

Virtual reality and anxiety: a preliminary review of current research in psychology

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Abstract. The purpose of this review is to present some studies existing in the literature that show that patients that experience anxiety in real-life situations can obtain advantages through virtual reality, as alternative form of cognitive, emotional and behavioural exposition.

After a brief introduction, we will proceed to an analysis of the scientific contributions concerning virtual reality-based interventions. Google Scholar employed to search studies on this topic from 1992 through 2019. Studies were eligible if the article: (a) concerned subjects with anxiety disorders; (b) showed the effects of VR exposure therapy for anxiety treatment; (c) employed the use of immersive VR only, keeping out not-immersive VR; (d) was published in English; (e) referred to randomized controlled trials (RCTs). Overall, six studies met the eligibility criteria.

The benefits of VR have been largely acknowledged and VRE is revealing effective resources in different fields of psychology and health-related disciplines. However, existing evidence is insufficient because of the paucity of studies and lack of high-quality research designs. In the future, studies may build upon these limitations to extend virtual reality-based interventions into clinical settings.

Keywords¹: Virtual reality, Anxiety, Psychology, Mental health, Human-Computer interaction.

1. Introduction

The term anxiety is used to define a series of cognitive, behavioral and physiological reactions in response to the perception of a situation or stimulus considered dangerous.

Anxiety also includes a number of specific disorders, such as generalized anxiety disorder, separation anxiety disorder, selective mutism, specific phobias, social anxiety disorder, panic disorder, anxiety disorder drug or substance induced, or due to another medical condition [1].

Pathological anxiety is associated with three or more of the following symptoms, some of which must be present for a duration of about six months: restlessness or feeling tense; difficulty concentrating or memory lapses; irritability; easy fatigue; muscle tension; sleep disturbances (difficulty falling or staying asleep, or restless and unsatisfactory sleep).

Anxiety becomes pathological when it significantly affects the individual's quality of life, manifesting itself frequently, in inappropriate moments, and disproportionately to the real threat posed by the situation.

However, when anxiety does not become a disorder, it performs an adaptive function. Adaptive anxiety allows the individual to implement functional behavior in response to a situation that generates tension [2].

Regarding virtual Reality is a technology which simulates real environments through the usage of technological tools and interfaces: «the term “Virtual Reality” (VR) has been used historically to describe 3-D environment displays with which participants can interact in pseudo-real time, though many prefer terms such as VET (Virtual Environment Technology) or VEs (Virtual Environments) which avoid assumptions about the replacement of true reality with an alternative simulated reality» [3].

In Psychology, Virtual Reality systems consist of a set of computing devices enabling a new kind of Human-Computer Interaction [4,5]. Human-Computer Interaction (HCI) is a field based in the design and the use of computer technology, which focuses on the interfaces between people (users) and computers. HCI researchers observe the ways humans interact with computers, and they design technologies that let humans interact with computers in novel ways.

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VR emerged in the 1960s and shortly after it became an effective resource in psychology [6]. The opportunity to constantly alter details of the virtual environment helps researchers to conduct different studies ignoring limitations from the real world [7].

In the past few decades, the development of technology has promoted the spread of visors, augmented displays, avatars and serious games: researchers distinguish displays according to the sensory channel they stimulate; they are visual displays as well as auditory or tactile. Currently visual displays represent the dominant sensory stimulation channel in VR systems because sight is the sensory function on which most of our conscious actions are based. It is also the sense organ more represented in the brain, too. The most used visual devices in VR systems are virtual helmets and augmented reality glasses [8].

Avatars are believable agents generated by a computer program. Two types of virtual avatar can be programmed into VEs: first, the avatar which represents the participant (the controller, who operates the viewpoint and navigates within the VE), and second, an independent virtual avatar with specific personality traits that behaves in a certain way [3].

VR is usually described as a particular collection of technological hardware and software. However, it is also possible to describe it in terms of human experience, using the concept of presence [4]: VR is the medium able to induce the experience of “presence” in a computer-generated world. Presence is usually defined as the “sense of being there”, or as the “feeling of being in a world that exists outside the self” [9]. Different studies showed a direct connection between the intensity of the emotions experienced in VR and the level of presence elicited by it [10]. The marked similarity between the virtual experience and the real one has led to the realisation of interventions based on virtual reality for the treatment of mental disorders. The purpose of this literature review was to identify papers examining the effectiveness of using virtual reality in anxiety disorders.

2. Application of virtual reality in psychology

For over two decades, virtual reality interventions have been used in the management of acute pain related to health interventions [11] and, more recently, virtual reality-based interventions have also been used for chronic pain management [12]. Huber [13] highlighted that using VEs in “*clinical cyber psychology*” is beneficial because a high level of control can be exerted over stimulus presentation and patient interactivity.

Moreover, virtual reality is an effective clinical tool. Indeed, for over 15 years, virtual reality has played a role in the assessment and treatment of addictive disorders [14] and mental disorders. In fact, in the case of body image disturbances [15], virtual reality can improve the body image. Whereas concerning eating and weight disorders, treatment with VR promotes the ability to regulate emotions [16,17], reduces hunger and above all decreases diet-related anxiety during and after the virtual food exhibition.

In particular, Ferrer-Garcia et al. [18] have shown at long-term follow-ups that VR had a higher efficacy in treating eating disorders and obesity than cognitive behavioral therapy (CBT). Since 1996 VR has been used in the assessment and treatment of autistic children [19].

Specifically, VR social simulations are able to replicate real-life events in order to improve social skills, non-verbal communication and emotional skills in autistic children, helping them in the management of different scenarios in a gradual way [20,21]. In the past decade, VR applications were used also for rehabilitation medicine and behavioral medicine. A particular form of VR therapy, called VR exposure therapy (VRET), may enhance psychological and medical functions, promoting improved mental and physical health [22].

2.1 Virtual reality-based interventions to treat anxiety disorders

Virtual reality is also used to treat obsessive-compulsive disorder, post-traumatic stress disorder (PTSD), panic disorder (PD), specific phobias, and social anxiety disorder (SAD). Through the VR experience, it is easier for the therapist to demonstrate to the patient that what looks like a fact is a result of his/her mind. Although exposure-based treatments for anxiety disorders are very effective, many patients are reticent to this type of exposure, but it has been seen that they are much more likely to undergo an exposure through virtual reality [23].

The results of research on VR-based techniques for treatment of anxiety largely suggest that VRE is associated with large declines in anxiety symptoms and behavioral change [24]. Furthermore, not only does it have a powerful impact on people's real life, but the benefits obtained from the treatment are maintained over time [25]. Even for specific phobias, such as acrophobia [26,27] arachnophobia [28,29] and fear of driving [30], VRE not only decreases time required for treatment but is found to be particularly effective for patients with whom in vivo treatment may not be safe or feasible. Moreover VR graded exposure therapy is a valid

alternative to typical imaginal exposure treatment for Vietnam combat veterans with posttraumatic stress disorder (PTSD). Indeed, after treatment, acute symptoms of PTSD reduced and the patients could remember what happened to them with much greater detail, without the same degree of associated terror[31].

Regarding generalized anxiety disorder (GAD), there are few studies examining the use of virtual reality for its treatment [32] and this may be due to the difficulty in recreating scenarios about the worries of patients with GAD.

Concerning social anxiety disorder, some studies through the reconstruction of a virtual room populated by an audience of avatars in front of the speaker, have shown that a virtual reality exposure therapy was effective in decreasing the anxiety of public speaking[33,34].

However, most studies on the efficacy of VRE for the treatment of social anxiety in comparison with exposure in vivo have been conducted with a combination of cognitive interventions and VRE, not considering the possible effect of a stand-alone virtual reality exposure intervention .

Infact, only a randomized controlled trial investigated the efficacy of a stand-alone virtual reality exposure intervention in individuals with social anxiety disorder including virtual verbal interaction, it showed a better decrease in social anxiety symptoms at follow-up assessments in the in vivo exposure condition compared to the virtual reality condition. Although virtual reality exposure therapy effectively reduced anxiety and avoidance in social situations, it did not significantly reduce fear of negative evaluation and so the VRE as a stand-alone treatment is effective, and can successfully be applied for treatment purposes in individuals with SAD[35]

3. Method

We considered the available literature on the effectiveness of virtual reality in treating a wide range of psychiatric disorders with a specific focus on anxiety disorders.

The search strategy was devised by examining the literature for indexed keywords in published journal articles: “virtual reality” alone and in association with “psychology”, “ treatment” and “anxiety”. These words were searched for as keywords, title and abstract.

The overall methodology followed can be divided into two phases:

1) literature search using the Google Scholar digital scientific library and the documents published between 1992 and 2019 were chosen.

2) selection of relevant works, i.e., the most frequently cited and recently published articles in the sector.

The literature search was conducted independently by the co-authors. All potential articles were held in full text and archived in a shared folder, after which each reviewed each article independently to ensure they included only relevant articles.

3.1 Eligibility criteria

Studies that meet the following inclusion criteria were selected for our review: (a) subjects with anxiety disorders; (b) effects of VR exposure therapy for anxiety treatment; (c) employed the use of immersive VR only; (d) published in English; (e) referred to randomized controlled trials (RCTs). Overall, six articles met eligibility criteria (see Table 1).

Table 1
Studies list

| Articles | Anxiety Disorder | Design | Conclusions | Limitations |
|------------------------|------------------|--|--|---|
| Rothbaum et al. (1995) | Acrophobia | The VR graded exposure (VRGE) was conducted in five sessions over three weeks. The subject was in a virtual elevator, was encouraged to spend as much time at each “floor” as needed for his anxiety to decrease and was | VRGE was effective in reducing self-reported anxiety and avoidance of heights. | Limited generalizability and the absence of follow-up data. |

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|-------------------------------|----------------|---|---|--|
| | | allowed to progress at his own pace. | | |
| Garcia-Palacios et al. (2002) | Spider Phobia | The treatment was composed of gradual exposure tasks. There was no fixed number of sessions. In the first sessions, participants saw a virtual spider in a virtual kitchen and approached as closely as they could. The virtual spider responded to being touched by fleeing. | VR exposure with tactile augmentation significantly reduced fear and avoidance of spiders after an average of four, one-hour VR therapy sessions. | The sample was relatively small and a follow-up evaluation was not included |
| Krijn et al. (2004) | Acrophobia | Treatment consisted of three sessions of 1.5 h. In each session the patient was exposed to the virtual environment(s) for 1 h which were gradually presented: a shopping mall with four floors, a fire escape with six floors in open space, a roof garden on a building and a virtual building site with eight floors. Results of VRET were comparable with those of exposure in vivo. | VRET was found to be as effective as exposure in vivo. | The sample is too small and the sessions are too few to see a real effect of VRET's effectiveness on fear of heights |
| Michaliszyn et al. (2010) | Spider Phobia | Via randomized, controlled clinical trial, Eight of 90-minute treatment sessions were planned which consisted of gradual exposure tasks and cognitive restructuring. | The study demonstrated significant decrease of fear after eight 90-minute treatment sessions. | This study did not include physiological measures such as heart rate and skin conductance. |
| Anderson et al. (2013) | Social Anxiety | Participants with a principal diagnosis of social anxiety disorder who identified public speaking as their primary fear were recruited and were randomly assigned : a virtual reality exposure therapy, exposure group therapy, or wait list. | Virtual reality exposure therapy is equally effective as exposure group therapy | Research with a larger sample is needed to better underline differences between the treatments. |
| Kampmann et al. (2016) | Social Anxiety | A randomized controlled trial investigated the efficacy of a stand-alone virtual reality exposure intervention in individuals with social anxiety disorder. | The participants receiving individual in vivo exposure therapy and those who received virtual reality exposure therapy | Two limitations are present in this study. First, the absence of homework exercises which are an integral part of exposure |

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|--|---|--|
| <p>Sixty participants diagnosed with social anxiety disorder were randomly assigned to virtual reality exposure therapy and individual in vivo exposure therapy, or waiting-list</p> | <p>performed better in speech, general perceived anxiety than those in the control group.</p> | <p>therapy in clinical practice and second the social situations in exposure exercises were not identical in both treatment conditions</p> |
|--|---|--|

4. Conclusions

In sum, this article demonstrates that virtual reality exposure therapy is related to large declines in symptoms of both anxiety and other mental disorders, and is similar in efficacy to traditional exposure therapy. As it has already been mentioned, through the use of head mounted displays, headphones and data gloves, it is possible to stimulate the patients visually, audibly and tactilely, depending on the type of disorder they have. Therefore, the ability to realistically create a variety of social situations in a playful atmosphere is one of the great advantages of VR[27]. Furthermore, with this technique, the therapist is able to point out to the patient that what is happening in the virtual environment does not match reality, while looking very much like it. In fact, another advantage of using VR is that it is a safe and controlled environment and which can consequently promote a sense of personal effectiveness [36]. In this way, patients will be able to manage the stimulus to which they are exposed to better than in the real world. All these characteristics make virtual reality exposure therapy an effective clinical tool for treating patients with anxiety disorders.

Although achieving positive results, several limitations of the selected papers should be highlighted. First, relatively small sample sizes and the VR sessions are too few may limit the generalizability of the outcomes. Second, the absence of follow-up assessment does not allow us to know if the beneficial effects of VR are maintained over time. Third, the included studies were carried out in a laboratory setting neglecting the clinical settings. Also most of the studies considered rely on qualitative measures rather than quantitative measures to assess anxiety. As a result of the paucity of literature on this topic and higher-quality study designs among large samples further research before execution of virtual reality-based interventions for anxiety within clinical settings.

Finally, the bibliographic research was mainly carried out using Google Scholar, the digital scientific library. Therefore, more specific databases, such as Scopus, Web of Science, PubMed, PsychInfo could be used for this review.

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