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# Virtual reality therapies for mental health disorders: an introduction

Daniel Freeman



**oxford**vr



# My last conference

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PROGRAM CHAIR: Alyssa Ward, Ph.D.

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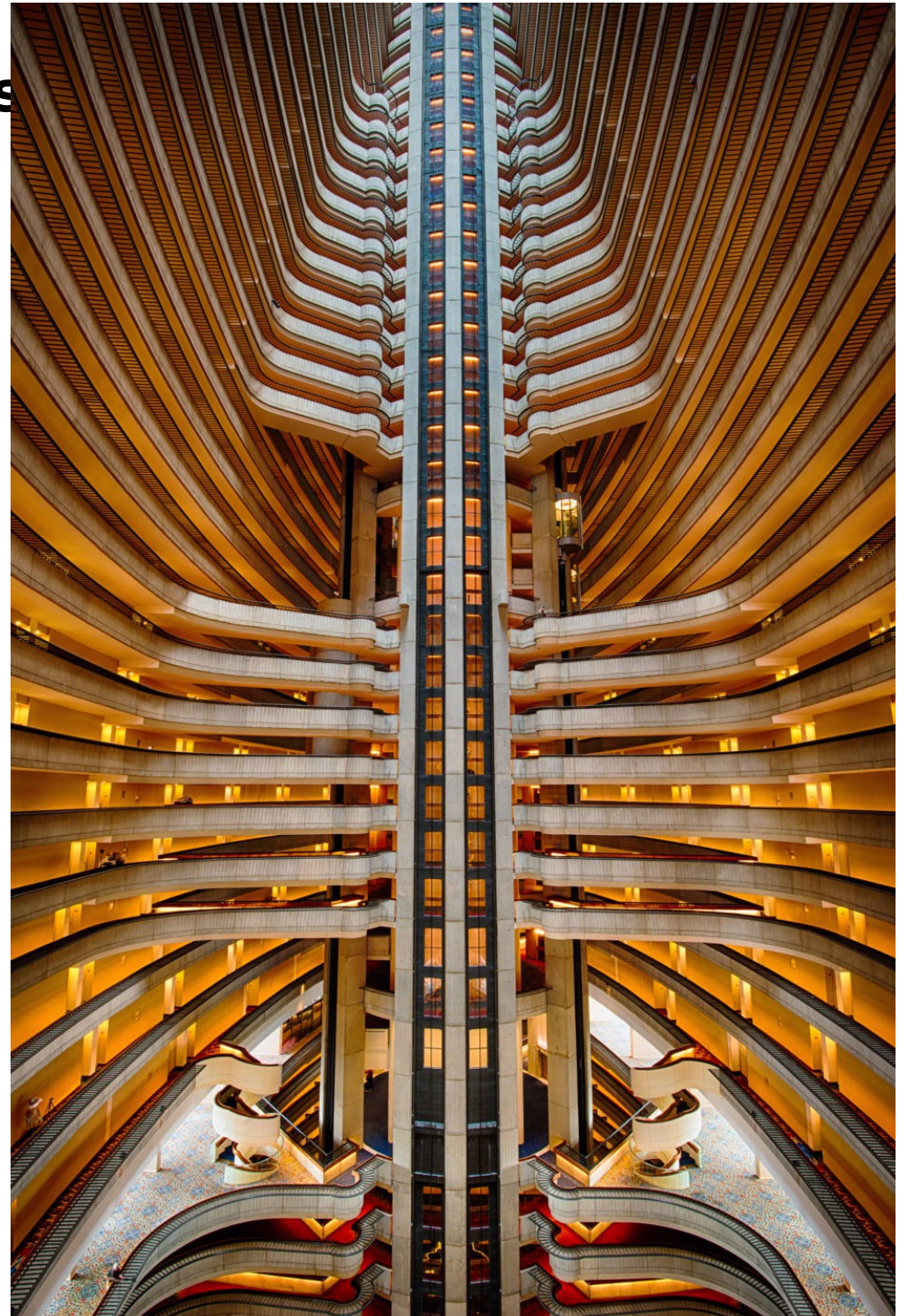
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# Atlanta Marriott Marquis

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**This hotel is historically  
important in the history  
of VR for mental health**



# First study

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BEHAVIOR THERAPY 26, 547-554, 1995

## Virtual Reality Graded Exposure in the Treatment of Acrophobia: A Case Report

BARBARA OLASOV ROTHBAUM

*Emory University School of Medicine*

LARRY F. HODGES

ROB KOOPER

*Georgia Institute of Technology*

DAN OPDYKE

*Georgia State University*

JAMES S. WILLIFORD

*101st Airborne Division (Air Assault), Fort Campbell*

MAX NORTH

*Clark Atlanta University*

This is the first case report to test the efficacy of computer-generated virtual reality (VR) for the treatment of acrophobia (fear of heights). The subject was a 19-year-old undergraduate student with a fear of heights, particularly of elevators. Twice weekly, sessions were conducted for 3 weeks, for a total of 5 sessions. Outcome was assessed on measures of anxiety, avoidance, attitude, distress, and included a behavioral avoidance test. VR graded exposure was successful in reducing fears of heights. VR graded exposure is proposed as a new medium for exposure therapy.

# First study

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## *Treatment*

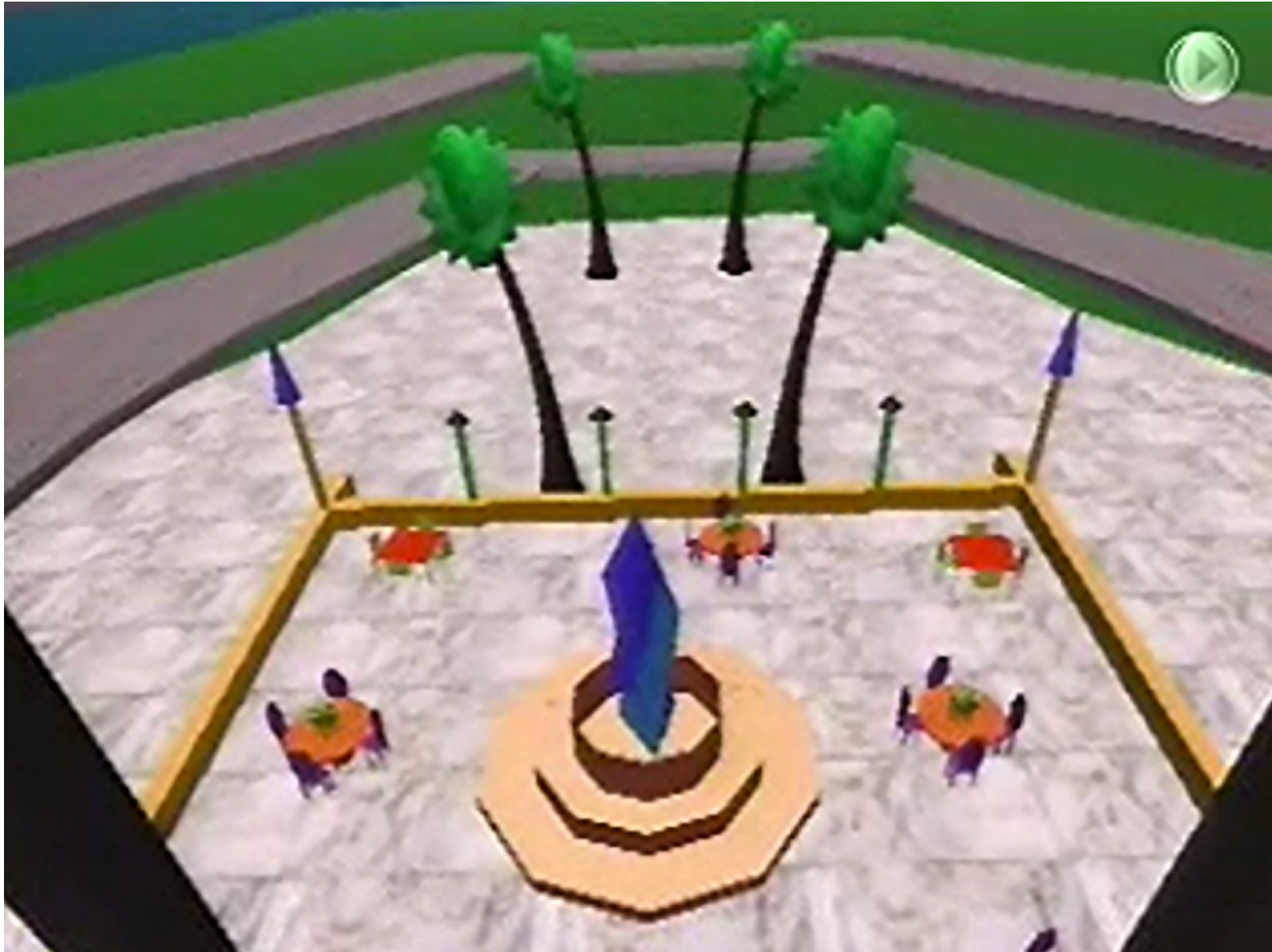
Individual VRGE was conducted in five sessions over 3 weeks. Sessions were 35 to 45 minutes long and conducted by an advanced clinical psychology graduate student. All sessions were video recorded and were reviewed by a licensed clinical psychologist in supervision. The subject was encouraged to spend as much time at each “floor” as needed for his anxiety to decrease and was allowed to progress at his own pace. SUDs were rated every 5 minutes during exposure on a 0 (no discomfort) to 100 (panic-level anxiety) scale. The therapist simultaneously viewed on a video monitor the VEs in which the subject was interacting and therefore was able to comment appropriately. The therapist’s comments were essentially identical to what would be expected for conventional in vivo exposure, for example, “Can you try to let go of the railings?”; “Do you want to get closer to the edge?”; and “You’re doing very well: your anxiety is coming down just by staying in the situation,” as well as inquiring as to the subject’s thoughts and physical feelings.

Photographic quality textures were fed into the computer to enhance the realism of the VEs. The glass elevator simulated the elevator at the Marriott Marquis Convention Hotel in downtown Atlanta, complete with balconies, artwork, and marble floor. The subject controlled the movement of the elevator via three “buttons” within the VE to move up, down, or stop. The elevator moved 49 floors, up to 147 meters at the top, and the floor number ap-





## Virtual elevator (thanks to Barbara Rothbaum)





## VR: well-known advantages

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- Trigger same reactions as real world situations.
- Patients are much more willing to enter the situations that are difficult for them.
- Learning transfers to the real world.



# VR for PTSD

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*Journal of Traumatic Stress, Vol. 12, No. 2, 1999*

## **Virtual Reality Exposure Therapy for PTSD Vietnam Veterans: A Case Study**

**Barbara Olasov Rothbaum,<sup>1,5</sup> Larry Hodges,<sup>2</sup> Renato Alarcon,<sup>3</sup>  
David Ready,<sup>3</sup> Fran Shahar,<sup>1</sup> Ken Graap,<sup>4</sup> Jarrel Pair,<sup>2</sup> Philip Hebert,<sup>2</sup>  
Dave Gotz,<sup>2</sup> Brian Wills,<sup>2</sup> and David Baltzell<sup>3</sup>**

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*Virtual reality (VR) integrates real-time computer graphics, body tracking devices, visual displays, and other sensory input devices to immerse a participant in a computer-generated virtual environment that changes in a natural way with head and body motion. VR exposure (VRE) is proposed as an alternative to typical imaginal exposure treatment for Vietnam combat veterans with posttraumatic stress disorder (PTSD). This report presents the results of the first Vietnam combat veteran with PTSD to have been treated with VRE. The patient was exposed to two virtual environments, a virtual Huey helicopter flying over a virtual Vietnam and a clearing surrounded by jungle. The patient experienced a 34% decrease on clinician-rated PTSD and a 45% decrease on self-rated PTSD. Treatment gains were maintained at 6-month follow-up.*

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**KEY WORDS:** PTSD; Vietnam; virtual reality; exposure therapy.

- Fourteen 90 minute sessions, with a therapist.
- VR jungle and helicopter warfare scenes.
- Repeat exposures using an emotional processing approach.

# Meta-analysis

Journal of Psychiatric Research 143 (2021) 516–527



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Journal of Psychiatric Research

journal homepage: [www.elsevier.com/locate/jpsychires](http://www.elsevier.com/locate/jpsychires)



Review article

Efficacy of immersive PTSD treatments: A systematic review of virtual and augmented reality exposure therapy and a meta-analysis of virtual reality exposure therapy

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M. Olff<sup>a,e</sup>, A. Bakker<sup>a</sup>

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## ARTICLE INFO

### Keywords:

PTSD  
Treatment  
Virtual reality  
Augmented reality  
Systematic review  
Meta-analysis

## ABSTRACT

**Background:** Virtual reality exposure therapy (VRET) and augmented reality exposure therapy (ARET) are digitally assisted psychotherapies that potentially enhance posttraumatic stress disorder (PTSD) treatment by increasing a patient's sense of presence during exposure therapy. This study aimed to systematically review current evidence regarding the efficacy of VRET and ARET as PTSD treatment.

**Methods:** A systematic electronic database search, a systematic quality assessment and two meta-analyses were conducted in accordance with PRISMA guidelines.

**Results:** Eleven studies on the efficacy of VRET for PTSD ( $n = 438$ ) were found, but no studies on the efficacy of ARET. The majority of VRET studies were of a low quality and had heterogeneous results. Meta-analyses showed VRET outperformed waitlist control (standardized mean difference  $-0.64$  (95% CI  $-1.05$  to  $-0.22$ )) while no significant difference was found between VRET and active treatment conditions (standardized mean difference  $-0.25$  (95% CI  $-0.77$  to  $0.27$ )).

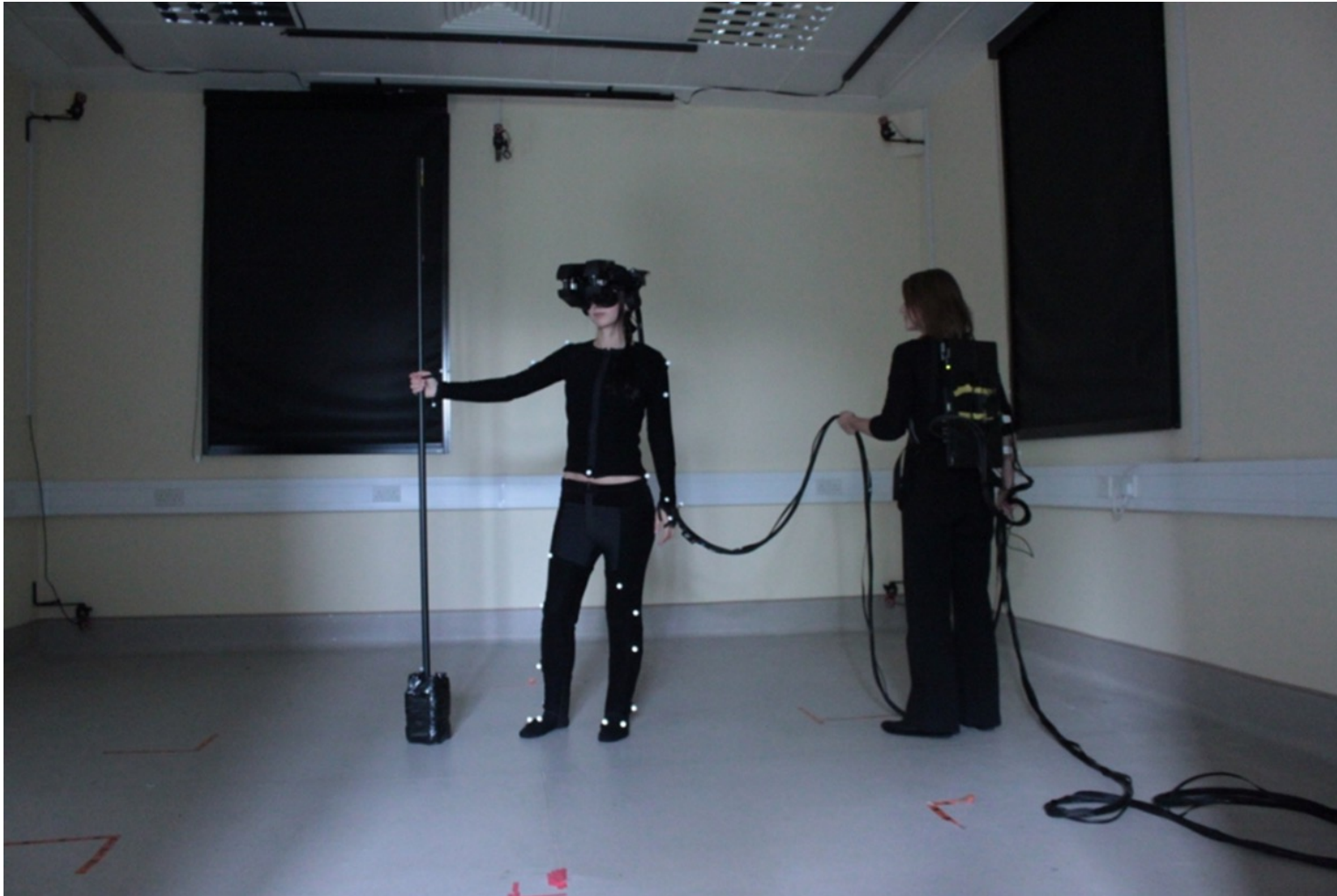
**Conclusion:** VRET was superior to waitlist control groups and as effective as other psychotherapies. However, the results showed considerable heterogeneity due to the low number of studies and variety of VRET methods. VRET may be an effective alternative to current treatments and shows promise for the treatment of PTSD patients that have not responded to previous treatment. Future research should focus on high quality RCTs, including information on side effects and adverse events, with sufficient numbers of participants. This study recognizes a research gap regarding the efficacy of ARET, while it may have potential for PTSD treatment.

- Eleven studies (438 patients in total)
- Moderate effect ( $d=0.64$ )
- Outcomes similar to other evidence-based therapies (though indications of slightly higher effect size).



## My second VR lab (2010)

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# Virtual reality in the treatment of persecutory delusions: randomised controlled experimental study testing how to reduce delusional conviction

Daniel Freeman, Jonathan Bradley, Angus Antley, Emilie Bourke, Natalie DeWeever, Nicole Evans, Emma Černis, Bryony Sheaves, Felicity Waite, Graham Dunn, Mel Slater and David M. Clark

BJPsych

The British Journal of Psychiatry (2016)  
209, 62–67. doi: 10.1192/bjp.bp.115.176438



David Clark



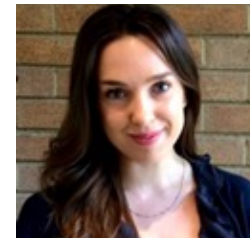
Mel Slater



Jonathan Bradley



Angus Antley



Emily Bourke



Natalie DeWeever



Nicole Evans



Emma Černis



Bryony Sheaves



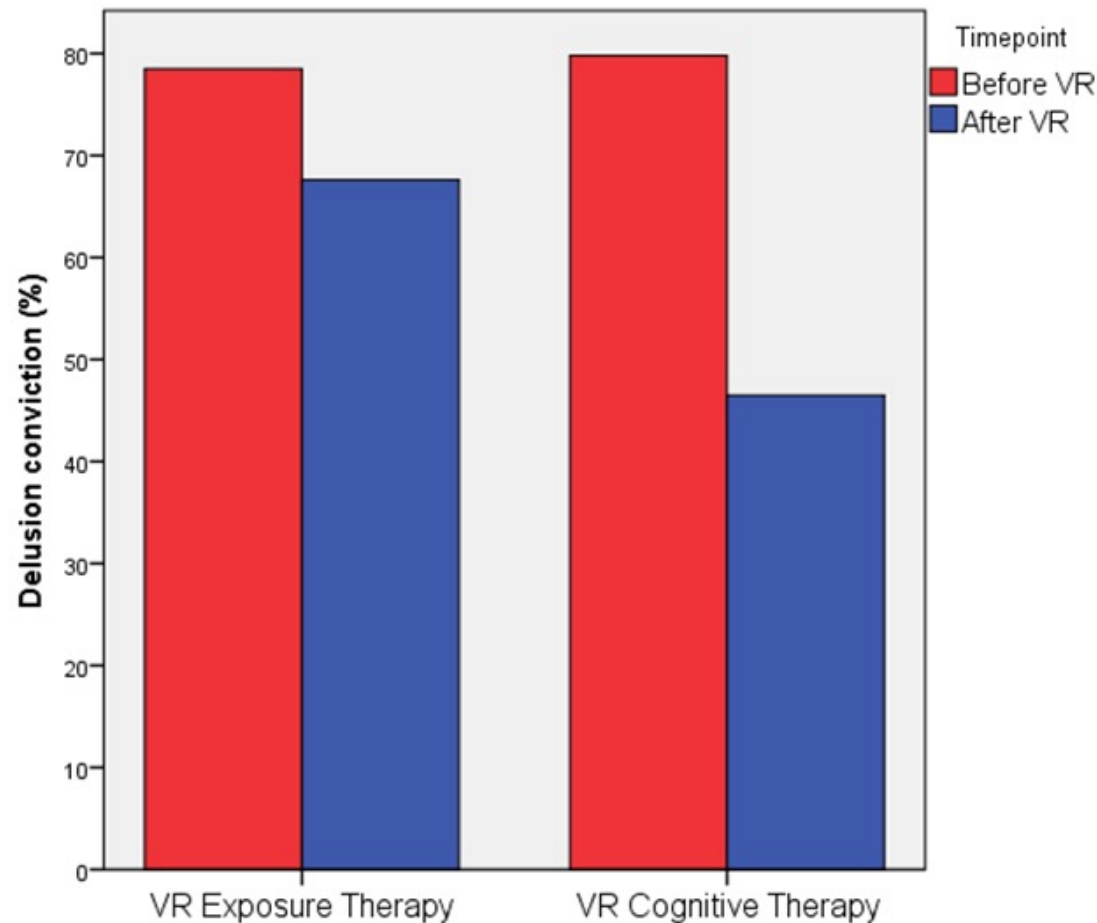
Felicity Waite



Graham Dunn

# Outcome on persecutory delusions

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Compared with VR Exposure, VR Cognitive Therapy led to a further 22.0% point reduction,  $p=.024$ ,  $d=1.3$ .



# The traditional VR approach

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- Reliant on the therapist – therapy with VR added.
- VR just a trigger for difficulties.
- Reliant on computer scientist support and expensive kit.

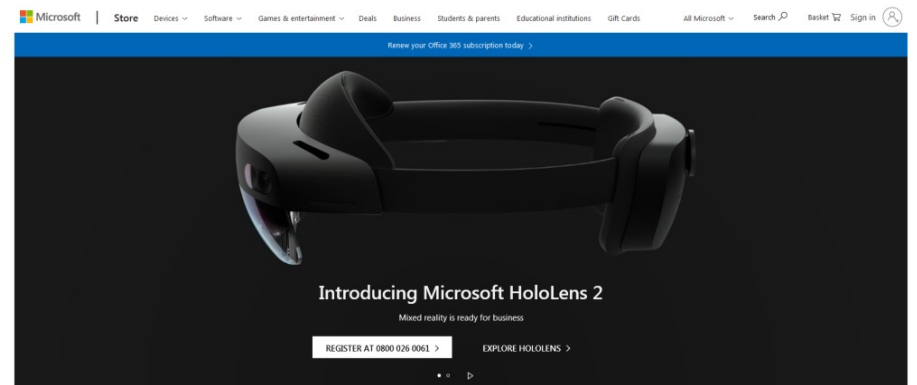
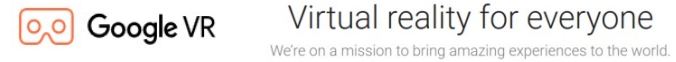
=> Highly specialist and therefore unlikely to have impact.



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**Things have changed  
enormously**

# VR investment





## The *new* advantages of VR

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- Potential to automate the provision of psychological therapy - a therapist is not needed.
- Can go beyond just simulating what would do in the real world.
- The treatment can be made compelling and interactive.

=> An opportunity to provide high quality psychological treatment to millions more people.



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**Can psychological therapy be  
automated in VR?**

# Automated psychological therapy using immersive virtual reality for treatment of fear of heights: a single-blind, parallel-group, randomised controlled trial

Daniel Freeman, Polly Haselton, Jason Freeman, Bernhard Spanlang, Sameer Kishore, Emily Albery, Megan Denne, Poppy Brown, Mel Slater, Alecia Nickless



## Summary

**Background** Engaging, interactive, and automated virtual reality (VR) treatments might help solve the unmet needs of individuals with mental health disorders. We tested the efficacy of an automated cognitive intervention for fear of heights guided by an avatar virtual coach (animated using motion and voice capture of an actor) in VR and delivered with the latest consumer equipment.

**Methods** We did a randomised trial of automated VR versus usual care. We recruited adults aged older than 18 years with a fear of heights by radio advertisements in Oxfordshire, UK. We diagnosed fear of heights if participants scored more than 29 on the Heights Interpretation Questionnaire (HIQ). We randomly allocated participants by computer in a 1:1 ratio to either automated VR delivered in roughly six 30-min sessions administered about two to three times a week over a 2-week period (intervention group) or to usual care (control group). Randomisation was stratified by severity of fear of heights. The research team, who were unaware of the random allocation, administered three fear-of-height assessments, at baseline (0 weeks), at the end of treatment (2 weeks), and at follow-up (4 weeks). The primary outcome measure was HIQ score (range 16–80, with higher scores indicating greater severity). This trial is registered with the ISRCTN registry, number ISRCTN11898283.

**Findings** Between Nov 25, 2017, and Feb 27, 2018, 100 individuals were enrolled and underwent randomisation, of whom 49 were assigned to the VR treatment group and 51 to the control group. All participants completed the 4-week follow-up. The mean total treatment time in VR was 124·43 min (SD 34·23). Compared with participants in the control group, the VR treatment reduced fear of heights at the end of treatment (mean change score –24·5 [SD 13·1] in the VR group *vs* –1·2 [7·3] in the control group; adjusted difference –24·0, 95% CI –27·7 to –20·3; Cohen's *d*=2·0; *p*<0·0001). The benefit was maintained at follow-up (mean change score –25·1 [SD 13·9] in the VR group *vs* –1·5 [7·8] in the control group; adjusted difference –24·3, 95% CI –27·9 to –20·6; Cohen's *d*=2·0; *p*<0·0001). The number needed to treat to at least halve the fear of heights was 1·3. No adverse events were reported.

**Interpretation** Psychological therapy delivered automatically by a VR coach can produce large clinical benefits. Evidence-based VR treatments have the potential to greatly increase treatment provision for mental health disorders.

**Funding** Oxford VR, and the National Institute of Health Research Oxford Health Biomedical Research Centre.

*Lancet Psychiatry* 2018;  
5: 625–32

Published Online  
July 11, 2018  
[http://dx.doi.org/10.1016/S2215-0366\(18\)30226-8](http://dx.doi.org/10.1016/S2215-0366(18)30226-8)

See [Comment](#) page 606

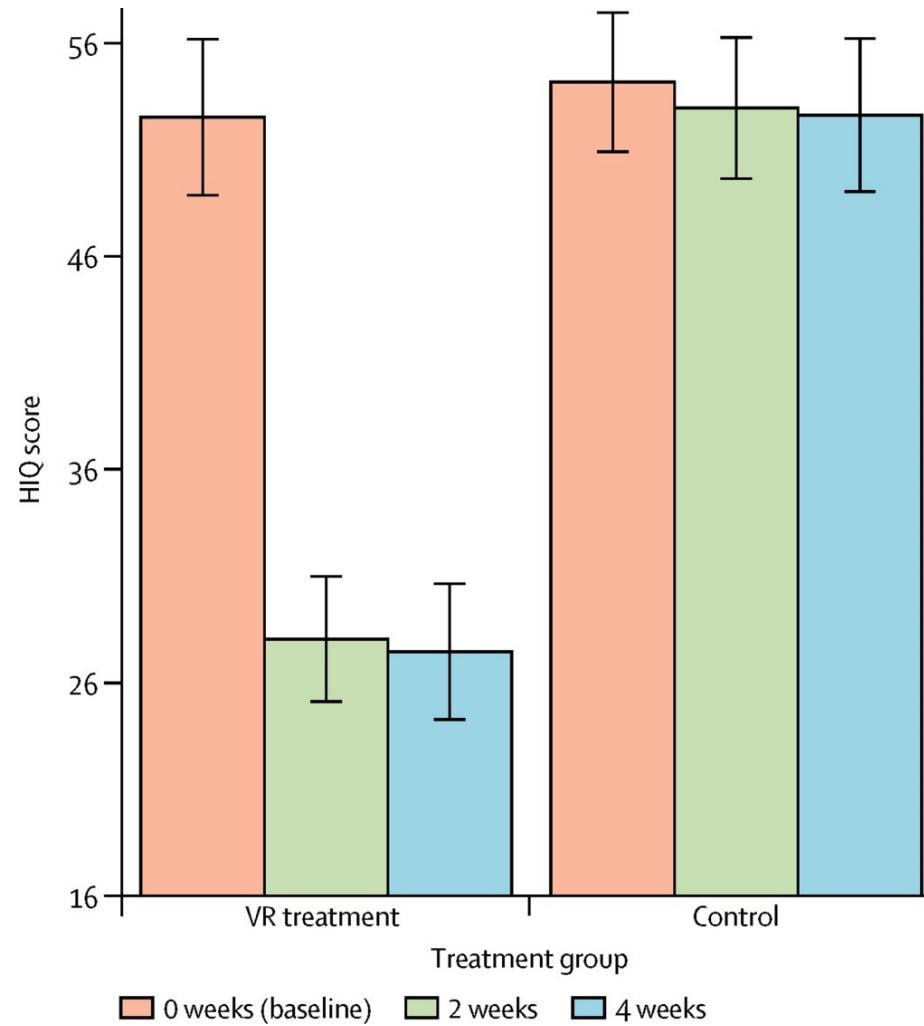
Department of Psychiatry (Prof D Freeman PhD, P Brown BA) and Nuffield Department of Primary Care Health Sciences (A Nickless MSc), University of Oxford, Oxford, UK; Oxford VR, Oxford, UK (Prof D Freeman, P Haselton BSc, J Freeman MA, B Spanlang EngD, E Albery BA, M Denne BSc, M Slater DSc); Oxford Health NHS Foundation Trust, Oxford, UK (Prof D Freeman); Virtual Bodyworks, Barcelona, Spain (B Spanlang, S Kishore PhD, M Slater); and Department of Clinical Psychology and Psychobiology, Faculty of Psychology, University of Barcelona, Barcelona, Spain (M Slater)

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[daniel.freeman@psych.ox.ac.uk](mailto:daniel.freeman@psych.ox.ac.uk)



# Automated therapy

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Effect size = 2.0

NNT to halve fear of heights = 1.3

# The most effective intervention




Journal of Affective Disorders

Volume 282, 1 March 2021, Pages 786–794





Research paper

## Efficacy and acceptability of different interventions for acrophobia: A network meta-analysis of randomised controlled trials

Po-Han Chou <sup>a, b, 1</sup>, Ping-Tao Tseng <sup>c, d, e, f, 1</sup>, Yi-Cheng Wu <sup>g</sup>, Jane Pei-Chen Chang <sup>g, h, i</sup>, Yu-Kang Tu <sup>i, j, k</sup>, Brendon Stubbs <sup>h, k, l, m</sup>, Andre F. Carvalho <sup>m, n, o</sup>, Pao-Yen Lin <sup>o, p, q</sup>, Yen-Wen Chen <sup>d</sup>, Kuan-Pin Su <sup>i, q, r, s</sup> 

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<https://doi.org/10.1016/j.jad.2020.12.172>

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### Highlights

- The most interventions were superior to the control to improve acrophobia.
- Further, the VR coach-delivered psychotherapy was the most efficacious one.
- Only the VR based CBT was associated with higher drop-out rate than the control.
- The most interventions were efficacious and safe for acrophobia management.

# gameChange

Improving lives through VR therapy

[www.gamechangeVR.com](http://www.gamechangeVR.com)

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**“To transform NHS services for patients with psychosis by showing that automated psychological therapy using VR can be scaled up to provide a powerful psychological treatment that changes lives.”**

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# Organisations

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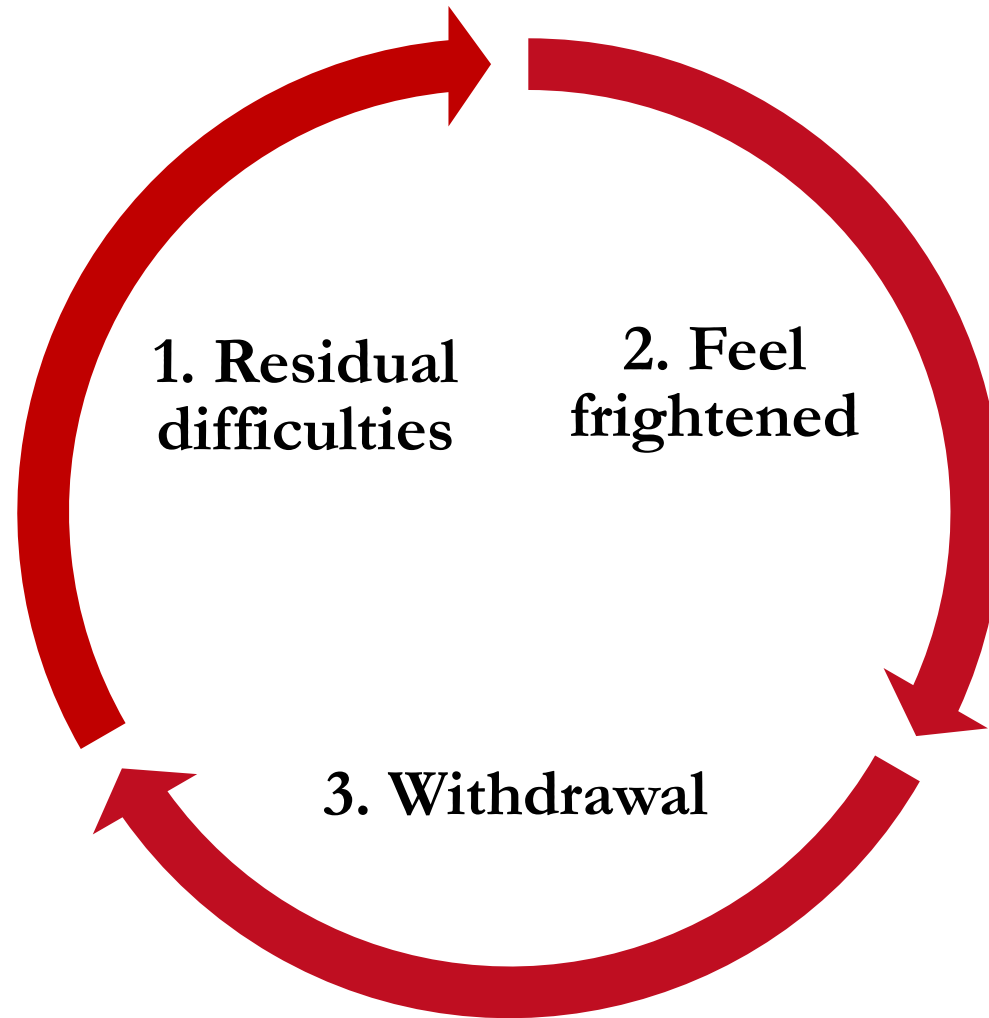
MindTech Healthcare  
Technology Co-operative

oxfordvr



The clinical target: agoraphobic withdrawal

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# Agoraphobic withdrawal

Schizophrenia Research 211 (2019) 44–50



Contents lists available at ScienceDirect

Schizophrenia Research

journal homepage: [www.elsevier.com/locate/schres](http://www.elsevier.com/locate/schres)



## Treatable clinical intervention targets for patients with schizophrenia

Daniel Freeman <sup>\*</sup>, Kathryn M. Taylor, Andrew Molodynski, Felicity Waite

Department of Psychiatry, University of Oxford, UK  
Oxford Health NHS Foundation Trust, UK



### ARTICLE INFO

#### Article history:

Received 22 December 2018

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Available online 17 July 2019

### ABSTRACT

**Background:** Treatment approaches for patients with psychosis need major improvement. Our approach to improvement is twofold: target putative causal mechanisms for psychotic experiences that are treatable and also that patients wish treated. This leads to greater treatment engagement and clinical benefit. To inform mental health service provision we assessed the presence of treatable causal mechanisms and patient treatment preferences.

**Methods:** Patients with non-affective psychosis attending NHS mental health services completed assessments of paranoia, hallucinations, anxious avoidance, worry, self-esteem, insomnia, analytic reasoning, psychological well-being, and treatment preferences.

**Results:** 1809 patients participated. Severe paranoia was present in 53.4% and frequent voices in 48.2%. Of the causal mechanisms, severe worry was present in 67.7%, avoidance at agoraphobic levels in 64.5%, analytic reasoning difficulties in 55.9%, insomnia in 50.1%, poor psychological well-being in 44.3%, strongly negative self-beliefs in 36.6%, and weak positive self-beliefs in 19.2%. Treatment target preferences were: feeling happier (63.2%), worrying less (63.1%), increasing self-confidence (62.1%), increasing activities (59.6%), improving decision-making (56.5%), feeling safer (53.0%), sleeping better (52.3%), and coping with voices (45.3%). Patients with current paranoia and/or hallucinations had higher levels of the causal factors and of wanting these difficulties treated.

**Conclusions:** Patients with non-affective psychosis have high levels of treatable problems such as agoraphobic avoidance, worry, low self-esteem, and insomnia and they would like these difficulties treated. Successful treatment of these difficulties is also likely to decrease psychotic experiences such as paranoia.

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1

Treatment programming

2

Implementation studies

3

Clinical testing

4

Roll-out strategy

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P



## Patient involvement

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In the first six months:

- 16 patient workshops;
- 4 lived experience advisory panel workshops;
- Multiple individual sessions.
- 500+ hours of patient input.



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## The treatment

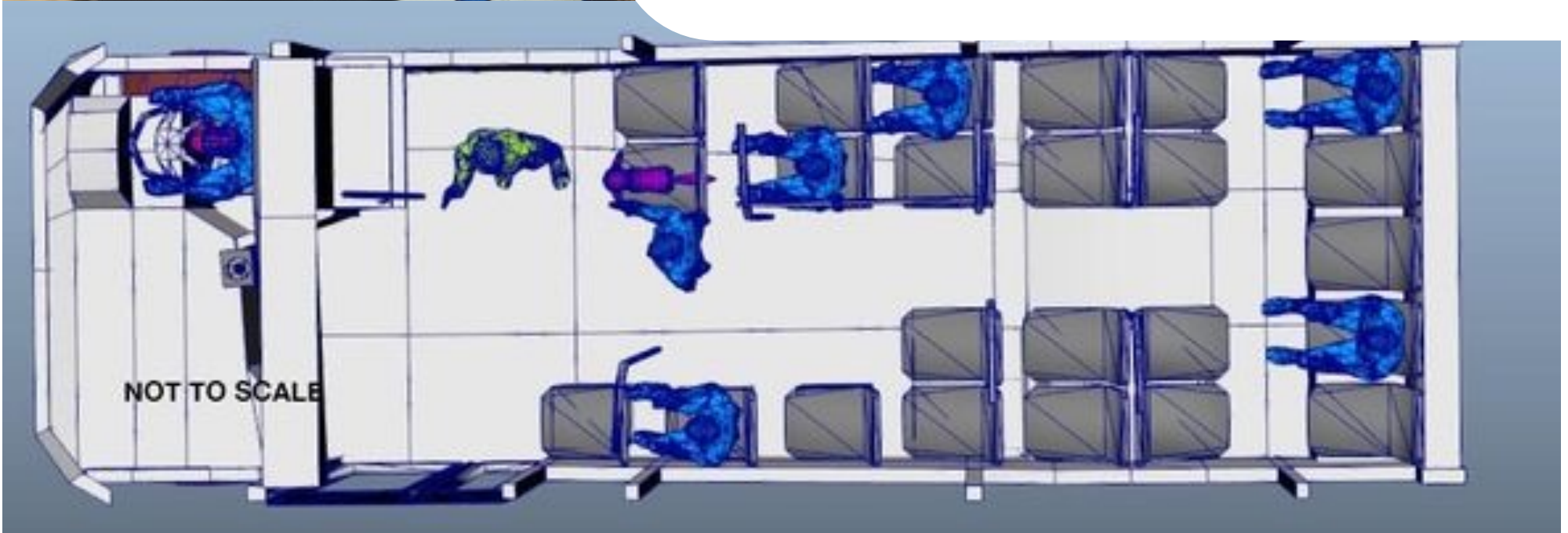
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CE marked, six session  
automated treatment,  
developed with user centred  
design.

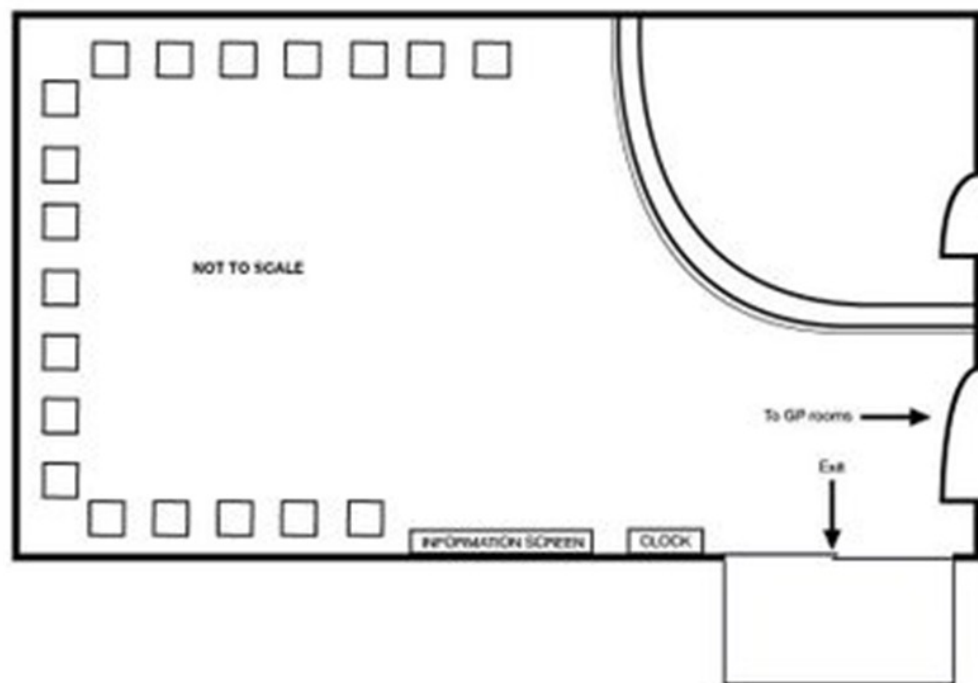
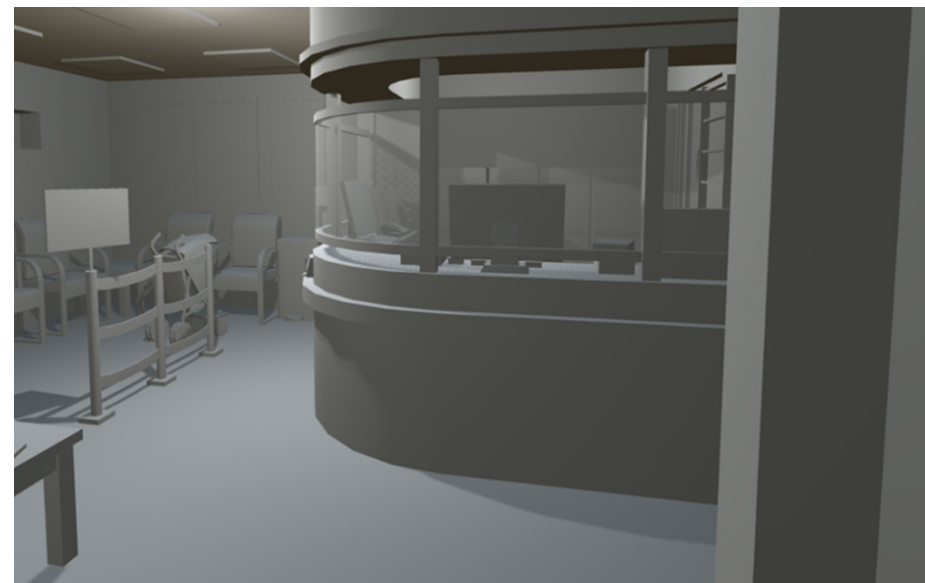




## User-Centred Design



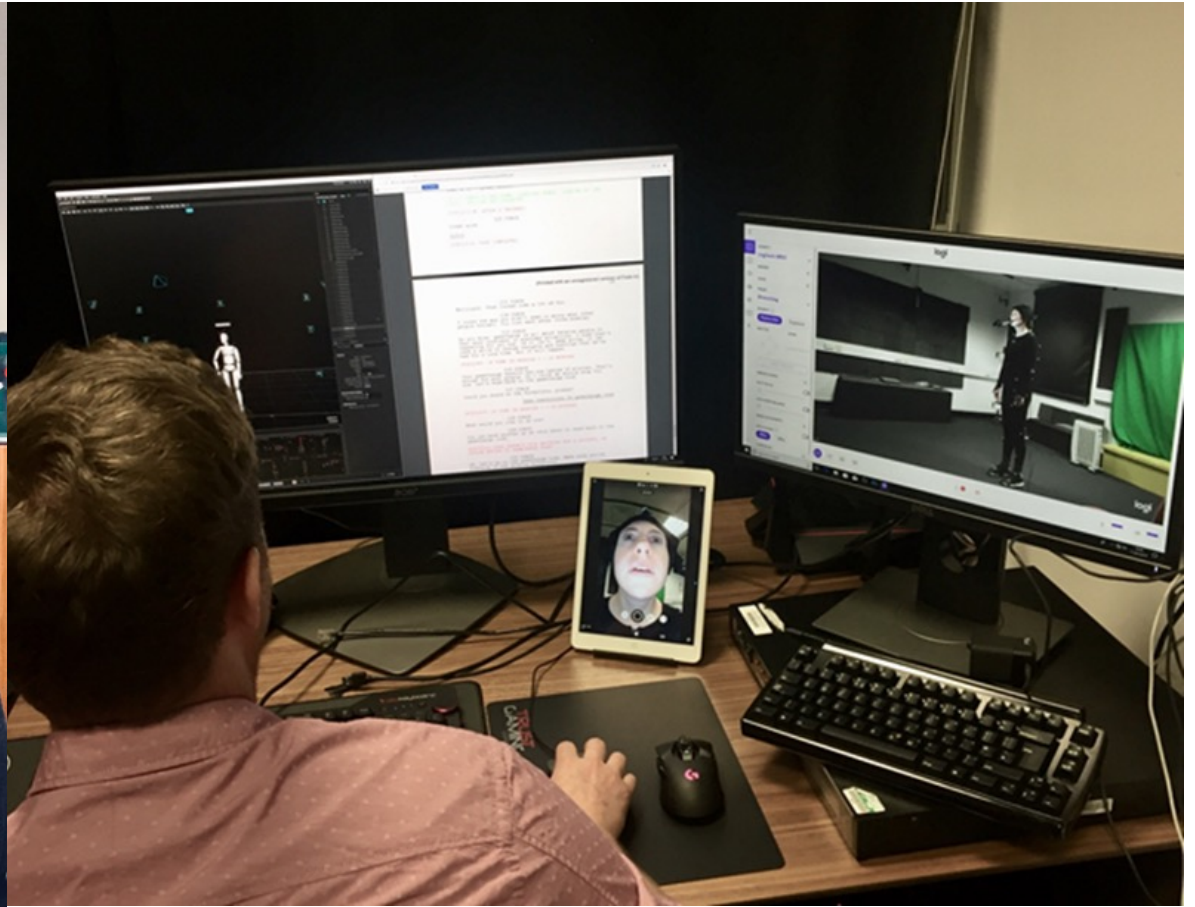






# Motion capture sessions

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# BMJ Open Automated virtual reality (VR) cognitive therapy for patients with psychosis: study protocol for a single-blind parallel group randomised controlled trial (gameChange)

Daniel Freeman,<sup>1,2,3</sup> Ly-Mee Yu,<sup>4</sup> Thomas Kabir,<sup>5</sup> Jen Martin,<sup>6</sup> Michael Craven,<sup>6</sup> José Leal,<sup>7</sup> Sinéad Lambe,<sup>1,2,3</sup> Susan Brown,<sup>6</sup> Anthony Morrison,<sup>8,9</sup> Kate Chapman,<sup>10</sup> Robert Dudley,<sup>11,12</sup> Eileen O'Regan,<sup>13</sup> Aitor Rovira,<sup>1,2,3</sup> Andrew Goodsell,<sup>1,2,3</sup> Laina Rosebrock,<sup>1,2,3</sup> Aislinn Bergin,<sup>6</sup> Tillie L Cryer,<sup>5</sup> Dan Robotham,<sup>5</sup> Humma Andleeb,<sup>5</sup> John R Geddes,<sup>1,2,3</sup> Chris Hollis,<sup>6</sup> David M Clark,<sup>2,3,14</sup> Felicity Waite<sup>1,2,3</sup>

**To cite:** Freeman D, Yu L-M, Kabir T, *et al.* Automated virtual reality (VR) cognitive therapy for patients with psychosis: study protocol for a single-blind parallel group randomised controlled trial (gameChange). *BMJ Open* 2019;9:e031606. doi:10.1136/bmjopen-2019-031606

► Prepublication history for this paper is available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2019-031606>).

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Accepted 24 July 2019

## ABSTRACT

**Introduction** Many patients with psychosis experience everyday social situations as anxiety-provoking. The fears can arise, for example, from paranoia, hallucinations, social anxiety or negative-self beliefs. The fears lead patients to withdraw from activities, and this isolation leads to a cycle of worsening physical and mental health. Breaking this cycle requires highly active treatment directly in the troubling situations so that patients learn that they can safely and confidently enter them. However patients with psychosis seldom receive such life-changing interventions. To solve this problem we have developed an automated psychological treatment delivered in virtual reality (VR). It allows patients to experience computer simulations of the situations that they find anxiety-provoking. A virtual coach guides patients, using cognitive techniques, in how to overcome their fears. Patients are willing to enter VR simulations of anxiety-provoking situations because they know the simulations are not real, but the learning made transfers to the real world.

**Methods and analysis** 432 patients with psychosis and anxious avoidance of social situations will be recruited from National Health Service (NHS) secondary care services. In the gameChange trial, they will be randomised

## Strengths and limitations of this study

- A multicentre randomised controlled trial of 432 patients with psychosis being seen in National Health Service mental health trusts, which will be the largest trial of virtual reality (VR) used to treat a mental health condition.
- Automated delivery of the VR intervention meaning high treatment fidelity and a highly scalable treatment that could greatly increase access to psychological therapy.
- Mediation built into the treatment design can test whether the treatment works as hypothesised.
- The control condition is treatment as usual meaning that it cannot be definitively established which VR treatment elements produce clinical change.
- It is impossible to blind patients to the treatment allocation, which could introduce bias into the treatment effect estimation.

**Trial registration number** ISRCTN17308399.

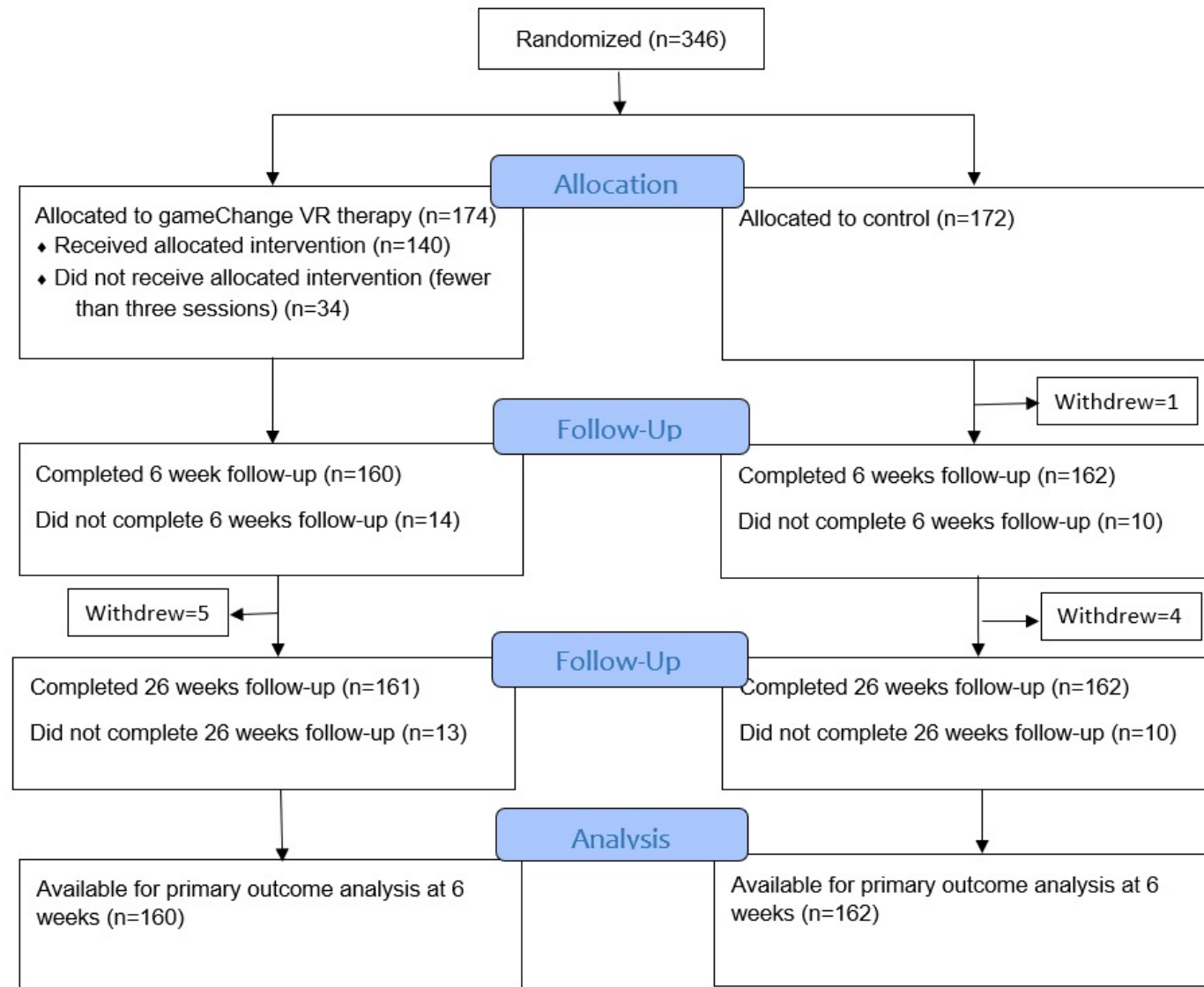
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# **Automated virtual reality therapy to treat agoraphobic avoidance and distress in patients with psychosis (gameChange): a multicentre, parallel group, single-blind, randomised controlled trial in England with mediation and moderation analyses**

Daniel Freeman, Sinéad Lambe, Thomas Kabir, Ariane Petit, Laina Rosebrock, Ly-Mee Yu, Robert Dudley, Kate Chapman, Anthony Morrison, Eileen O'Regan, Charlotte Aynsworth, Julia Jones, Elizabeth Murphy, Rosie Powling, Ushma Galal, Jenna Grabey, Aitor Rovira, Jennifer Martin, Chris Hollis, David M. Clark, Felicity Waite, on behalf of the gameChange Trial Group



# Trial flow diagram



# Summary

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- VR has enormous potential for assessment, understanding, and treatment of mental health problems. The best is yet to come.
- VR is not an answer in itself. Can be done very well...or not so well. The devil is in the detail of each application. Precision is needed. Linking with translation of best theory. And clinical testing.
- Can VR be used in therapeutic ways impossible in the real world to produce greater clinical effects than face-to-face therapy?

