



Short communication

Virtual reality in the psychological treatment for mental health problems: An systematic review of recent evidence

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ABSTRACT

The aim of this paper is to provide a review of controlled studies of the use of Virtual Reality in psychological treatment (VRT). Medline, PsychInfo, Embase and Web of Science were searched. Only studies comparing immersive virtual reality to a control condition were included. The search resulted in 1180 articles published between 2012 and 2015, of these, 24 were controlled studies. The reviewed studies confirm the effectiveness of VRT compared to treatment as usual, and show similar effectiveness when VRT is compared to conventional treatments. Current developments and future research are discussed.

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1. Introduction

The decreasing costs and increasing convenience and power of digital media is creating a revolution in healthcare and new technologies are affecting the way we provide and access care. Virtual Reality (VR) can enable the assessment of cognitions, emotions and behaviour in an ecologically valid environment. The ecological validity of VR derives from the precise presentation and control of dynamic perceptual stimuli. Indeed, virtual environments may provide valid assessments through presenting situations that combine the control of laboratory measures with the verisimilitude of everyday experiences (Parsons et al., 2011). Another important added value of VR is the sense of presence (the psychological sensation of “being there”) that individuals can experience in immersive VR environments (Slater, 2004). Furthermore, VR enables the manipulation of the environment and can be used to manipulate the environmental triggers that elicit distress in people with mental health problems, allowing them to learn to better manage their difficulties (Rizzo and Kim, 2005). VR has been used in clinical settings to treat a range of cognitive, emotional and motor problems in various psychological and psychiatric disorders and according to a recent poll of 70 psychotherapy experts, VR and other computerised intervention are ranked at the top of

interventions which are predicted to increase in use in the next ten years (Norcross and Prochaska, 2013). Until recently, a disadvantage of VR has been its high cost and hardware limitations. However, technological advances in computation speed and graphics processing power, and the integration of VR into the computer games industry have contributed to the creation of a much simpler, immersive VR systems, meaning it can run on a typical desktop computer at a fraction of the costs. These new developments are generating a new impulse in VR research and a substantial number of studies have been published in recent years. The aim of this manuscript is to provide an up-to-date systematic review of the literature about the effectiveness of VR in the psychological treatment for mental health problems. A previous comprehensive review (Eichenberg and Wolters, 2012), described in detail the studies conducted before 2012, therefore in this short communication we will briefly summarise those findings but focus on papers published after 2012. To facilitate access to more disorder specific information, whenever possible we will also provide up-to-date references to recent disorder specific reviews.

2. Methods

2.1. Design

A systematic review was conducted including pilot randomised clinical trials and randomized controlled trials, which have utilised VR in psychological treatment (VRT). Only studies comparing immersive and or interactive VR to a control condition were included. By immersive VR we mean a VR environment displayed in colour

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and in 3D using a head mounted display. The computer generated images and the movements of the user are synchronised, generating a virtual world in which the user can feel as immersed as in real life (Rizzo et al., 2013). Depending on the set-up, participants can interact with the environment either by head movements, full body turning or with a joystick. For a video example please see <https://vimeo.com/145992521> (Password: cure)

We also included the job interview studies by Smith and colleagues, which were not immersive, but were delivered used a computer screen. However they were interactive and could be tailored to the participant.

2.2. Selection procedure

Studies were included in the review if they were published on or after 2012, written in English; contained original empirical findings, published in a peer-reviewed journal; and focused on the efficacy or effectiveness or process of VRT. Studies were excluded from the review if they were; not treatment studies; case studies; reviews; not available in English; or book chapters.

The databases used were Web of Science, PsychInfo, Embase, and Medline. Reference lists of collected papers were also visually inspected to locate any cited journal articles addressing mental disorders before and after VRT.

2.3. Search criteria

Studies for review were identified following a keyword search for the terms 'virtual reality' in conjunction with 'treatment' OR

'therapy' OR 'mental health', OR 'mood disorders', 'depression', OR 'bipolar', OR 'mania', OR 'paranoia', OR 'psychosis', OR 'schizophrenia', OR 'phobias', OR 'obsessive compulsive disorder', OR 'anxiety', OR 'post traumatic stress disorder', OR 'trauma'. Only studies comparing immersive virtual reality to a control condition were included.

The search resulted in 1180 articles published between 2012 and 2015 (final search conducted August 2015). From these, 24 of these were controlled studies, which compared the effectiveness of VRT with an alternative treatment approach or a no treatment control (see Fig. 1).

3. Review

3.1. Brief review of the evidence before 2012

Most research carried out before 2012 focused on anxiety disorders (Opris et al., 2012), eating disorders (Ferrer-Garcia et al., 2013), phobias (Botella et al., 2014) and post traumatic stress disorder (DiMauro, 2014). Findings showed the effectiveness of VR compared to treatment as usual, but only small effect sizes when VR was compared to conventional cognitive behaviour therapy (Eichenberg and Wolters, 2012). A Cochrane Review of the available literature up to 2013 of the use of VR for serious mental disorders and found only three RCT, all with schizophrenia. Their conclusion was that VR had small effects regarding compliance, cognitive functioning, social skills and acceptability of intervention (Valimaki et al., 2014). More recently two reviews have reviewed

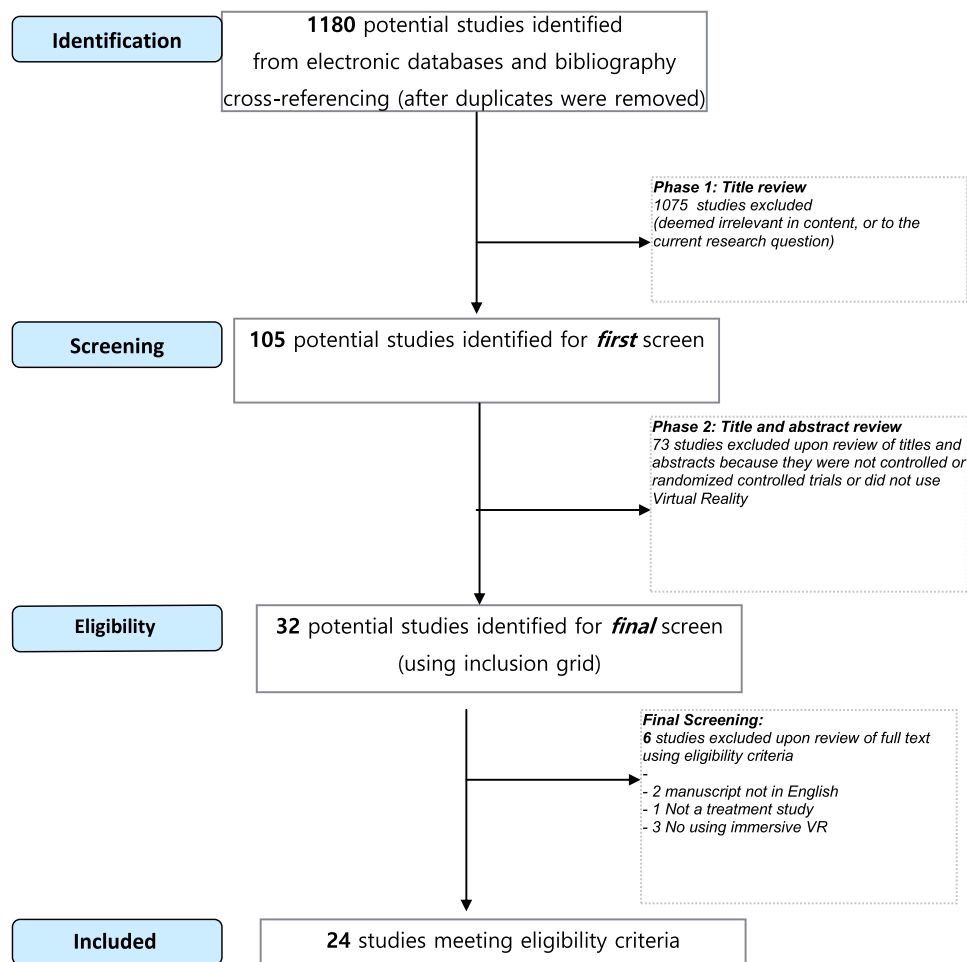


Fig. 1. Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) Diagram of selected studies.

Table 1

| Study | Year | Country | Clinical sample | Age | N | Treatment conditions | No. of sessions | Main findings | Strengths | Limitations |
|---|------|-----------------|--|---|---------------------------|--|---|--|----------------------------------|---|
| Agoraphobia with or without panic disorder Pelissolo et al. | 2012 | France | Panic disorder with agoraphobia | Mean age 44.1 Age range 24 to 72 | 92 (62 females, 30 males) | VRET CBT Waiting List | 12 weekly sessions of 60' 6 and 12 month Follow-up | Reduction in fear in both treatment groups. No difference between the groups but more effective than waiting list Maintained at Follow-up | Large sample size | Relatively large drop-out rate (27%) in both groups |
| Malbos et al. | 2013 | Australia | Panic disorder with agoraphobia | Mean age 37 Age range not stated | 19 (12 females, 9 males) | VRET only VRET+ CBT | 10 weekly sessions of 90' 3 month Follow-up | Mood, anxiety, fear and avoidance improved in both groups. No difference between the groups Maintained at Follow-up | Duration of treatment Follow-up | Small sample size No control group |
| Meyerbroeker et al. | 2013 | The Netherlands | Panic disorder with agoraphobia | Mean age not stated Age range for recruitment 18–65 | 55 (not stated) | VRET+CBT Exposure +CBT Waiting list | 10 weekly sessions of 60' | Reduction in panic disorder severity in both treatment groups. No difference between the groups but more effective than waiting list | Severely impaired patients | Relatively small sample size Relatively large drop-out rate (32%) in both groups |
| Penate-Castro et al. | 2013 | Spain | Agoraphobia with or without panic disorder | Mean age not stated Age range 24 to 60 | 50 (36 females 24 males) | CBT+medication VRET+CBT+med. Medication only | 11 weekly session of 30'-45' 6 months Follow-up | Reduction in agoraphobia severity in both CBT groups. No difference between the groups but more effective than medication alone. Maintained at Follow-up | Severely impaired patients | Relatively large drop-out rate (37%), larger in CBT group (50%). |
| Pitti et al. | 2015 | Spain | Agoraphobia with or without panic disorder | Mean age 39 Age range not stated | 99 (70 females, 29 males) | CBT+medication VRET+CBT+med. Medication only | 11 weekly session of 30'-45' 6 months Follow-up | Reduction in agoraphobia severity in all three groups. VRET+CBT+med. had slightly better results at Follow-up | Severely impaired patients | Relatively large drop-out rate |
| Social Anxiety Disorder and Public Speaking Anxiety Safir et al. | 2012 | Israel | Public Speaking Anxiety | Mean age 27 Age range not stated | 88 (70 females, 18 males) | VRET+CBT CBT Waiting list | 12 weekly sessions of 60' 12 months Follow-up | The reduction in public speaking anxiety in both groups reported in Walach et al 2009 was maintained at Follow-up. | Large sample size Long Follow-up | Most participants were young female students. |
| Anderson et al. | 2013 | USA | Social Anxiety Disorder | Mean age 39 Age range 19 to 69 | 97 (60 females, 37 males) | VRET Exposure group therapy Waiting list | 8 weekly sessions 12 months Follow-up | Reduction in social anxiety in both groups. Maintained at Follow-up | Large sample size Long Follow-up | Exposure involved public speaking in a group which may not be the same as social anxiety disorder |
| Fear of flying Mayerbroeker et al. | 2012 | The Netherlands | Fear of flying | Mean age not stated Age range for recruitment 18 to 65 | 67 (not stated) | VRET+Yohimbine Hydrochloride (YHO) VRET+Placebo | 4 weekly sessions of 60' | Fear of flying reduction in both groups. No evidence that YHO enhanced outcome | Large sample size | Relatively large drop-out rate (27%) in both groups |
| Rus-Calafell et al. | 2013 | Spain | Fear of flying | Mean age 37 Age range for recruitment 18 to 65 | 15 (13 females, 2 males) | VRET Imaginal exposure | 8 sessions twice a week of 60' to 75' 6 month Follow-up | Fear of flying reduction in both groups, but VRET showed better results. Maintained at Follow-up | Follow-up | Small sample size |
| Spider phobia Shiban et al. | 2013 | Germany | Spider phobia | Mean age 28 Age range 18 | 30 (not stated) | VRET+ in four different scenarios VRET+ in a single scenario | 2 sessions | Fear of spiders was reduced in both groups. | | Small sample size. Only one |

Table 1 (continued)

| Study | Year | Country | Clinical sample | Age | N | Treatment conditions | No. of sessions | Main findings | Strengths | Limitations |
|--|-------|---------|---|--|--|--|--|---|---|--|
| Shiban et al. | 2015a | Germany | Spider phobia | to 58 Mean age 31 Age range 18 to 60 | 32 (not stated) | VRET+ Reactivation stimulus+ in vivo exposure VRET+ Control stimulus+ in vivo exposure | 4 sessions twice a week 6 month Follow-up | Multiple context reduced renewal effect. Fear of spiders was reduced in both groups. Reactivation stimulus did not attenuate fear. Fear reduction maintained at Follow-up | Follow-up | session. No control condition Small sample size. Both groups had VRET and in vivo |
| Shiban et al. | 2015b | Germany | Spider phobia | Mean age 23 Age range 18 to 38 | 58 (49 females, 8 males, 1 not stated) | VR single stimulus and single context VR multiple stimuli and single context VR single stimulus and multiple contexts VR multiple stimuli and multiple scenarios | 2 sessions 2 weeks Follow-up | Fear of spiders was reduced in all groups, but was more pronounced in the multiple context condition. Only the multiple stimuli, single context condition had long term effect on fear attenuation at follow-up | Follow-up | Relatively small sample size for four conditions. |
| More than one phobia Moldovan and David | 2014 | USA | Social Phobia N=15 Flying phobia N= 9 Acrophobia N=8 | Mean age not stated Age range for recruitment over 18 | 32 (15 females, 17 males) | VRET+CBT Waiting list | 1 session of 60' | No differences found between the two groups | | No active control condition. Small sample size. Only one session. |
| Management of Psychological Stress Gaggioli et al. | 2014 | Italy | Teacher and Nurses exposed to high levels of psychological stress | Mean age 39 to 46 Age range not stated | 121 (73 females, 48 males) | VRET+VR relaxation+biofeedback+cognitive restructuring Imaginal Exposure+imaginal relaxation+diary+cognitive restructuring Waiting list | 10 sessions twice a week of 60' | Perceived stress, and coping skills improved in both treatments. VR group showed a decrease in anxiety and larger improvements in perceived stress and coping skills. | Large sample size. | No follow-up |
| Eating disorders Marco et al. | 2013 | Spain | Eating disorders | Mean age 22 Age range 1 to 40 | 34 all females | CBT CBT+VR | 15 CBT group sessions 8 individual CBT +VR 12 months Follow-up | Body image improved in both groups, but VR was more efficient and accelerated changes regarding body image and eating disorder psychopathology. Maintained at Follow-up | Follow-up | Relatively small sample size |
| Post Traumatic Stress Disorder (PTSD) Rothbaum et al. | 2014 | USA | War veterans with PTSD | Mean age 35 Age range 22 to 55 | 156 (8 females, 148 males) | VRET+D-cycloserine VRET+alprazolam VRET+Placebo | 5 weekly sessions of 90' 6 months Follow-up | All three groups showed a reduction of PTSD after treatment Effects of D-cycloserine are inconclusive. Maintained at Follow-up | Large sample size. Use of biomarkers. Follow-up | Relatively large drop-out rate. |
| Difede et al. | 2014 | USA | PTSD following the World Trade Centre attack | Mean age 43 to 47 Age range for recruitment 18 to 70 | 25 (6 females, 19 males) | VRET+D-cycloserine VRET+Placebo | 12 weekly sessions of 90' 6 months Follow-up | Both groups showed a reduction of PTSD after treatment. D-cycloserine was associated with greater reduction of PTSD as well as improvement in sleep, depression and anger expression. | Follow-up | Small sample size. |
| Smith et al. ^a | 2015 | USA | War veterans with PTSD | Mean age 51 Age range for recruitment 18 | 33 all males | VR job interview training Treatment as usual | 10 sessions of 60' over 5 to 10 days | Role-play job interview was better in VR job interview training group. | High attendance. Found to be easy to | No active control condition Small sample size |

| | | | | | | | | | | | |
|---|------|-----------|----------------------------------|---|---------------------------|---|--------------------|---|--|---|--|
| | | | | to 65 | | | | | | use Increased confidence | |
| Schizophrenia Rus-Calafell et al. | 2013 | Spain | Schizophrenia | Mean age 38 to 42 Age range 18–55 | 32 (6 females, 16 males) | VR social skills training | Treatment as usual | 16 weekly sessions of 60' 6 month Follow-up | Social cognition and functioning improved with the VR social skills training. Reduction of negative symptoms. Maintained at follow-up | High treatment acceptance. Follow-up | No active control condition Small sample size |
| Tsang and Man | 2013 | Hong Kong | Schizophrenia | Mean age 40 Age range for recruitment 18 to 55 | 75 (42 females, 33 males) | Prevocational training+VR vocational training Prevocational training+Vocational group training Prevocational training | | Prevocational training of 180 minutes each day. 10 sessions twice a week of 30' | Both training were associated with an improvement of cognitive functioning. The VR group showed better results. | Improved self-efficacy | Relatively large drop-out rate. No long term follow-up |
| Smith et al. ^a | 2015 | USA | Schizophrenia | Mean age 40 Age range for recruitment 18 to 55 | 32 (12 females, 20 males) | VR job interview training | Treatment as usual | 10 sessions of 60' over 5 to 10 days 6 month Follow-up | Role-play job interview was better in VR job interview training group. At 6 months Follow-up participants in the VR groups had higher odds of receiving a job offer. | High attendance. Found to be easy to use Increased confidence | No active control condition Small sample size |
| Smith et al. ^a | 2014 | USA | Schizophrenia Bipolar Depression | Mean age not stated Age range for recruitment 18 to 65 | 37 (not stated) | VR job interview training | Treatment as usual | 10 sessions of 60' over 5 to 10 days | Role-play job interview was better in VR job interview training group. | High attendance. Found to be easy to use Increased confidence | No active control condition Small sample size |
| Autism Smith et al. ^a | 2014 | USA | Autism | Mean age 23 Age range for recruitment 18 to 31 | 26 (6 females, 20 males) | VR job interview training | Treatment as usual | 10 sessions of 60' over 5 to 10 days | Role-play job interview was better in VR job interview training group. | High attendance. Found to be easy to use Increased confidence | No active control condition Small sample size |
| Smith and Bell ^a Follow-up of the above study | 2015 | USA | Autism | As above | 23 (3 females, 20 males) | VR job interview training | Treatment as usual | 6 month Follow-up of the above study | At 6 months Follow-up participants in the VR groups had higher odds of receiving a job offer. | Follow-up | As above |

VR: Virtual reality; VRET: Virtual reality Exposure Therapy; CBT: Cognitive Behaviour Therapy.

^a The studies by Smith and colleagues did not use immersive VR delivered via a head mounted display, but were delivered used a computer screen. However they were interactive and could be tailored to the participant.

the evidence for the assessment and treatment of schizophrenia in a more comprehensive manner (Macedo et al., 2015; Veling et al., 2014) and a recent review also investigated the use of VR in autism (Grynszpan et al., 2014).

3.2. Evidence published after 2012

The current review found 24 controlled studies published since 2012. Table 1 briefly summarises each study, their main findings, strengths and limitations.

Overall, the present review indicates that VRT has potential within mental health research. VRT has been shown to be more effective than treatment as usual or waiting list control, and has similar results as conventional CBT and or in vivo exposure. The available evidence varied depending on the mental health disorder reviewed, and our results confirm that multiple sessions treatment protocols of VRT can be a valuable treatment for agoraphobia with or without panic disorder (Malbos et al., 2013; Meyerbroeker et al., 2013; Pelissolo et al., 2012; Penate-Castro et al., 2014; Pitti et al., 2015); fear of flying (Malbos et al., 2013; Meyerbroeker et al., 2013; Pelissolo et al., 2012; Penate-Castro et al., 2014; Pitti et al., 2015); social anxiety and fear of public speaking (Anderson et al., 2013; Safir et al., 2012); and spider phobia (Shiban et al., 2015a, 2013, 2015b). Also promising are the findings regarding the use of VRT for PTSD (Difede et al., 2014; Rothbaum et al., 2014; Smith et al., 2015a); and for the management of psychological stress (Gaggioli et al., 2014). Single session VR exposure did not seem effective for specific phobias (Moldovan and David, 2014). Limited research has been published recently for eating disorders (Marco et al., 2014) and autism (Smith et al., 2015c, 2014a). In schizophrenia VR was used to deliver vocational or social skills training, but no studies were reported using VR to target the distress associated with hallucinations or delusion (Rus-Calafell et al., 2013; Smith et al., 2015b, 2014b; Tsang and Man, 2013).

The findings should be considered in light of a number of limitations. A substantial number of studies reported relatively high drop-out rates, these were partly due to participants finding the treatment too confronting, and partly due to cyber-sickness a side effect of the use of VR headsets which induces nausea and dizziness. It is also important to note that studies often had small sample sizes and lacked statistical power.

Furthermore the studies reviewed were conducted with young or middle aged adults and no evidence was found with younger children or older adults.

Finally we only included studies using immersive virtual reality, and therefore excluded studies, which were conducted using internet platforms such as Second Life and studies which did not use 3D immersive equipment.

4. Conclusion

Digital technology has become an integral part of our daily life, therapies will benefit from becoming integrated in these exciting technical innovations. VR is becoming accessible and in the next few years immersive 3D head mounted displays such as the Oculus Rift (<https://www.oculus.com/en-us/>) or headsets which can be used with a mobile phone such as Unofficial Cardboard VR (<http://www.unofficialcardboard.com>) as well as platforms for walking in place navigation such as the Virtux OMNI (<http://www.virtuix.com/>) will become as common as the Xbox and the Play Station are nowadays. Increasingly the goals of modern medicine are that it should be personalised, predictive, preventative and participatory (P4, (Hood and Friend, 2011)). Adapting therapy to these media forms will ensure more people can access with the therapeutic process and it will help establish which individual factors

play a role in the onset of mental health problems (Predict); it will Personalise treatment (right treatment, for the right person at the right time); it will be Preventative (improve functioning and wellness) and highly Participatory (interactive and responsive environments). Increasing the use of VR in clinical practice will help address some of the methodological limitations of current studies which often have small sample size, high drop out rates and lack long term follow-up.

Author disclosure statement

The authors have no conflict of interest to disclose.

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