The Use of Virtual Reality in Psychotherapy for Anxiety Disorders

The State-of-the-Art and the Evaluation of its Effectiveness

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Abstract

Cognitive behavioural therapy supported by virtual reality (VR) technology has become an increasing field of research in the treatment anxiety disorders. The exposure of individuals to anxiety-provoking virtual stimuli induces reduction of fear behaviour. Significant decreases of pathological fear have been found in studies on agoraphobia with and without panic disorder, specific phobias, social phobia, and post-traumatic stress disorder. The text at hand provides a comprehensive review on the current research literature and addresses the issue whether VR-based therapy's effectiveness is sufficient for a broad implementation in practice. Furthermore, the pros and cons of VR-based therapy are weighted up and the shortcomings of present research are discussed. Ultimately, a prospect on the future of VR-based therapy is taken into account.

Keywords: virtual reality, psychotherapy, anxiety disorders

Content

Introduction

Virtual reality (VR) is a new mode in the field of human-computer interaction leaving behind simple screen presentations. Individuals are no longer mere observer but rather actively involved in a computer-generated virtual environment (VE) in form of operating different devices and performing tasks (Mühlberger & Pauli, 2011). In the context of psychotherapy, VR provides the opportunity to simulate both different and difficult to design real-world environments and situations, respectively. In this connection, VR-based therapy serves as a substitute for psychotherapies requiring contact with real-world stimuli (e.g. handling real spiders) since exposure in vivo has become apparent to be an insurmountable obstacle for some individuals (Bohil, Alicea, & Biocca, 2011). In a Delphi poll that addressed the future of psychotherapy, 70 experts predicted an increase in the use of VR for therapeutic interventions (Norcross, Pfund, & Prochaska, 2013). This estimate is largely due to a series of advantages by using VR technology in psychotherapy, such as the regulation of the degree of exposure in therapeutic scenarios (Price, Mehta, Tone, & Anderson, 2011), or the possibility to adapt the VEs to the patients' needs (Bohil et al., 2011). Undoubtedly, a major part of the VR-based therapy's acknowledgement is that it has been reported to be highly cost effective and every bit as successful as the gold-standard therapy exposure in vivo (North, North, & Coble, 1997; Powers & Emmelkamp, 2008).

The effectiveness of VR-based therapy has been recorded for a couple of psychological conditions, particularly for a variety of anxiety disorders such as a agoraphobia with and without panic disorder (Castro et al., 2014; Meyerbroeker, Morina, Kerkhof, & Emmelkamp, 2013), specific phobias (Emmelkamp et al., 2002; Rothbaum, Hodges, Smith, Lee, & Price, 2000), and post-traumatic stress disorder (Difede et al., 2007).

Although the efficacy of VR-based therapy has been demonstrated, some authors challenge its benefits in comparison with traditional therapeutic approaches, regarding both

its effectiveness and its economical advantages (e.g., Meyerbröker & Emmelkamp, 2010). An underexplored realm in VR-based therapies shows up on the subject of the fidelity level needed in VEs. To date, research is stuck for an answer on the relationship between the "realness" factor in VEs and treatment outcome.

Considering the high lifetime prevalence of anxiety disorders, their high comorbidity rates, and the massive impairments they entail (Kroenke et al., 2007), therapy alternatives are required to be effective in both economic and treatment respects. The objectives of this thesis is to provide a comprehensive overview about the state-of-the-art of VR-based therapy in anxiety disorders, to ascertain its success, as well as to evaluate its suitability as an alternative to traditional in vivo psychotherapies. Hence, this thesis addresses the question whether treating pathological fear with assistance of virtual means is effective and whether it is a promising approach for the wider public. Additionally, the requirements for a prosperous VR-based therapy will be examined and discussed.

Last but not least, this thesis will look at the future prospects of VR-based therapy and will briefly compare them to augmented reality approaches that might present a better therapy option in the future. Conclusively, the application of VR-based therapy for other mental disorders will be briefly explored and discussed.

Virtual Reality

As an application field in computer and information technology, VR is defined as a sophisticated human-computer interface that creates an authentic simulation analogous to reality (Bohil et al., 2011; Schultheis & Rizzo, 2001). The user interacts actively and in real-time within an immersive[1] computer-generated three-dimensional environment (Bohil et al., 2011). The basic equipment consists either of a head-mounted display (HMD) (figure 1.) or a computer automatic virtual environment (CAVE) (figure 2.). In advanced VR systems, devices such as synchronized tracking systems, earphones, gesture-sensing gloves, scent machines, and haptic-feedback devices are employed in order to enhance the liveliness of VEs (Bordnick, Carter, & Traylor, 2011; Busscher, de Vliegher, Ling, & Brinkman, 2011). Especially tracking devices that enable to run user's real-world body movments consistently in the VE (i.e., the viewing direction in the VE changes in accordance with the user's actual head and body movement), and the incorporation of sound effects relating to the user's position in a VE, are of particular importance for the virtual experience (Schultheis & Rizzo, 2001). However, vital to the success of VR systems is the credibility of the perceived (virtual) reality, called "sense of presence".

The Sense of Presence

The sense of presence depends on several components of which two are of primary character: immersion and interaction (e.g., touching and moving objects in real time in a artificial environment). Presence is understood as a psychological condition, that is the perception of being engaged with a virtual stimuli, or better still, of actually being physically situated in a VE in place of the real world (Bohil et al., 2011; Gorini, Griez, Petrova, & Riva,

[1] Immersion refers to the number of senses stimulated by technological means, the amount of interaction levels, as well as the scope and fidelity of the VE/stimulus and its receptivity to motor inputs.

2010). Although there is a widely held belief of a positive relationship between the sensory cognition of presence, emotional response, and therapy outcome, literature brings forth contradictory statements (Price & Anderson, 2007).

Recently, Kim, Rosenthal, Zielinski, and Brady (2014) compared different VR systems (Desktop PC without HMD, Desktop PC with HMD, and a 6-wall fully immersive CAVE), aiming to detect which device elicits the highest level of presence. Their findings reveal that more advanced VR systems (i.e., from Desktop PC to CAVE) result in a higher sense of presence. However, according to Krijn et al. (2004), either the application of HMDs (lower sense of presence) or CAVEs (higher sense of presence) differs in effect upon treatment response. Taking the considerable higher costs of a CAVE system into account, Rothbaum et al. (2006) suggest that HMDs are sufficient in engaging people into VR.

Figure 1. HMD. Retrieved October 18, 2014 from http://www.worldviz.com/products/head-mounted-displays

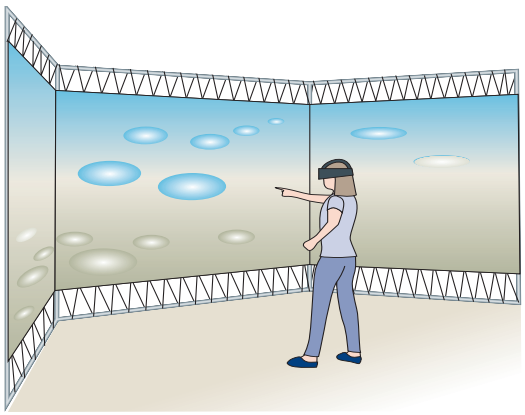

Figure 2. CAVE. Bohil et al. (2011)

Busscher et. al., (2011) followed this drift, suggesting that only a certain level of presence is necessary in order to achieve positive therapy outcomes. According to Price and Anderson (2007) a direct relationship between presence and therapy outcome does not exist. However, they imply that presence is conducive to therapy outcome in so far as it contributes in

eliciting an emotional response during the exposure. Therefore, they deduced that presence may be a necessary but not a sufficient condition for positive therapy outcome.

Yet, the latest research gives evidence to assume that presence may be related to therapy outcome, as its results reveal that high level of presence provokes higher level of anxiety (Kim et al., 2014).

Nevertheless, it should be noted that evolving a sense of presence can differ among individuals. Accordingly, Price and Anderson (2007) suggested that highly phobic individuals experience higher levels of presence than those with an initially low level.

Virtual Reality-Based Therapy and its Theoretical Framework

For clarification it seems important to take a quick look at the terminology before elaborating on specific treatment components. Literature yields a great deal of terms for psychotherapy and rehabilitation using VR technologies (e.g., Virtual Reality Exposure Therapy, Virtual Reality Exposure, Experiential Cognitive Therapy, CBT plus VR Exposure Therapy, etc.). Therefore, Levac & Galvin (2013) suggested to apply "VR-based therapy" on the grounds that VR systems are tools, and not therapy itself. The therapeutic approach within VR-based therapy is almost exclusively Cognitive Behavioural Therapy (CBT).

In virtue of its demonstrated efficacy, CBT-based exposure in vivo is the most frequently applied psychotherapeutic approach amongst all anxiety disorders (Hofmann & Smits, 2008; Mühlberger & Pauli, 2011). Characteristic is the systematic exposure to an external (e.g., heights) or internal (e.g., fear of evaluation by others) feared stimuli that leads on to habituation and, eventually, to extinction of the pathological behaviour (Carvalho, Freire, & Nardi, 2010). The underlying principle is rooted in the model of emotional processing of fear (Foa & Kozak, 1986). Based on the assumption that fear settles down in memory structures that pave the way for fear behaviour, and that change occurs by altering

these structures, Foa and Kozak (1986) proposed the concept of systematic desensitization for the decrease of pathological fear. At first, the fear network must be activated through exposure to the anxiety-provoking stimulus. In the next step, concurrently cognitive and affective new information needs to be integrated into the original memory structure, in order to achieve an emotional change and thereby reducing fear behaviour. In particular, the fear eases through prolonged or repeated exposures, causing its full disappearance. On that account, CBT, assisted by VR devices, has emerged as a particularly suitable technique in treating anxiety disorders, as it can substitute real stimuli or situations (Riva, 2005). Nevertheless, VR-based therapy only serves as an intermediate stage (Coelho, Waters, Hine, & Wallis, 2009), since the incentive of VR-based therapy is to become inured to the real fear-evoking stimuli. Hence, exposure in vivo is, if possible, suggested as the ultimate objective (Rothbaum et al., 2000).

Commonly, VR-based therapy and exposure in vivo therapies do not differ in terms of therapy content during the first couple of sessions, meaning that all individuals receive the same treatment at the beginning. This ranges from psychoeducational sessions that may be composed of an introduction in relaxation training and of explaining the rationales behind the therapy (e.g., Difede et al., 2007; Marco, Perpiñá, & Botella, 2013), to trauma interview and training in breathing techniques (e.g., McLay et al., 2012), to anxiety management techniques, thought stop technique, and cognitive restructuring (e.g., Rothbaum et al., 2006). Some studies even contain a relapse prevention session at the end of the therapy (e.g., Botella et al., 2007).

Virtual Reality-Based Therapy in Anxiety Disorders

Most empirical evidence for VR in psychotherapy is documented in the field of anxiety disorders (ADs) (Riva, 2005). Distinctive for ADs (aside from post-traumatic stress disorder) is the lack of real danger, yet still individuals feel a disproportionate fear followed

by avoidance of a situation or a specific object (Olatunji, Cisler, & Deacon, 2010). The following overview presents the current stage of research in the treatment of anxiety disorders using VR. For an overview of all studies included see table 1.

Agoraphobia (with and without Panic Disorder)

Exposure to anxiety evoking situations is considered to be highly prolific in treating agoraphobic avoidance behaviour (Carvalho et al., 2010). However, the complexity of agoraphobia combined with panic disorder calls for focus on both agoraphobic avoidance behaviour and panic (Meyerbroeker et al., 2013), which can be addressed through VR-based therapy (Meyerbröker & Emmelkamp, 2010).

In the most recent randomized clinical trial (RCT) on agoraphobia with and without panic disorder conducted by Castro et al. (2014), three experimental conditions (VR-based + medication, N = 30; CBT + medication, N = 30; medication only, N = 20) were compared. In each condition 11 individual therapy sessions were accomplished, of which the first three were almost identical. The VR included VEs such as an airport building and a plane, a square and a street, and an elevator. Participants were presented to the four agoraphobic situations that were the most stimulating. They were wearing HMDs in order to experience the projected videos in 3D on a 2.5m x 2m screen and they were able to interact with the VE through a wireless joystick. In line with expectations, the VR condition and the CBT (in vivo) condition were statistically superior to the control group (medication only) on every variables measured. In contrast, the analysis of the post-treatment and 6-months follow-up data reveals salient differences between the two test conditions. The CBT therapy obtained better scores in post-treatment throughout all variables compared to the VR-based therapy, whereas the outcome was exactly the opposite at the 6-month follow-up assessment.

Combining all effects VR-based therapy turned out to achieve greater clinical significance[2]. However, the results did not differ statistically significant. The researcher reasoned that the difference in clinical efficacy stemmed from the fact that in the VR participants could adapt gradually to the feared stimuli. Contrary to medication coupled with psychotherapy, no decreases of agoraphobic symptoms were found in medication (paroxetine and venlafaxine) alone. However, the two treatment conditions have to be interpreted carefully due to the interaction of psychotropic drugs and psychotherapy. Therefore, an independent conclusion about their role cannot be drawn. In matter of fact, the results only allow an interpretation of the factor therapy as a role of its interaction with medication (Castro et al., 2014).

In another RCT with agoraphobic patients (N = 55), the outcomes of VR-based therapy, exposure in vivo, and a waiting list (WL) control, were compared. The 10-session treatment included either real world viewing of public places such as supermarkets, shopping malls, or public transportation. The artificial world, produced either by HMD or CAVE, also contained numerous places of that kind, in which the crowdedness was gradually increased in order to offer a platform to acclimatise. The study reveals that both of the active treatment conditions successfully reduced avoidance behaviour, panic anticipation, and fear of panic consequences as well as both developed better coping behaviours than the control group. No significant intergroup variation was detected but on panic disorder severity that showed a significant larger decline on behalf of in vivo therapy. Considering all measures VR-based therapy appears to be slightly inferior to the in vivo exposure therapy regarding its effectiveness (Meyerbroeker et al., 2013).

In a RCT conducted by Botella et al. (2007), in vivo exposure and VR-based therapy yielded analogically successful results in people meeting the DSM-IV criteria for

[2] Clinical significance refers to symptoms reduction from pre-treatment to post-treatment/follow-up, lying between 30% (Garcia-Palacios et al., 2002) and. 50% (Castro et al., 2014) in minimum.

agoraphobia with panic disorder. Moreover, the 12-month follow-up findings give evidence for long-term efficacy of VR-based therapy in agoraphobia with panic disorder.

Specific Phobias: Arachnophobia

Garcia-Palacios, Hoffman, Carlin, Furness III, and Botella (2002) were the first authors who compared the outcomes of a controlled study concerning spider phobia. VR-based therapy (N = 12) produced clinically and statistically improvements on all objective and subjective tests, whereas the data of the control group (N = 11) remained unchanged across all measures.

In addition to the VR condition and the control group, Michaliszyn, Marchand, Bouchard, Martel, and Poirier-Bisson (2010), included an exposure in vivo condition into their study design. Eight 90-minute treatment sessions for all participants (all fulfilling diagnose for Specific Phobia Animal Type of DSM-IV) were conducted, no matter whether they belonged to the VR group (N = 16) or the in vivo condition (N = 16). The only difference was the type of gradual exposure within the groups in sessions 2 to 7. Participants of the virtual exposure were faced with a large black-widow spider. In vivo exposure included contact with two real spiders. Both subjectively and objectively gathered data showed significant relieve in anxiety in both groups. However, exposure in vivo performed slightly better even though not significantly, and findings remained stable at 3-months follow-up. A decisive limitation in this study may be the absence of tactile augmentation in the VR. Thus, it may explain to a certain degree the superior power of the in vivo condition.

Specific Phobias: Fear of Flying (FOF)

The first RCT in FOF traces back to Rothbaum et al. (2000). They compared the effectiveness of VR exposure and exposure in vivo against a WL control group. The participants' self-reports revealed virtually identical outcomes in the two forms of therapy,

and superiority with respect to the control group. It bears mentioning that the vast majority of the WL would have chosen the VR-based therapy, if they were to decide on a treatment approach.

Based on this previous trial, Rothbaum and collegues published a revised and more comprehensive study in 2006. Each group compromised 25 randomly assigned individuals, all of whom finished eight treatment sessions. Subsequently, the WL control was allocated either to VR-based therapy or to exposure in vivo, meaning that VR-based therapy was given to 36 and exposure in vivo to 37 people, respectively. During the VR sessions a successive approximation to increasingly fear-evoking moments (e.g., check-in, sitting at the window seat, plane takes off, different weather conditions, etc.; see figure 3.) were realised. In contrast, the exposure in vivo therapy included typical procedures at the airport, such as the check-in procedure and being at the waiting area. After completion of all sessions participants were asked to take a plane within two weeks after the end of the treatment. In the WL group only 20% could follow the therapist's instruction, whereas in both active treatment groups the equal number of participants (76%) were able to make a two-hour flight. Results have shown similar effectiveness for VR-based therapy and exposure in vivo, persisting at 6- and 12-months follow up (Rothbaum et al., 2006).

Figure 3. Left: Illustration of a virtual check-in. Right: the inside view of a virtual plane. Retrieved October 18, 2014 from: http://ii.tudelft.nl/vret/index.php/Fear_of_Flying

Specific Phobias: Acrophobia

People suffering from fear of heights experience severe impairments, as they have to avoid a number of places such as elevators, planes, and bridges. Even offices and flats in high buildings may pose a insurmountable obstacle (Coelho et al., 2009).

In 2002, Emmelkamp et al. examined the impact on treatmeant outcomes of three sessions either of VR-based therapy (N = 17), or of exposure in vivo (N = 16), using a Behavioral Avoidance Test (BAT). The VE was an exact replica of the environment used in the in vivo condition, that is a multi-storey mall with escalators and balustrades, a fire escape, and a rooftop garden. The results revealed that VR exposure is every bit as effective as exposure in vivo for people diagnosed with acrophobia. Moreover, the results remained unchanged in a 6-months follow up assessment.

A clear weakness of the above-mentioned study is the absence of a control group. Therefore, Krijn et al. (2004) included a control group with acrophobic patients into their design. Although the main goal of the study was to compare the effectiveness of two different immersive systems, their results endorse previous findings on the treatment of acrophobia. Thus, the received data indicates statistical significance in favour of VR-based therapy for fear of heights.

Social Phobia

In treatments conducted with participants suffering from a specific phobia, priority is given to the fear-evoking stimuli/situation, while a multi-layered disorder such as social phobia requires a more elaborated approach. An inherent part of social phobia concerns the excessive fear of other people's judgment. As a consequence, it is crucial to address the evaluative part in the treatment of social anxiety, which can be achieved by employing group therapy. On the other hand, in vivo group therapy may be too demanding for those affected, therefore it does not present an option (Meyerbröker & Emmelkamp, 2010).

TABLE 1. Overview outcome studies VR-based therapy

Study	*N*	Clinical sample	Design	Condition (*N*)	Sessions	Post assessment	Follow-up
Agoraphobia							
Botella et at. (2007)	37	Agoraphobia	RCT	VRBT (*N* = 12) IVE (*N* = 12) WL control (*N* = 13)	9 9	VRBT = IVE[a] VRBT > WL[b] IVE > WL	12 months, stable
Castro et al. (2014)	80	Agoraphobia	RCT	VRBT + drug (*N* = 30) CBT + drug (*N* = 30) Drug alone (*N* = 20)	11 11	VRBT = CBT VRBT > drug CBT > drug	6 months, stable
Meyerbroeker et al. (2013)	55	Agoraphobia	RCT	VRBT (*N* = 19) EVI (*N* = 18) WL control (*N* = 18)	10 10	VRBT < EVI[c] VRBT > WL EVI > WL	No
Specific phobias							
Garcia-Palacios et al. (2002)	23	Arachnophobia	RCT	VRBT (*N* = 12) WL control (*N* = 11)	3-10	VRBT > WL	No
Michaliszyn et al. (2010)	43	Arachnophobia	RCT	VRBT (*N* = 16) In vivo exposure (*N* = 16) WL control (*N* = 11)	7-8 7-8	VRBT = In Vivo VRBT > WL In vivo > WL	3 months, stable
Rothbaum et al. (2000)	49	Fear of flying	RCT	VRBT (*N* = 15) Standard Exposure (*N* =15) WL control (*N* = 15)	8 8	VRBT = SE VRBT > WL SE > WL	6 and 12 months, stable
Rothbaum et al. (2006)	75	Fear of flying	RCT	VRBT (*N* = 25) Standard Exposure (*N* =25) WL control (*N* = 25)	8 8	VRBT = SE VRBT > WL SE > WL	6 and 12 months, stable
Emmelkamp et al. (2002)	33	Acrophobia	RCT	VRBT (*N* = 17) In vivo exposure (*N* = 16)	3 3	VRBT = In Vivo	6 months, stable
Krijn et al. (2004)	37	Acrophobia	RCT	VRBT: CAVE (*N* = 14) VRBT: HMD (*N* = 10) WL control (*N* = 10)	3 3	CAVE = HMD > WL	6 months, stable

Social phobia							
Anderson et. Al (2013)	97	Social phobia	RCT	VRBT (N = 30) EGT (N = 39) WL control (N = 28)	8 8	VRBT = EGT VRBT > WL EGT > WL	3 months, stable
PTSD							
Beck et al. (2007)	8	PTSD	Case series	VRBT (N = 6)	10	Significant pre-post improvements	No
Difede et al. (2007)	21	PTSD	Quasi-experimental design	VRBT (N = 13) WL control (N = 8)	Flexible up to 14	VRBT > WL	6 months, stable
McLay et al. (2011)	20	PTDS	RCT	VRBT (N = 10) TAU (N = 10)	4-20 NA	VRBT = TAU	No
McLay et al. (2012)	42	PTDS	Open label study	VRBT (N = 20)	4-15	Significant pre-post improvements	3 months, stable

[a]Treatment A is equally effective as treatment B.
[b]Treatment A has superior effectiveness to treatment B.
[c]Treatment A has inferior effectiveness to treatment B.
VRBT, virtual reality-based therapy; IVE, in vivo exposure; WL control, waiting list control; CBT, cognitive behavioural therapy; EVI, Exposure in vivo; EGT, exposure group therapy; TAU, treatment as usual.

As reference groups to the VR-based therapy (N = 30), Anderson et al. (2013) used an exposure group therapy (EGT) sample (N = 39) and WL controls (N= 28). Eligible were only participants meeting the DSM-IV-TR criteria for social phobia. The two randomly assigned active treatment groups completed eight sessions each and nothing but the modality of exposure differed, since the setting was the same (i.e., different locations with varying number of people being present). The virtual audience (also referred to as avatars) was able to show different reactions, such as signalling interest, boredom, support, distraction, or resentment. Moreover, the avatars could pose questions; either standardized or individually. The obtained results of this study did not show consistent patterns. For instance, VR-based therapy did not turn out to be more effective than the WL in self-reported fear of negative judgement that is regarded as a key aspect of social phobia. However, VR-based therapy and EGT improved broadly similar in almost every assessment (e.g., self-reported fear of public speaking). Yet, EGT achieved larger effect sizes and more people experienced remission in social phobia at 3-months follow-up, although this was not statistically significant. Conversely, but again not statistically significant, fewer people dropped out of VR-based therapy than of EGT.

Post-Traumatic Stress Disorder

Similarly to people suffering from specific phobias, post-traumatic stress disorder (PTSD) patients avoid anxiety-provoking stimuli. Still, they need to be faced with those in order to achieve treatment success (Difede et al., 2007). However, due to its nature it is evident that in multitude cases exposure in vivo therapy is hardly feasible, as a rape victim cannot be faced with the perpetrator or a combat veteran cannot be sent to a war zone for the sake of therapy (Beck, Palyo, Winer, Schwagler, & Ang, 2007).

A published RCT included current military members with a diagnosis of combat related PTSD showed clinically significant change for the better in VR-based therapy.

Participants (N = 10) assigned to the artificial modality were immersed into a VE (e.g., battlefield, base camp, Iraqi marketplace, attacked military convoy; see figure 4) that was closest to their own experienced trauma in Afghanistan or Iraq. Scenarios were supplied with war sounds to enhance the perception of reality. The graphics' quality is reported to be comparable to a high-quality, contemporary video game. Through observation of participants' physiological values, gradual intensification (e.g., increase of violence) could be initiated at the right time in order to reinforce the experience (McLay et al., 2011).

Figure 4. Virtual Iraq Exposure to treat PTSD. Retrieved October 18, 2014 from: http://www.virtuallybetter.com/virtual-iraq/

This study contained some limitations of which the uneven number of therapy sessions across and within the conditions is most notably. Moreover, the results of the reference group (N = 10) are hardly interpretable, since the patients were treated with a range of different traditional therapy approaches (e.g., cognitive processing therapy, Eye Movement Desensitization). Another point is that the post-assessments took place delayed in time (mean in weeks: VR = 13.6; traditional treatment = 16.9). Overall, these facts do not allow an adequate evaluation. However, with respect to its effectiveness, VR-based therapy tends to result in significantly greater improvement than traditional therapies in PTSD. A year later, McLay et al. (2012) confirmed their previous findings.

Research is not limited to combat related PTSD, but also employed to treat traumatized people such as those undergoing the WTC terror attacks in 2001 (Difede et al.,

2007). In this study the used VE represented the events of 9/11 accurate to reality. In order to prevent possible emotional overpowering, patients (N = 13) were exposed to 11 sequences, each containing a growing level of intensity (beginning with a plane flying over the WTC towers without collision, eventually coming to the scene when they actually crushed into them, using screaming and detonating sound effects too). Findings reveal clinically and statistically significant recovery for patients treated with VR exposure relative to the WL control group (N = 8). Results at the 6-month follow-up evaluation remained steady. Additionally, the authors derive from this study another important insight; they indicate that the repeatedly raised criticism about the restricted flexibility of VR simulations, as it could not represent all witnessed cues and therefore fail to engage patients, turned out to be unfounded. According to their analysis, even though their participants had substantial different experiences of 9/11, all of them scored high in the engagement variable. Shortcomings of this study were the quasi-experimental design, as well as it was not judged against the traditional treatment approach, exposure in vivo, for comparison (Difede et al., 2007).

Furthermore, the outcomes of uncontrolled case series (N = 6) on motor vehicle accident related PTSD encourage further research in this field, since the preliminary data of VR-based therapy appears to reduce PTSD symptoms significantly (Beck et al., 2007).

The Pros and Cons for Virtual Reality-Based Therapy

The above-listed studies give account about the effectiveness of VR-based therapy. In general, the presented outcomes showed to be equally beneficial in relation to the golden standard, exposure in vivo. The following two sections will illustrate pros and cons of this upcoming approach, going beyond the mere evaluation of its effectiveness.

Advantages

Psychotherapy delivered by immersive technologies in the manner of VR has some remarkable advantages when measured against in vivo psychotherapy.

According to Botella et al. (2007), a considerable number of patients face considerable difficulties once they are exposed to real feared stimuli. Presumably, this is due to the unpredictable nature of tangible stimuli or situations (e.g., animal's behaviour, flight turbulences) (Bouchard, Côté, St-Jacques, Robillard, & Renaud, 2006), or it is simply conceived as too daunting (Garcia-Palacios, Botella, Hoffman, & Fabregat, 2007). Conversely, Botella et al. (2007) highlight the opportunity of tailored systematic approximation to the anxiety evoking stimuli in VEs as well as the option to repeat the exposure as often as required. By implication, VR-based therapy offers a certain calculability of events, which leads to a higher willingness for participation. Additionally, due to obvious reasons it is common that in most cases exposure in vivo takes place outside of the therapist's bureau. This entails enormous amount of time, thus higher therapy costs. On the contrary, VR-based therapy can be performed within a standard session at a safe and familiar surrounding (Rothbaum et al., 2000). Certainly, the purchasing of VR systems is a costly business, but this issue will be addressed later.

Another favourable characteristic presented through VR is the widely stated benefit of additional control allowing the therapist to focus on monitoring the patient's behaviour, which in turn facilitates the therapist to intervene adequately, if necessary. Moreover, keeping the experimental variables under constant control engenders good internal and ecological validity (e.g., Gorini et al., 2010; Gutiérrez-Maldonado, Ferrer-García, Caqueo-Urízar, & Moreno, 2010).

Furthermore, several authors proclaim lower dropout rates in VR-based therapy as in vivo (e.g., Schultheis & Rizzo, 2001). This notion is validated through the findings of

Garcia-Palacios et al. (2007), which show VR treatment enjoys greater popularity among patients than exposure in vivo. Given the dropout rates of the studies discussed above, no salient contrasts can be found.

Castro et al. (2014) followed a different track by suggesting that the progressive exposure in VEs promises better effects in individuals' reprocessing (i.e. habituation) towards the critical stimuli than in vivo confrontation. Furthermore, they assume that in the light of all the individuals with long-term disorders who had run through a number of abortive in vivo treatments, VR-based therapy offers them a new prospect for therapy success.

In the past, some therapists applied imaginative exposure as an alternative to in vivo exposure. Yet, for some patients it caused difficulties to imagine the anxiety-provoking stimulus or situation in a way sufficient for therapy. In a comparative study between imaginative and VR exposure therapy, the VR-based therapy has proven to be the more beneficial approach (Wiederhold et al., 2002).

Disadvantages

This section is dedicated to the drawbacks of VR technology and its application in therapy. One issue appears when people fail to digest the synthetic stimuli while exposed to VE and as a consequence they do not evolve a sense presence (Rothbaum et al., 2000). Moreover, it is reported that some individuals indeed engage in the VE but do feel nauseous after being back in reality (Bohil, Alicea, & Biocca, 2011). This so-called cybersickness (or simulation sickness) is ascribed to the inconsistency between sensory inputs (e.g., the participant sees himself moving in the VE but does not receive any feedback of the vestibular organ) (Mühlberger & Pauli, 2011). In the worst case VR exposure would not be feasible, however Mühlberger and Pauli (2011) estimate this scenario to be highly unlikely.

VR-based therapy may be more cost-effective than in vivo therapy (see "advantages"), but on the reverse the acquisition costs of its devices are not cheap. Nevertheless, the apparatus prices have been plummeting sharply for the past few years. Going by Botella and collegues (2007), they costs came up to 150.000 euros in 1996, whereas they paid only about 6.000 euros for their newest equipment. Bouchard et al. (2006) refer to an amount around 10.000 $US, whereas Bohil and collegues (2011) maintain numbers ranging from 10'000 up to more than 100 thousand US dollars. This extreme disparity may originate from the wide range of devices with different levels of sophistication. Furthermore, researchers have to make huge efforts in order to develop and design a VE, which may end up being very pricey as well (Riva, 2005).

Discussion

Starting from the premise of CBT-based exposure in vivo's effectiveness, this paper is for the purpose of analysing the current state of research in psychotherapy extended through virtual reality technologies. Well-founded empirical results are available for the treatment of several anxiety disorders and all reviewed studies deliver impressive or promising results with regard to its effectiveness. However, the obtained findings are somewhat inconsistent, thus drawing an overall conclusion about its significance relative to standard interventions proves to be difficult. Specific phobias are by far the best examined disorders providing the most convincing results. They show either equal or better outcomes in comparison with in vivo therapy. The trials for agoraphobia came up with results neither favouring VR-based therapy, nor rejecting it. In social phobic individuals, outcomes redound to the benefit of exposure group therapy (in vivo) insignificantly. The PTSD research hold promise as it present the prospect of being at least an adequate alternative for in vivo therapy. Regardless of the encouraging findings, ample research has been conducted only for

specific phobias, whereas the other listed disorders require further experiments before being relevant in the field.

The meta-analysis by Powers and Emmelkamp (2008) generated marginal larger effect sizes for VR-based therapy compared toexposure in vivo in general. However, this superiority was achieved only through the compilation of all studies together, while such benefits did not stand out in single comparisons.

As a general remark it can be registered that with the exception of a few designs the studies consist of an insufficient number of participants. Further, only a few authors have been taken physiological measurements (e.g., heart rate, galvanic skin conductance) into account. Due to the fact that self-reported evaluations are vulnerable to distortion, a more objective acquisition of data is necessary. This estimation rests on the fact that exposure to negative cues cause stronger skin conductance reactions. In addition, physiological measurements may shed light on potential distinctions in the underlying physiological and cognitive processes during VR-based therapy and exposure in vivo therapy, respectively (Meyerbröker & Emmelkamp, 2010). As a major deficiency, some studies commented on do not include a BAT prior to therapy completion; hence it is questionable whether behaviour changed in a VE is also changed in reality. As a consequence, those results need to be treated with caution.

Another shortcoming is the lack of standardized protocols, thus, it is hardly identifiable to what extent the treatment outcomes have been the results of VR components; or whether they have to be attributed to the number of sessions, or the possibly varying content in psychoeducation and coping strategies. Future research may conduct comparative studies using different protocols in order to develop a generally valid therapy manual.

The issue at stake is whether the received results in VR-based therapy research are convincing enough to replace or to extend the present standard - in vivo therapy -

considering that the latter has been yielded a plethora of empirical research underlining its effectiveness. The answer to this questions goes beyond a simple yes or no, but rather over weighting up the pros and cons accurately. First of all, there has more research to be done to determining the relation between presence and anxiety on therapy outcome. The first and only useable study that tested this correlation dates back ten years; its findings implied no positive relation between presence and anxiety on treatment outcome. Judging from the fact that the field of computer and communication technology virtually produces innovations on a daily basis, the study of Krijn and colleagues (2004) is simply outdated. Moreover, the theoretical conjecture that a high degree of presence is connected positively with treatment outcome is still prevalent. This is plausible looking at the latest research, demonstrating that more advanced VR systems cause greater change in skin conductance during aversive exposure (Kim et al., 2014). In addition, findings of Price, Mehta, Tone, & Anderson (2011) imply that VE' authenticity is important for those with minor disorders, as otherwise they fail to dive into a virtual experience. Aside form that, Busscher et al. (2011) suggest that growing presence is followed by lower states of cybersickness and lower dropout rates. In sum, the question about the required level of sophistication of a VR system is not resolved yet, thus new research on the sense of presence's relevance is inevitable.

On top of that, research has neglected further important areas. On grounds of a systematic overview Lambert (1992) reckoned that across all approaches therapy effectiveness is reliant upon several impact levels, in particular, 30% Common Factors (alias Therapeutic Alliance); 40% Extratherapeutic Change; 15% Expectancy (placebo effects); and 15% Techniques. In view of these variables, quite a few factors are being omitted in current research on VR psychotherapy. First, none of the assessed studies incorporated the therapeutic alliance into their evaluation, although, the quality of the therapeutic relationship perceived from the patient's perspective is believed to be the best predictor for therapy

outcome and substantial for therapy success in general (Auckenthaler, 2012, S. 181-182). Second, VR embodies a virginally procedure that might lead to skyrocketing expectancies in patients. Ergo, placebo effects may have biased the obtained results in favour of VR-based therapy. Especially prone to that exaggerated expectations may be individuals suffering from a chronic disorder who went through a number of unsuccessful treatments before. Third, only a small percentage of therapy success appears to account to the therapeutic approach, thus there is a gap in research concerning the application of VR tools in different therapeutic approaches. Certainly, due to its exposure characteristic CBT is particularly suited for adding VR technologies into its scope. However, it is conceivable that for example Katathym Imaginative Psychotherapy, Hypnoanalysis, Psychodrama, or Gestalt Therapy may benefit from using VR, even if it is only as an element that gives an impetus to retrieve repressed memories.

Finally, recurring to the subject of virtual psychotherapy's surplus value as compared with traditional psychotherapy. Despite that the VR-based therapy has demonstrated its effectiveness in reducing pathological fear, and despite the indisputable fact that VR-based therapy can provide benefits at various levels, such as providing therapy access to a broader public, enhancing engagement motivation, gradual exposure, control over stimuli, repetition, behaviour monitoring, and less effort, a definite answer must await further research. Considering that the research work on VR-based therapy has started at the turn of the millennium, I argue that the preliminary findings are somewhat underwhelming, particularly with reference to neglected research on the sense of presence and as well the ignoring of well-recognised factors such as therapeutic alliance.

Conceivably, VR-based therapy may be pushed to the background before its implementation starts on a large scale. Augmented Reality (AR) has the potential to substitute VR's position in psychotherapy as it offers the same advantages at lower costs.

The application of VR requires the manufacture of a whole virtual scene, whereas AR only adds the fundamental virtual elements to the reality in which the individual can interact with the respective stimuli while seeing his own body. As chief difference to VR, AR does not situate the individuals to an artificial place, thus effects do not rely on the capability of generating a sense of presence (Baus & Bouchard, 2014). However, an imminent shift to the application of AR in psychotherapy is hardly to be expected. First, research on this subject is in its very early stages. Second, the research work that has been done so far may indeed show positive findings, but it is limited to spider phobias. This is largely because the technology for AR is not yet sophisticated enough, to address more complex disorders such as social phobia.

VR-based therapy is clearly best tested for anxiety disorders, yet the use of VR technology in psychotherapy has been examined for other mental disorders in recent years. Initial studies on VR-based therapy for addiction (Bordnick et al., 2011), schizophrenia (Park et al., 2011) and autism (Kandalaft, Didehbani, Krawczyk, Allen, & Chapman, 2013) have shown encouraging outcomes, thus future research on these subjects is suggested. But, primarily in eating disorders some systematic and controlled research has been done (e.g., Marco et al., 2013). This may be due to the assumed proximity of anxiety disorders and eating disorders, as they probably underlie mutual cognitive avoidance strategies such as blocking out the felt anxiety through destructive behaviours (Pallister & Waller, 2008). However, VR-based therapy in eating disorders is still in its infancy and an universal statement about its effectiveness would be premature, even though a comparison between VR-based therapy and exposure in vivo yielded slightly better outcomes on the virtual approach's behalf (Cesa et al., 2013).

In sum, a number of studies give evidence that pathological fear can be reduced through VR-based therapy. Further, research literature implies equal therapy effectiveness

between VR-based therapy and exposure in vivo psychotherapy. However, only on the subject of specific phobias enough convincing results haven been obtained in order to declare VR-based therapy as an alternative routine method to traditional in vivo psychotherapy.

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