Virtual Reality-based Interventions for Patients with Paranoia

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Abstract

Background: Paranoia is an important psychiatric symptom with an important effect on daily life. Virtual reality (VR) based treatments are suggested as an effectual treatment for patients with paranoia, facilitating learning. To our knowledge, there is a lack of systematic reviews to evaluate VR-based treatment as a treatment for paranoia or paranoid delusions. This study aimed to review reports that investigate VR-based treatment as a treatment for patients with paranoia.

Methods: Studies published up to 20/07/2020 about VR-based interventions for the treatment of patients with paranoid delusions or paranoia were reviewed in five databases including PubMed, Embase, Web of Science, PsycINFO, and Scopus.

Results: From the total of 252 initial searches, 6 were included in the study based on inclusion criteria. Four studies were performed as randomized controlled trials and two were before-after studies. All of them showed positive results in the main target, including increased social participation, reduced anxiety, and suspicious ideas and paranoid symptoms.

Conclusion: VR-based interventions are effective treatments. Although the use of VR technology is limited for a variety of reasons, including the cost, it improves symptoms in patients with paranoia.

Background

Psychotic disorders are considered severe mental health problems leading to abnormal thoughts and conception (1). The term refers to a spectrum of disorders that is one of the major causes of long-term disability worldwide (2). One important feature of psychosis is delusion (1) with paranoid delusion (3), sometimes referred to as persecutory delusion (4) being the most common type. Paranoia is an important sign in many mental conditions, but may also occur in the public population (4, 5). Studies showed that almost 30% of people in the general population are paranoid (6, 7). Paranoia is the groundless threatening thoughts that other people intend to cause harm (4, 5) and can be delusions. This may be due to misinterpretation of interpersonal behaviors (8) and lead to a sense of vulnerability (9). Frequent and persistent suspicions may adversely affect the performance (3) and the patient interacts less with others, prefers more isolation, quits activities (10), and might develop suicidal ideation (11). Though medications are still the mainstay of treatment of psychotic disorders, delusions, and level of functioning are not always cured by antipsychotics (12). Therefore, effective complementary treatments are yet needed to make a significant improvement (13).

Promising results have been achieved by targeted Cognitive behavioral therapy (CBT) for psychosis. These techniques, provoke and facilitate learning of safety within the feared situations (14–16). This leads to proper reactions and thus eliminate paranoia (13). However, for many patients with persecutory delusions, it is very tough to get into a stressful situation because of intense anxiety. The chance of practicing it in an ordinary situation is also reduced when patients are admitted to a hospital (13, 15). One solution is to use social situations in virtual reality (VR) that it is much easier for patients to access.

VR is a technology that digitally furnishes a 3D ambience (17). VR ranges from environments with complete immersion (in which individuals can physically interact with objects and virtual persons) to non-immersion levels (18). As VR produces responses resembling the real-world events (19, 20), it can be used to evaluate (21), understand the causes (22), and treat different health conditions (23). VR has been introduced as an effective treatment in a broad range of psychiatric disorders (24) including phobia (25), post-traumatic stress disorder (26), anxiety disorders (27), and paranoia (23).

VR provides valuable facts that give a better understanding of paranoia (15, 28) while providing an endurable situation for patients (29). Experiences show that VR based therapies are time-saving (22) and improve patient-doctor relationship (30). Virtual social environments can prepare patients to learn the appropriate reaction before entering the real world (31). A recent systematic review by Rus-Calafell, Mar et al. shows that VR facilitates learning in new emotional and behavioral responses and can be used for social skills training (32).

In recent years, several reports have systematically reviewed the results of researches examining the effects of VR based treatments on various mental conditions. But, to our knowledge, there is a lack of systematic reviews evaluating studies using VR-based treatments for paranoia. Therefore, in this study, we aimed to: (1) investigate VR-based studies aiming to treat patients with paranoid and evaluate the efficacy, (2) identify features, technologies used and methods of providing VR-based interventions, (3) describe the limitations of existing studies (4), provide suggestions for future studies and practical recommendations for more effective VR-based interventions.

Methods

This study is a systematic review. The PICOS framework is used to recognize proper sources and search for related evidences to form a focused question and facilitate literature search. Within this framework, the population includes patients with paranoid disorder, intervention includes virtual reality therapy, comparison group includes routine therapy, non-VR-based treatment, pre-treatment VR-based, and untreated conditions, and outcome includes improvement symptoms of the disease.

Literature search

In order to collect data, a search was performed on 19/02/2020 in 5 important medical, health, and psychological databases including PubMed, Embase, Web of Science, PsycINFO, and Scopus. The search was performed without a time limit. Related sites and magazines were searched manually to ensure that all sources were identified. Also, references to all studies included in the study were manually searched to identify any additional studies that were not identified

during the electronic database search. To update the results, a second search was performed on 20/07/2020. The keyword search strategy changed based on each database. Generally, the following keywords and search strategies were used:

(VR OR "Virtual Reality" OR "Virtual Realities" OR "Virtual environment" OR Simulation) AND (Paranoi* OR persecutory) AND (treat* OR therap*).

Then the results obtained from various sources were reviewed to remove duplicates and then entered into Endnote resource management software.

Inclusion and exclusion criteria

The inclusion and exclusion criteria were determined based on the defined PICOS. Inclusion criteria included studies that: (a) published in English, (b) included patients with paranoia or paranoid delusion, (c) were conducted for therapeutic purpose, (d) the intervention was based on virtual reality. Review articles, letters, abstracts, conferences, editorials, and notes were excluded as well as sources with no available full text.

Study selection

After removing duplicate references, screening was performed in two stages. In the first stage, titles and abstracts of the identified articles were reviewed to select relevant studies based on inclusion criteria. Then, in the second phase, two researchers separately reviewed the full text of articles that were identified according to the relevant criteria. Decisive agreement was made through discussion in terms of disagreement between scholars in the selection of articles.

Quality assessment

All the papers, regardless of the results of their methodological quality, underwent data extraction and synthesis due to the technical and developmental nature of the original papers. So we did not exclude studies that technically had good quality but did not meet the requirements of the checklists.

Data extraction

Selected studies were reviewed thoroughly and data were extracted by a researcher using the designed data extraction sheet and then verified by a second researcher. The chosen data were: Publication data (i.e., author, year, and country), aim of the study, study design, sample size, participant's data, technology used, scenario/avatar, methodology data, evaluation, and results.

Results

Study selection

The process of selecting articles, including the number of initial and screened studies, excluded studies, and eventually included studies, is summarized in Figure 1. Overall, 252 studies were identified: 41 articles from PubMed, 56 from Scopus, 97 from Embase, 54 from Web of Science, and 4 from PsycINFO. After removing duplicates, and screening their title and abstract, 43 articles were selected for full-text review. Then conference abstracts, reviews, unrelated topics, and studies that did not report results were excluded. One more article that was not available as full text and no replies received from the authors was also excluded. Finally, 6 studies remained for the review.

Characters of study

The full Characters of included studies are shown in Table 1. From the included studies, three studies were conducted in the Netherlands, two in the UK and the other in Germany. Four studies were randomized controlled trials (RCTs) and two were pre-posttest studies. General aim was evaluating effectiveness of using virtual environments for reducing persecutory delusions and paranoia. The total sample in the included studies were 392 patients. The mean age of the samples in the five studies was about 39 years, except for one study that the age range was reported to be 20 to 36 years.

Table 1
Summary characteristic of included studies in systematic review.

Author, year, Country	Aim of study	Study design	Sample size		Participants				
					Diagnosis	Age		Gender (male/female)	
			experiment	control		experiment	control	experiment	control
Geraets et.al. 2020 Netherlands (36)	Examined whether treatment with VR-CBT for paranoia influences momentary affective states, and whether VR-CBT changes the adverse interplay between affective states and paranoia.	RCT	43	48	Psychotic disorder, paranoid ideations	38.1	49.9	29/14	34/14
Pot-Kolder et.al. 2020 Netherlands (38)	Determine the short-term cost-effectiveness of VR-CBT.	RCT	58	58	Patients with a psychotic disorder suffering from paranoid ideation	36.5	39.5	40/18	42/16
Freeman et.al. 2016 UK (37)	To test the hypothesis that VRCT would lead to greater delusion reduction than alone VR-exposure.	RCT	15	15	Persecutory delusions	42.1	40.6	10/5	6/9
Pot-Kolder et al. 2018 Netherlands (35)	Investigated the effects of VR-CBT paranoid thoughts and social participation.	RCT	58	58	Psychotic disorder with paranoid ideation in the past month	36.5	39.5	40/18	42/16
Moritz et al. 2014 Germany (33)	Evaluated a brief intervention aimed to induce doubt and to decrease delusions.	Pre- post test	33		Schizophrenia	M=40.5		21/12	
Gega, et al. 2013 UK (34)	Explore the feasibility of the VE system as a therapy tool for patients who were recovering from psychosis and who had residual paranoia and comorbid social anxiety	Pre- post test	6		Paranoia and social anxiety	20 to 36		6 /0	

Interventions

The technology used in VR-based interventions to create a virtual environment includes tools for creating a situation, image and sound that are meant to enhance the sense of presence. A summary of the technology used in the reviewed studies is described in Table 2. The most commonly used hardware was Head-Mounted Display (HMD), which was used in four studies. In one study, a speaker was used to produce the sound. A recording camera was used in one of them, and a room with specific dimensions was used to create a virtual environment. Unity3D was the most commonly used software. Designed scenarios included a variety of social environments with a number of human avatars. Interventions continued for 16 sessions in four studies, and 12 in one, lasting for one to two hours. One study did not explain about the number and duration of sessions. These sessions were mostly offered in hospitals and centers for mental health care.

After the first evaluation before the intervention, patients have been evaluated several times during treatment sessions. In four studies, evaluation was performed in three stages. In another study, pre- and post-intervention evaluations were performed. One study did not describe the exact timing of the assessments. Several items were evaluated with relevant tools, including distress, perceived social threat, thoughts, feelings, social contexts, momentary paranoia, persecution, patients' thoughts, and level of anxiety.

In almost all of the studies, the results show that VR-based interventions reduce paranoid thoughts, delusions and safety behaviors (33-36). The results of one study show that VR-CBT treatment is more effective than conventional therapy in improving the symptoms of feeling suspicious, disliked, hurt, and anxious (36). The results of two studies show a reduction in patients' anxiety (34, 35). And two studies show that patients found that they were safe from what they feared (35, 37). One study to evaluate the cost-effectiveness of VR-based interventions found that these interventions, in addition to increasing patients' social participation, were cost-effective (38). Details are described in Table 2.

Table 2
Intervention characteristic of included studies in systematic review.

Author, year	Technology used		Scenario / Avatar	Methodology			Evaluation		
	Hardware	Software		Sessions	Duration of the sessions	Place of the session	Evaluation time	Tests/scores used	Evaluation items
Geraets et.al. 2020	HMD[1], Logitech F310 Game pad, Sony HMZ, high-definition resolution of 1280×720 per eye, 51.6 diagonal field of view, and a 3DOF tracker for head rotation.	Vizard software	Street, bus, café, supermarket	16	1 h	seven treatment centers in the Netherlands	6-10 days at baseline, post treatment and 6 month follow-u	ESM[2], ecological momentary assessment	Paranoia(suspicious, dislike, hurt), negative affect (anxious, insecure, disappointed, lonely, guilty, unsafe, annoyed), positive affect (cheerful, enthusiastic, relaxed, I like myself)
Pot-Kolder et.al. 2020	HMD, Logitech F310 Game pad, Sony HMZ, high-definition resolution of 1280×720 per eye, 51.6 diagonal field of view, and a 3DOF tracker for head rotation.	Vizard software	Street, bus, café, and supermarket	16	0:30– 1 h	seven treatment centers in the Netherlands	At baseline and at 3 and 6 months post baseline.	GPTS[3]	Time spent with others, momentary anxiety, momentary paranoia
Freeman et.al. 2016.	HMD	Unity3D, XVR	Underground train and lift/ The underground scenarios from no avatar to 22. The lift scenarios from two avatars to 6.	16	1:40 – 2:10	Patient's home or hospital	Before and During the testing day	Before(PANSS[4], PSYRATS[5], the Safety Behaviors Questionnaire, Persecutory Beliefs, the Beck Anxiety Inventory, the Beck Depression Inventory), during test (visual analogue rating scales)	Conviction, distress

Author, year	Technology used		Scenario / Avatar	Methodology			Evaluation		
	Hardware	Software		Sessions	Duration of the sessions	Place of the session	Evaluation time	Tests/ scores used	Evaluation items
Pot-Kolder et al. 2018	HMD, Logitech F310 Gamepad, Sony HMZ, high-definition resolution of 1280×720 per eye, 51.6 diagonal field of view, and a 3DOF tracker for head rotation.	Vizard software	Street, bus, café, supermarket/Therapists could change vary the number of human avatars (0–40), the characteristics of the avatars (including sex and ethnicity), and the avatars' responses to the patient (neutral or hostile, eye contact) to match the paranoid fears of the patient, therapists could also make the avatars say pre-recorded sentences.	16	1 h	Seven Dutch mental health centers.	At baseline, after treatment (3 months from baseline), and at a 6 month follow-up visit.	<p>Momentary paranoia and perceived social threat subscales.</p> <p>Secondary outcomes: the safety behavior questionnaire, persecutory delusions, GPTS, social interaction anxiety scale, Beck depression inventory.</p> <p>Functional outcomes: social and occupational functioning assessment scale Manchester short assessment of quality of life, after the fourth and eighth sessions, presence in virtual reality: the Igroup presence questionnaire, and cyber sickness symptoms with the simulator sickness questionnaire.</p>	<p>Momentary thoughts, feelings, social contexts, symptoms,</p> <p>negative affect, positive affect, momentary paranoia, and perceived social threat.</p>
Moritz, et al. 2014	For the noise condition: applied PC speakers.	<p>Unity 3D, artificial characters: 3D modeling software DAZ-studio.</p> <p>Body animations: (BVH[6]) data from the motion capturing procedure.</p>	Virtual street/ 6 different avatars were created, each showed a neutral, angry or happy face, and the participant only met one avatar at a time	-	-	In- and outpatient facilities of two psychiatric hospitals in Hamburg	Before and after the experiment	Paranoia Checklist, POD[7]	The degree to which subjects remembered the identity, location and effect of each of the pedestrians.

Author, year	Technology used		Scenario / Avatar	Methodology			Evaluation		
	Hardware	Software		Sessions	Duration of the sessions	Place of the session	Evaluation time	Tests/scores used	Evaluation items
Gega, et al. 2013	15*15 meters portable booth a video-processing unit with a camera linked to a computer and video recorder, a screen monitor, and an adjustable sitting stool	camera	One hundred specially video clips that last 2–10 minutes and depict a variety of social situations/ The characters in these situations could be hostile, rude, neutral or friendly. Some characters ask innocuous questions or personal questions.	12	1 h	-	At baseline (week 0), at 12 and 24 week	Persecution (GPTS, beliefs about self and others (BCSS[8]), social anxiety (Social interaction anxiety scale)	Persecution , patients thought, anxiety rating

Discussion

The aim of this systematic review was to investigate the effect of using VR in the treatment of patients with paranoia or paranoid delusions. Studies have shown that patients with paranoia feel interacted in the VR environment and experience thoughts of persecution (39). According to previous studies, VR-based interventions have been acceptable and effective in improving mental illnesses (40).

Paranoid patients often have suspicious thoughts in social situations and in dealing with people. Anxiety is also one of the main symptom in these people (41). The use of VR has various purposes in the treatment of patients with paranoid, including eliminating the paranoid thoughts, reducing social anxiety, increasing community participation, and changing their negative beliefs about themselves and others. Ultimately patients should believe that they are safe from what they are afraid of, and thoughts of suspicion about people are wrong. Therefore, the aim of the reviewed studies here, was to investigate the effect of VR-based interventions for improving the symptoms of the disorder (33–38). One study evaluated paranoia, as well as positive and negative affects and showed a decrease in paranoia and negative affects, but no significant effect on positive mental state (36).

VR technology provides many features to increase people's sense of immersion, especially in programs that focus on treating social anxiety disorders. To this end, avatars were designed to be more realistic and sociable in order to better communicate with patients (42). The same happens for patients with paranoia. VR provides a safe environment for the patient, and allows therapists and researchers to accurately identify the paranoid symptoms that may arise as a result of exposure. Different hardware and software are used to create a virtual environment. Head-mounted display and 3DOF tracker have been used to move in the laboratory environments. In a study that has used a camera to create an environment, a 15 × 15-meter portable room with a variety of equipment has been used including seating area, screen and etc. Various softwares are also used to design virtual reality, of which Unity3D is more common. In studies that used Unity3D, XVR and Vizard software to design virtual reality, few scenarios were created. In one study, a camera was used to create a virtual environment that allowed the recording of several video clips from different social situations. The expense of the equipment, and lack of VR specialists, especially for the mentally ill, has limited the practice (25). This is reflected in the partially low number of studies we could include. Though this might change when more evidences are provided about the effectiveness.

Different scenarios have been designed as the social environment in which the patient might get involved in the daily life. For example, in one study, patients were asked to walk on a virtual street, which was conducted in two phases, including a practice trial and two experimental trials. The walk was about 250 meters, with a corner changing the direction in the midway, and finally ends when turning left (33). Scenarios are logically designed based on the nature of the target symptom, and range from starting a conversation for improving social skills of patients with autism (43).

Three of the reviewed studies were conducted by a same team, with similar technology, scenarios and intervention method. A cost-effectiveness analysis was added to the newest. Accordingly, this intervention improves social participation, reduces paranoid ideation and social anxiety. Although the VR technologies are expensive, the intervention is cost-effective in a long-term follow-up (35, 36, 38).

A recent systematic review concluded that VR based treatments are effective interventions for psychosocial remediation in schizophrenia (44). Majority have used non-immersion environments making it possible to create the desired setting and avatars that interact with patients, though immersion environments might be the one step beyond. Though the review is not determining, except for one study which states that some patients did not consider VR environments to be real. While being aware of virtual nature of the environment might reduce patients' anxiety, sufficient immersion is needed to create a strong sense of presence and emotional engagement that is necessary for a successful treatment (34).

The limitations mentioned by the reviewed studies are related to the momentary evaluations of the interventions, and the limited number of scenarios. Despite evidence for cost-effectiveness, the high cost of the technology is one of the obstacles to widespread use, and long-term review is needed for a conclusion (37, 38). Moreover, results of two studies are limited by the absence of a control group (34, 35). The fact that some patients (probably with deeper psychopathology) might be afraid to participate is also limiting generalizability of the results (33). Finally, the number of studies is small, though they show promising effect of VR-based interventions for improving paranoia.

Studies can address the limitations mentioned above by a larger sample size, comparing the results to a control group and considering a longer follow up duration. It might be noteworthy to include effect of gender, and duration of the disorder. Manifestation of psychiatric symptoms is influenced by several psychological factors. Experience of the reviewed studies indicate that measuring different psychological factors might give a better understanding of etiology as well as deeper insight to effect of the VR-based intervention. A good example might be the comprehensive approach for understanding the cognitive and behavioral components of how a patient reacts to the environmental stimuli, than includes coping styles, mental states, personality characteristics, cognitive ability as well as details of the VR environment. Application of VR-based interventions within different social context and using suitable scenarios, might provide more interesting findings as well.

This study has some limitations. One common limitation for all systematic review studies is the bias in the selection of articles, therefore the search strategy was planned to include all of studies in this field. Though only papers published in English were included. We could not succeed to reach the full text of one study as described before.

Conclusion

This review shows that VR-based interventions are effective for treatment of patients with paranoia. Although the use of VR technology is limited for a variety of reasons, including cost, this type of intervention is more attractive than conventional interventions. VR-based interventions improve symptoms in patients with paranoid delusions, increase patients' social participation, reduce stress and suspiciousness. Moreover, it provides a better control of treatment sessions for therapists.

Abbreviations

VR: Virtual Reality

VR-CBT: Virtual Reality based-Cognitive Behavioral Therapy

VE: Virtual Environment

RCT: Randomize Controlled Trial

HMD: Head-Mounted Display

ESM: Experience Sampling Method

GPTS: Green's Paranoid Thoughts Scale

PANSS: Positive and Negative Syndrome Scale

PSYRATS: the Psychotic Symptoms Rating Scale

BCSS: Brief Core Schema Scales

Declarations

Ethics approval and consent to participate

The study is approved by ethical committee of Tabriz university of medical sciences (IR.TBZMED.REC.1399.584).

Consent for publication

Not applicable.

Availability of data and material

All data generated or analyzed during this study are included in this article.

Competing interests

None.

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None.

Authors' Contributions

TS: Conceptualization, Methodology, supervision; EM: Data curation, Writing- Original draft preparation. SF: Validation, investigation, Writing and Editing. All read and approved the final draft and agreed for submission.

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Figures

Figure 1

PRISMA flow diagram illustrating study selection.