Lee et al., 2007) was examined as well. Studies on the effectiveness of VR in treating posttraumatic stress disorder are also available.

Posttraumatic stress disorder

Approximately 30% of individuals who experience a traumatic event suffer from a psychological disorder as a result. One of these disorders is the posttraumatic stress disorder (PTSD), which has been recognized as a formal diagnosis since 1980. According to the ICD-10, PTSD comprises the following symptoms: Those affected were exposed to a short or long-lasting event or situation of an exceptionally threatening or catastrophic nature, which is likely to cause pervasive distress in almost anyone. This leads to symptoms such as intrusions (flashbacks, repeating dreams), avoidance of activities and situations reminiscent of the trauma, the partial or complete inability to recall some important aspects of the event or situation, or symptoms of hyperarousal (e.g. increased startle reaction, sleeping disorders). Potentially traumatic events can be divided into two groups: manmade disasters (war, torture, and exile; sexual abuse, violent crimes, bullying) and natural disasters (e.g. earthquakes, accidents, life-threatening diseases) (Fischer, Weber & Eichenberg, in print).

There are a handful of studies that examine the utilization and effectiveness of VR in treating PTSD, in particular PTSD as a result of *terrorist attacks* and *wartime experiences*.

Difede and Hoffmann (2002) developed a VR environment for patients suffering from PTSD as reaction to the events of September 11, 2001 in New York. In their initial case study, the authors describe the treatment of a 26-year-old woman whose 9/11-related posttraumatic stress disorder had not responded to traditional imaginal exposure therapy. Having witnessed the attacks from across the street, she had survived without serious physical injury, but developed severe PTSD symptoms. She suffered from flashbacks, avoidance, hypervigilance, and difficulty falling and staying asleep.

The patient was treated with six VR sessions of 45-60 minutes. She was exposed to the following virtual scenarios:

1. A jet flies over the WTC towers, but doesn't crash, normal New York city street sounds.
2. Then a jet flies over, hits building, but no explosion
3. Then a jet flies over, crashes with explosion, but no sound effects
4. Then a jet flies over, crashes with explosion and explosion sound effects
5. Burning and smoking building (with hole where jet crashed), no screaming
6. Burning and smoking building (with hole where jet crashed) and screaming
7. Burning and smoking building (with hole where jet crashed), screaming, and people jumping
8. Second jet crashes into second tower with explosion and sound effects
9. Second tower collapses with dust cloud
10. First tower collapses with dust cloud
11. The full sequence

According to standardized clinical and self-report measures, the patient's symptoms were reduced immediately following the VR exposure treatments. This result was validated in a controlled study using a small random sample (Difede et al., 2006).

In Israel, Josman et al. (2008) developed the VR environment "BusWorld" with the aim of using VR therapy to help individuals who had experienced terrorist bombings. To test the functionality of the system, they ran a pilot test with 30 healthy subjects and gradually exposed them to four levels containing a re-enacted attack. The psychotherapeutic treatment comprised of ten VR sessions of 90-120 minutes each.

There are several studies about using VR to treat patients suffering from PTSD as a result of wartime experiences. Rothbaum et al. (2001) examined the effectiveness of VR in a controlled study with 10 Vietnam veterans. The veterans were exposed to authentically recreated war scenes (e.g. flight over Vietnam accompanied by auditory and visual effects of rockets and explosions) in eight VR sessions. While they experienced a reduction in PTSD symptoms after the sessions, the intrusion-score increased after the 6-month catamnesis.

Gerardi et al. (2008) tested the environment "Virtual Iraq" in a single case study of a 29-year-old soldier who had spent a year-long tour in Iraq. He was exposed to "Virtual Iraq" in four sessions of 90 minutes each; the exposure included olfactory elements (e.g. the smell of burnt rubber).

Fig. 5. „BusWorld“ (source: research.haifa.ac.il)

Overall these study designs give rise to ethical concerns. Exposing Vietnam veterans suffering from severe PTSD symptoms to authentically recreated war scenarios or exposing witnesses of the 9/11 attacks to the same, dramatic virtual situation is a form of exposure that is contra-indicated as far as current research on trauma therapy is concerned. Several phases (i.a. stabilization, developing a therapeutic relationship, resolution of the traumatic memory, where the course of the traumatic situation is outlined and thus encapsulated) must precede re-experiencing and processing the traumatic experience (comp. Fischer, 2000; 2007). None of these phases were considered in the studies referred to here. Therefore, the risk of re-traumatization in VR exposure therapy is higher than the likelihood of successful processing of the traumatic experience. (For more critical issues, e.g. risk of renewed traumatization because the presented stimuli do not exactly depict the traumatic situation that the patient experienced, see Wagner & Maercker, 2009). At the same time, VR can be used to educate health professionals about recognizing symptoms by practicing adequate negotiation using a simulated case (see Kenny et al., 2008).

4. Conclusion

First studies show that virtual realities are an effective instrument within behavior therapy treatment of anxiety disorders. There are no indications that VR treatment of fear of heights and fear of flying, for example, are less effective than traditional in-vivo exposure therapy. Meanwhile several aspects that are immanent to a VR setting seem to accommodate some patients, for example in their willingness to be exposed to anxiety-provoking stimuli in the first place. There are also advantages to therapists that are summarized in Table 1.

At the same time, however, VR applications hold a number of restrictions and disadvantages for patients because of the risk of new or re-traumatization and ethical considerations and to therapists because VR technology requires technical equipment and the familiarization with this equipment.

Possibilities	Limitations / Risks
For the patient • Increased willingness to be confronted with the anxiety-provoking stimuli (increased subjective perception of safety and control over the presented stimuli) in the first place • A more private atmosphere, lower logistic and financial expenditure (fear of flying) • For patients with limited ability to visualize: VR aids the imagination of the anxiety-provoking situation	**For / To the patient** • „Simulator sickness" • Risk of new traumatization if the specific VR does not reflect the patient's traumatic situation accurately • Risk of re-traumatization if certain phases (i.a. stabilization) do not precede re-experiencing and processing the traumatic experience • Habituation to war and violence: Ethics?!
For the therapist • Exposure is possible in the practice • Possibility of subtler graduation in progression and intensity • In training: learning by simulated cases	**For / To the therapist** • Technology-based treatment: interference-prone • Acquisition is expensive • Training is necessary

Table 1. Advantages and disadvantages of using VR in psychotherapy

Overall, the results at hand are definitely in need of additional data if they are to be considered validated and differential evidence of the effectiveness of VR. The number of studies and random samples is too small to make general statements; moreover, they have pilot study character. In addition, long-term catamneses are missing. Examining personality variables (e.g. attitude towards technology, comprehension of reality and identity, ability to visualize) as possible moderators in order to develop criteria for the *intra- and inter-individual integration* of VR in psychotherapy is advised. With the integration of any kind of media application in therapy, the effects on therapist and patient variables as well as the effects on the therapeutic relationship should be examined.

VR exposure should be seen as a media reception, where the individual experiencing it plays an active and constructive role. The presented stimuli are processed on a cognitive level and assembled to a mental model that is linked to memories and conceptions. Hence, the research results of perception and media psychology are important fundaments in the further development of VR therapy settings. One prerequisite for the effectiveness of VR treatments is that the virtual world has to reflect the real world in a way that enables coherent cognitive and emotional processing. This means that the presentations of VR worlds are enhanced to provide ideal visual, auditory, and tactile stimuli. The VR applications so far have been prototypes. They have not been widespread enough, nor has the technical equipment involved been affordable enough so that VR could be used by behavioral therapists in regular practices to benefit their patients.

Although VR exposure therapy is the traditional domain of behavior therapy, *psychodynamic therapy* has been expanded with the conceptual integration of media-based interventions and training techniques. For an in depth report, refer to Eichenberg (2007). This reference states that media can also be integrated in psychodynamic therapies as long as the primacy “establishment of a relationship comes before technology” is ensured. (For an example see the integration of the self-help book “New ways out of trauma” [Fischer, 2005] in psychodynamic trauma therapies (refer to Angenendt, 2003).

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Virtual Reality

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Technological advancement in graphics and other human motion tracking hardware has promoted pushing "virtual reality" closer to "reality" and thus usage of virtual reality has been extended to various fields. The most typical fields for the application of virtual reality are medicine and engineering. The reviews in this book describe the latest virtual reality-related knowledge in these two fields such as: advanced human-computer interaction and virtual reality technologies, evaluation tools for cognition and behavior, medical and surgical treatment, neuroscience and neuro-rehabilitation, assistant tools for overcoming mental illnesses, educational and industrial uses In addition, the considerations for virtual worlds in human society are discussed. This book will serve as a state-of-the-art resource for researchers who are interested in developing a beneficial technology for human society.

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