Clinical Psychology Review 34 (2014) 634–644

Contents lists available at ScienceDirect

Clinical Psychology Review

Outcomes associated with virtual reality in psychological interventions: where are we now?

Wesley A. Turner *, Leanne M. Casey

[a] School of Applied Psychology, Griffith University, Brisbane, Queensland, Australia
[b] Griffith Health Institute, Griffith University, Brisbane, Queensland, Australia

HIGHLIGHTS

- We conduct a meta-analysis of outcomes associated with clinical virtual reality randomised controlled trials.
- We examine the methodological rigour of clinical virtual reality interventions.
- Virtual reality interventions have substantial effect sizes.
- Though no correlation was found between treatment outcomes and methodological rigour, virtual reality interventions studies must improve their methodological rigour.

ARTICLE INFO

Article history:
Received 22 April 2014
Received in revised form 15 July 2014
Accepted 9 October 2014
Available online 18 October 2014

Keywords:
Virtual reality
VR
eHealth
Technology
Review
Meta-analysis

ABSTRACT

The impending commercial release of affordable VR systems is likely to accelerate both the opportunity and demand for VR applications that specifically target psychological conditions. The aim of this study was to conduct a meta-analysis of outcomes associated with VR psychological interventions and to examine the methodological rigour used in these interventions. Literature search was conducted via Ovid, ProQuest Psychology Journals and ScienceDirect (Psychology) databases. Interventions were required to: be published between 1980 to 2014; use a randomised controlled trial design; be published in a scholarly journal; focused primarily on psychological/behavioural intervention; include validated measures; include reported means and standard deviations of outcome measures; and include one group with clinical/subclinical disorders, syndromes or distressing behaviours. Thirty eligible studies were identified. Random effects meta-analysis found an overall moderate effect size for VR interventions. Individual meta-analyses found an overall large effect size against non-intervention wait-lists and an overall moderate effect size against active interventions. No correlation was found between treatment outcomes and methodological rigour. Limitations may include limited study numbers, the use of a single coder, a need for more in-depth analyses of variation in form VR intervention, and omission of presence as a moderating factor. The current review supports VR interventions as efficacious, promising forms of psychological treatment. Use of reporting guidelines such as the CONSORT and CONSORT-EHEALTH statements should promote greater emphasis on methodological rigour, providing a firm foundation for the further development of clinical VR applications.

Contents

* Corresponding author at: School of Applied Psychology, Griffith University, Mt Gravatt Campus, 176 Messines Ridge Road, Mt Gravatt, QLD 4122, Australia. Tel.: +61 7 37353343.
E-mail address: wesley.turner@griffithuni.edu.au (W.A. Turner).

http://dx.doi.org/10.1016/j.cpr.2014.10.003
0272-7358/

1. Introduction

1.1. Virtual reality in psychological intervention

Despite several decades of research, use of virtual reality (VR) in psychological interventions has only grown more recently (Gorini & Riva, 2008; Repetto & Riva, 2011). Rise in the use of VR interventions is likely due to rapid advancements in underlying technologies. Substantial improvements have been made in several areas, including computer graphics, speed and processing power; head-mounted displays (HMD) and VR glasses/goggles quality; and motion tracking technology (Gregg & Tarrier, 2007). Costs associated with purchasing and maintaining VR systems have also dropped markedly, resulting in the impending commercial release of affordable VR systems such as the Oculus Rift and Sony HMZ-T2 Personal 3D Viewer (Gregg & Tarrier, 2007; Rougeau & Hawkins, 2013; Tamblin, 2013). Release of such systems into the general market is likely to accelerate both the opportunity and demand for VR applications that specifically target psychological conditions.

Existing VR interventions provide a range of interactive systems, environments and mechanisms by which psychological and behavioural change can be targeted in novel and engaging ways. Often making use of similar if not identical hypothesized mechanisms of action to traditional face to face interventions, VR interventions are now available to treat a variety of psychological disorders and behavioural issues (Fox, Arena, & Bailenson, 2009) while providing greater flexibility in intervention timing, greater cost effectiveness, and an increased ability to tailor interventions to individual preferences (Carlbring & Andersson, 2006; Clough & Casey, 2011). Though the use of VR technology in the field is not yet widespread (Repetto & Riva, 2011), the substantial increase in use of VR within psychological research has resulted in several recent meta-analyses (Opris et al., 2012; Parsons & Rizzo, 2008; Powers & Emmelkamp, 2008).

Results have been promising: VR interventions demonstrate strong pre-post effect sizes (Cohen's $d = 0.95$, Parsons & Rizzo, 2008) and strong overall effect sizes when compared to non-intervention wait lists ($d = 1.12$, Opris et al., 2012; $d = 1.11$ Powers & Emmelkamp, 2008), although low effect sizes were observed in comparisons between VRET (virtual reality exposure therapy) and in-vivo exposure/cognitive behavioural therapy (d = no effect, Opris et al., 2012; d = 0.35, Powers & Emmelkamp, 2008), However, these reviews have focused only on using VR to deliver exposure (VRET) in the treatment of anxiety disorders. It is unknown whether these findings can be generalised to VR interventions overall.

Additionally, there has been little assessment of the methodological rigour of research into VR interventions, despite the need for improvement in this area (Parsons & Rizzo, 2008). Sub-optimal methodology and methodological reporting can raise numerous concerns: inadequate randomisation and blinding can lead to bias (Strech, 2012); and participant and administration setting information can influence the generalisability of research findings (Knüppel, Metz, Meerpohl, & Strech, 2013). To position VR research in clinical psychology to take advantage of the potential expansion offered by current developments in technology, it is timely to review the outcomes associated across the available range of VR based psychological interventions and to examine the methodological rigour used to substantiate these outcomes.

1.2. Defining VR

Definitions vary in what technological devices constitute VR systems. They may be regarded as being strictly comprised of HMDs or VR glasses/goggles and 3D virtual environments (Gregg & Tarrier, 2007), or may be used in a much broader sense, referring to any technological system that immerses a user in a virtual environment (VE). Discrepancy in definitions may be due to the evolving nature of the technology itself, with rapid improvements resulting in greater options in interactive technologies (Adamovich, Fluet, Tunik, & Merians, 2009; Bohil, Alicea, & Biocca, 2011). Early images of bulky, cumbersome and heavily wired headwear and peripherals in the 1980s have given way to the promise of sleek, easily portable and relatively affordable VR systems that can be purchased for home use (Fox et al., 2009). Despite variations in definition and technology, VR is defined by its capacity to allow users to explore and engage with a VE, experiencing a sense of presence ('losing oneself') in a computer generated world (Fox et al., 2009; Baños et al., 2011; Bordnick, Traylor, Carter, & Graap, 2012; Botella et al., 2007; Repetto & Riva, 2011; Rothbaum et al., 2006).

A number of devices are often used in addition to VR to aid in recreating real life scenarios, thus fostering a sense of presence, a factor seen by some as vital to successful immersion (Gorini & Riva, 2008; Gregg & Tarrier, 2007; Rothbaum et al., 2006)(although presence may be of greater importance in the treatment of clinically anxious individuals via VR based exposure, Ling, Nefs, Morina, Heynderickx, & Brinkman, 2014). These additional devices may include delivery of tactile (haptic) and aural sensation (Bordnick et al., 2012; Krijn et al., 2004), as well as simulations of real life steering wheels, gears and pedals in VR driving simulators (Cox et al., 2010), and replica seats, windows and partial cabins in VR flight simulators (Muhlberger, Wiedemann, & Pauli, 2003; Rothbaum et al., 2006).

1.3. Methodological rigour in VR research and the CONSORT statements

A vital question in assessing outcomes is whether the methodology used to produce these outcomes is of an appropriate standard.