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Automated VR therapy for improving positive self-beliefs and psychological well-being in young patients with psychosis: a proof of concept evaluation of Phoenix VR self-confidence therapy

Daniel Freeman[1,2] , Jason Freeman[1], Memoona Ahmed[1], Phoebe Haynes[1], Helen Beckwith[1,2], Aitor Rovira[1,2], Andre Lages Miguel[1], Rupert Ward[1], Matthew Bousfield[1], Ludovic Riffiod[1], Thomas Kabir[1,2], Felicity Waite[1,2] and Laina Rosebrock[1,2]

[1]Department of Experimental Psychology, University of Oxford, Oxford, UK and [2]Oxford Health NHS Foundation Trust, Oxford, UK

Corresponding author: Daniel Freeman; Email: daniel.freeman@psy.ox.ac.uk

Abstract

Background: Low self-confidence in patients with psychosis is common. This can lead to higher symptom severity, withdrawal from activities, and low psychological well-being. There are effective psychological techniques to improve positive self-beliefs but these are seldom provided in psychosis services. With young people with lived experience of psychosis we developed a scalable automated VR therapy to enhance positive-self beliefs.
Aims: The aim was to conduct a proof of concept clinical test of whether the new VR self-confidence therapy (Phoenix) may increase positive self-beliefs and psychological well-being.
Method: Twelve young patients with non-affective psychosis and with low levels of positive self-beliefs participated. Over 6 weeks, patients were provided with a stand-alone VR headset so that they could use Phoenix at home and were offered weekly psychologist meetings. The outcome measures were the Oxford Positive Self Scale (OxPos), Brief Core Schema Scale, and Warwick-Edinburgh Well-being Scale (WEMWBS). Satisfaction, adverse events and side-effects were assessed.
Results: Eleven patients provided outcome data. There were very large end-of-treatment improvements in positive self-beliefs (OxPos mean difference = 32.3; 95% CI: 17.3, 47.3; Cohen's $d = 3.0$) and psychological well-being (WEMWBS mean difference = 11.2; 95% CI: 8.0, 14.3; Cohen's $d = 1.5$). Patients rated the quality of the VR therapy as: excellent ($n = 9$), good ($n = 2$), fair ($n = 0$), poor ($n = 0$). An average of 5.3 ($SD = 1.4$) appointments were attended.
Conclusions: Uptake of the VR intervention was high, satisfaction was high, and side-effects extremely few. There were promising indications of large improvements in positive self-beliefs and psychological well-being. A randomized controlled clinical evaluation is warranted.

Keywords: Cognitive behavioural therapy (CBT); Positive psychology; Psychosis; Self-esteem; Virtual reality (VR)

Introduction

Low self-esteem is a core psychological factor in the occurrence of many mental health disorders (Miller *et al.*, 1989; Silverstone and Salsali, 2003; Sowislo and Orth, 2013). It stems from both the presence of negative self-beliefs and the relative absence of positive self-beliefs (Brown *et al.*, 1990;

Fowler *et al.*, 2006). Such self-doubt likely creates a sense of vulnerability that psychiatric symptoms build upon, which inhibits engagement in activities, and that lowers psychological well-being (e.g. Mann *et al.*, 2004; Marshall *et al.*, 2014; Paradise and Kernis, 2002). Developing, elaborating and consolidating positive self-beliefs may be one route to increase self-confidence and hence improve overall psychological well-being. In this paper we report the first evaluation of a potentially scalable immersive therapy designed to improve positive self-beliefs in patients at the early stages of psychosis.

Our work has focused in particular on positive self-beliefs in the context of psychosis. In a study of 1800 patients diagnosed with non-affective psychosis attending clinical services, lower levels of positive self-beliefs assessed by the 6-item subscale of the Brief Core Schema Scale (Fowler *et al.*, 2006) were associated with higher levels of paranoia ($r = -0.17$) and hallucinations ($r = -0.20$) (Freeman *et al.*, 2019). Levels of positive self-beliefs were also strongly correlated in this patient group with levels of psychological well-being ($r = 0.62$). Almost two thirds of the group reported that they wanted to be more self-confident. We have also shown that it is possible to improve positive self-beliefs in patients with psychosis via face-to-face therapy sessions (Freeman *et al.*, 2014). We conducted a pilot randomized controlled trial with 30 patients with persistent persecutory delusions in the context of a non-affective psychosis diagnosis. Compared with treatment as usual, six sessions of cognitive behavioural therapy and positive psychology techniques produced large improvements in positive self-beliefs (Cohen's $d = 1.0$) and psychological well-being (Cohen's $d = 1.2$). The intervention was designed to improve self-confidence, and the techniques most often used were increasing engagement in meaningful positive activities, reviewing the person's strengths, savouring, and a positive data log.

Psychological therapy development work can be greatly facilitated by precision in measurement. In a representative general population cohort, and working with young people with lived experience of psychosis, we have recently developed a scale to identify potentially tractable positive self-cognitions strongly connected to psychological well-being (Freeman *et al.*, 2023). The Oxford Positive Self Scale (OxPos) consists of four types of positive self-beliefs that link to established psychological intervention techniques. The first type is *mastery*, which denotes beliefs about achieving things, doing things well, and succeeding. The techniques of behavioural activation and mastery and control methods (Dimidjian *et al.*, 2011) are particularly relevant here. The second type is *strength*, which denotes beliefs about coping, not giving up, and keeping going. Behavioural experiments in challenging situations (Bennett-Levy *et al.*, 2004) are relevant in this case. The third type of positive self-belief is *enjoyment*, consisting of beliefs about enjoying things and being able to relax. Savouring and relaxation techniques (Manzoni *et al.*, 2008; Seligman, 2019) are pertinent here. The final type is *character*, which refers to beliefs about being a good person. Strengths and values identification (Seligman, 2019) can be especially helpful here. Structural equation modelling indicated that the OxPos scale explains 68.6% of variance in psychological well-being. The scale was developed with cut-offs to identify individuals who might need help.

Using virtual reality (VR) to deliver psychological therapy to enhance positive self-beliefs may have a number of advantages. First, it may be therapeutically beneficial: it could provide direct experiences of achievement, coping, enjoyment and relaxation that could then be used to spark such activities in the real world. Second, treatment can be made compelling and entertaining, and in our experience VR is viewed very positively by young people, meaning that uptake of treatment could be high. Third, automating treatment by inclusion of a virtual coach boosts the potential for scalability. New stand-alone VR headsets with improved user interfaces mean that it is now possible to leave kits with patients so that they can complete the therapy in their own time at home. In light of these potential advantages, we set out to develop the first automated immersive virtual reality treatment for self-confidence for young patients with schizophrenia. VR is increasingly being evaluated for different uses for patients diagnosed with psychosis (e.g. Cella *et al.*, 2022; Freeman *et al.*, 2016; Freeman *et al.*, 2022; Nijman *et al.*, 2023;

Pot-Kolder *et al.*, 2018). We aimed to provide initial Phase I proof of concept data for its potential to improve positive self-beliefs and psychological well-being. We focused on young patients with psychosis: it is important to arrest as soon as possible the downward spiral that a lack of self-confidence can bring. Moreover, at this life stage greater social, educational and employment opportunities may be available. Phoenix VR therapy was developed in tandem with the Oxford Positive Self Scale. Therapeutic tasks in VR were automated, with a staff member visiting regularly to help transfer the learning to the real world. We also wished to assess satisfaction with the new therapy and levels of any side effects. An *a priori* criterion was set that only if this Phase I evaluation showed at least moderate size improvements in positive self-beliefs would we then proceed to a Phase II randomized controlled trial.

Method

Design

The evaluation had an A-B design. Participants were assessed by a research assistant before (0 weeks) and after (6 weeks) receiving the Phoenix VR therapy.

Participants

Participants were NHS patients diagnosed with non-affective psychosis, with low positive self-beliefs, and aged 16–26 years old. The inclusion criteria were: participant is willing and able to give informed consent for participation in the trial; aged between 16 and 26 years old; attending NHS mental health services for treatment of psychosis; primary clinical diagnosis of non-affective psychosis (schizophrenia, schizoaffective disorder, delusional disorder, or psychosis NOS); low levels of positive self-beliefs indicated by a score of 50 or lower on the Oxford Positive Self Scale (the optimal cut-off for identifying the bottom quartile of the general population for level of psychological well-being as assessed by the Warwick-Edinburgh Mental Well-being Scale) (Freeman *et al.*, 2023a); and stable medication for at least one month with no significant changes planned. The exclusion criteria were: a primary diagnosis of another mental health condition (e.g. substance use disorder) that would be the first clinical priority to treat; current engagement in any other intensive individual psychological therapy; in forensic settings or Psychiatric Intensive Care Unit (PICU); command of spoken English inadequate for engaging in the VR therapy; photosensitive epilepsy or significant visual, auditory or balance impairment that would make use of VR inappropriate; significant learning difficulties that would prevent the completion of assessments. Participants were recruited from early intervention psychosis services and community mental health services in Oxford Health NHS Foundation Trust, Berkshire Healthcare NHS Foundation Trust, and Northamptonshire Healthcare NHS Foundation Trust.

Assessments

Oxford Positive Self Scale (OxPos; Freeman et al., 2023a)

The OxPos is a 24-item self-report scale assessing four types of positive self-beliefs: mastery (e.g. 'I can achieve things'), strength (e.g. 'I rise to the challenge'), enjoyment (e.g. 'I can have fun'), and character (e.g. 'I am a good person'). Each item is rated on a scale comprising: Do not believe it (0), Believe it slightly (1), Believe it moderately (2), Believe it very much (3), and Believe it totally (4). Therefore, scores can range between 0 and 96. Higher scores indicate higher levels of positive self-beliefs. It was developed with a representative sample of 2500 members of the UK population, with further validation in another 3000 individuals. The psychometrics of the scale, including test–retest reliability, are excellent. A higher-order confirmatory factor analysis model showed that a total scale score can be used, as well as the four subscale scores. In the current study, the Cronbach's alpha for the OxPos at baseline was 0.92, $n = 12$.

Warwick-Edinburgh Mental Well-being Scale (WEMWBS; Tennant et al., 2007)

The WEMWBS is a 14-item scale assessing well-being over the past fortnight. Each item (e.g. 'I've been feeling optimistic about the future') is rated on a 1 (none of the time) to 5 (all of the time) scale, and therefore the total score can range from 14 to 70, with higher scores indicating a greater level of well-being. In the current study, the Cronbach's alpha at baseline was 0.90, $n = 12$.

Brief Core Schema Scales-Self scales (BCSS; Fowler et al., 2006)

The self-report BCSS has six items assessing negative beliefs about the self (e.g. 'I am unloved') and six items assessing positive beliefs about the self (e.g. 'I am respected'). Each item is rated on a 5-point scale (0–4). Negative and positive self scores are distinct and summed separately. The scale was developed in a psychosis population and the Cronbach's alphas were 0.84 for negative self and 0.79 for positive self (Fowler *et al.*, 2006). Higher scores reflect greater endorsement of items.

Client Satisfaction Questionnaire (CSQ; Attkisson and Zwick, 1982; Attkisson and Greenfield, 1999)

Four items were used from the CSQ, with two additional questions about the number of sessions and the staff member supporting VR delivery (see Table 2 for all questionnaire items). This was the same satisfaction assessment as used in the gameChange trial (Freeman *et al.*, 2022).

Oxford-VR Side Effects Checklist (O-VRSE; Freeman et al., 2023b)

Participants are asked to report whether they had any of the 33 experiences listed in the checklist during the provision of VR therapy (see Table 3 for all items). 'No' is coded as 0, and 'Yes' is coded as 1.

Adverse events (AEs)

AEs were recorded throughout the trial and would include but were not limited to: death; suicide attempts; significant self-harm; any violent incident (needing police involvement); bizarre or unusual behaviour with high risk to self or others; formal complaints about therapy; hospital admission; any event which is life threatening; any event which results in persistent or significant disability or incapacity; any event which is otherwise considered medically significant.

The intervention

The evaluation tested Phoenix VR therapy, a virtual-reality application recommended for adults (16+) attending psychosis services with low levels of positive self-beliefs. It is intended to increase positive self-beliefs. The treatment was designed and programmed by our team at the University of Oxford. Young people with lived experience took part in the design process (Rosebrock *et al.*, submitted). Phoenix is a UKCA marked, Class I medical device (stand-alone software as a medical device). The application was built using the Unity 3D platform and was run on a Meta Quest 2 VR headset.

The primary treatment goal is to help young people with a diagnosis of schizophrenia (or related condition) build up positive self-beliefs and thus to increase their psychological well-being. Phoenix is used to spark positive self-beliefs that are then consolidated via real-world activities. Patients can keep the headset for the duration of the therapy (6 weeks) in order to use Phoenix whenever they choose. Generally, it is recommended to be used at least two or three times a week. The treatment is supported by a staff member over six sessions. In the first meeting the staff member introduces Phoenix and helps the person try it out. Over the course of treatment the staff member assists the person in setting real-world goals and between-session tasks to increase positive self-beliefs (e.g. scheduling activities, positive data logs). Typically, the patient spends
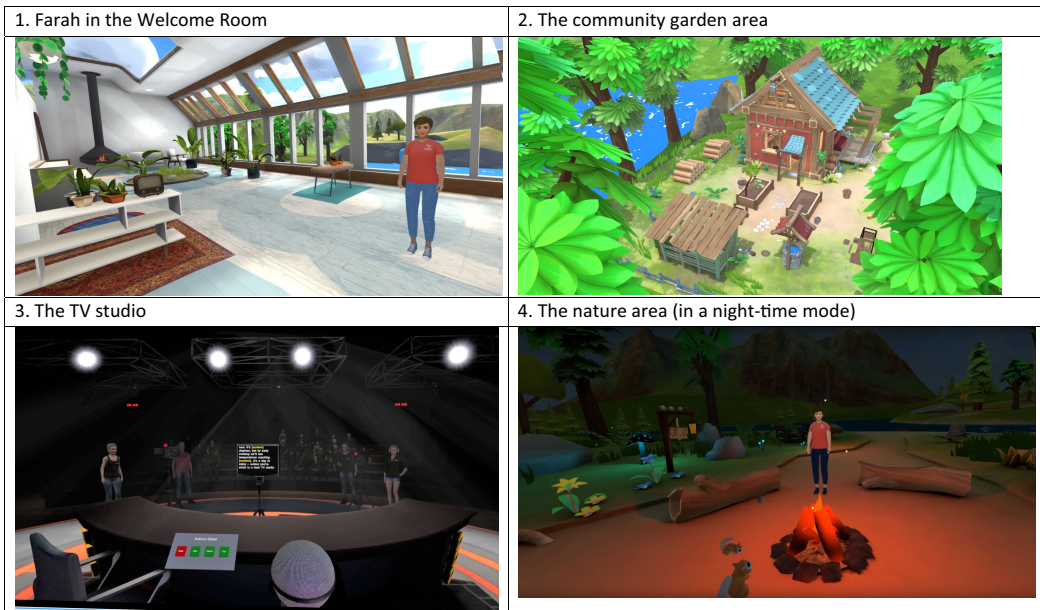
Figure 1. Pictures of the areas within the Phoenix VR programme.

approximately 20–30 minutes in VR during each therapist meeting. However, given that the headset is left with the person, the meeting could involve less or even no time in VR.

The six key mechanisms of action within Phoenix are to: build vivid memories of successful and rewarding interactions; identify strengths; learn to tolerate fearful emotions and still succeed; learn to appraise situations more positively and with more self-kindness; develop the ability to savour positive experiences and connect with other people; and increase engagement in meaningful activities. The approach built on the learning made in our face-to-face therapy trial delivery (Freeman *et al.*, 2014) but we only used techniques that VR might deliver well. Thus VR was used to implement techniques that concerned making direct learning through experience. For instance, we would use VR to help a person notice strengths activated during tasks but we would not use VR to work through a list of strengths and values. In Phoenix there are three main VR scenarios, each with a distinct therapeutic focus. A community garden is the setting for activities designed to create a sense of achievement and mastery and thus develop that belief that 'I can make a difference'. These activities comprise ten tasks relating to the care of plants, animals and a farmhouse. In a virtual TV studio, the user has to speak to camera in front of an audience, with ten levels of difficulty. The aim is for users to learn that they can succeed in challenging situations and thus develop the belief that 'I can do this'. The third scenario is the edge of a forest near a lake, and the activities include relaxation activities and games. By engaging in pleasurable activities, the user develops the belief that 'I can enjoy things'. Throughout the VR treatment a virtual coach (called Farah) guides the participant in the best way to think, feel and respond. Farah first meets users in her glass-fronted office that overlooks mountains, and provides instructions throughout the programme. Users choose which VR scenarios they wish to complete and can repeat activities. Pictures of the Phoenix scenarios are provided in Fig. 1.

Analysis

The focus of this proof of concept evaluation was on providing descriptive summary statistics for the outcome variables. Paired *t*-tests were conducted to assess change in the outcomes.

The analysis did not include reporting *p*-values, following recommendations that 'The analysis of a pilot study should be mainly descriptive or should focus on confidence interval estimation.' (Lancaster *et al.*, 2004). Effect sizes (Cohen's *d*) were calculated by dividing the change score obtained from the *t*-test by the standard deviation of the baseline average score. Satisfaction and side-effect data are presented in the summary tables (Tables 2 and 3). All statistical testing was conducted using SPSS version 28.0 (IBM, 2021). The aim was to recruit 12 patients to evaluate an initial signal of potential efficacy.

Results

There were 23 referrals to the study. Seven patients declined to be screened. The eligibility assessment was completed with 16 patients. Three patients did not have low levels of positive self-beliefs and one patient was receiving alternative psychological therapy. Therefore 12 patients entered the study. The first patient consented on 9 December 2022 and the last patient consented on 6 April 2023. The last data were collected on 23 May 2023.

The average age of the participants was 21.6 ($SD = 2.8$) (minimum $= 17$, maximum $= 26$). Eight participants were male and four participants were female. Eight participants were White, two participants were Indian, one participant was Pakistani, and one participant identified as White/Asian. All participants were single. Eight participants were unemployed and four were students. Ten participants were attending early intervention for psychosis services and one participant was attending a community mental health team, with two patients having received a diagnosis of schizophrenia and ten patients having an unspecified psychosis diagnosis. Ten participants were taking anti-psychotic medication, with a chlorpromazine equivalent mean daily dose of 146 mg ($SD = 47.6$) and a defined daily dose (DDD) of 0.81 ($SD = 0.21$). Eight patients were prescribed anti-depressants, no patients were prescribed anxiolytics, and one patient was prescribed a mood stabilizer.

Eleven patients took the VR headset home, but the other participant declined as they did not have a suitable space to use it. All patients tried the community garden tasks and the forest activities. All but one patient worked through the TV studio public speaking tasks. There was an average of 5.3 ($SD = 1.4$) ($n = 12$) appointments with the psychologist. Nine patients had the planned six meetings. Eight patients reported that they used the VR headset between appointments, with a range from using it once a week to using it every day. The average use per week from these reports was 2.1 ($SD = 0.8$) ($n = 8$).

Eleven patients provided end-of-treatment follow-up data (see Table 1). It can be seen that there are large improvements in every outcome, with the largest change being in positive self-beliefs as assessed by the Oxford Positive Self Scale. All of the 95% confidence intervals for the estimations of improvements were above zero. At an individual level for change in positive self-beliefs, all these participants increased their score on the OxPos. The improvement in number of points on the scale were: 2, 8, 15, 23, 25, 33, 34, 36, 38, 64, 77. From the satisfaction ratings (see Table 2) it appears that Phoenix was experienced positively. Levels of side-effects were very low (Table 3). Only three out of the 27 negative side-effect questionnaire items were endorsed, and these were all reported by the same participant. In contrast, participants reported many positive effects from provision and use of the technology. There were no serious adverse events.

Discussion

It was noticeable observing patients trying Phoenix VR that the immersion in the scenes and the activities brought an immediate lift in mood that gave a renewed optimism to thinking about new activities to add to the coming week. The basic principle of the VR bringing on a direct experience of positive self-beliefs – including a sense of achievement, that challenges could be overcome, and

Table 1. Outcome data (*n* = 11)

	Baseline mean score (SD)	End-of-treatment mean score (SD)	Mean difference estimated from a *t*-test	95% Confidence interval for mean difference estimated from a *t*-test	Cohen's *d*
Oxford Positive Self Scale – total score	38.6 (10.8)	70.8 (14.6)	32.3	17.3, 47.3	3.0
Oxford Positive Self Scale –Mastery score	10.3 (4.1)	20.5 (4.4)	10.2	6.0, 14.4	2.5
Oxford Positive Self Scale – Strength score	10.7 (4.6)	23.2 (5.2)	12.5	6.5, 18.4	2.7
Oxford Positive Self Scale – Enjoyment score	9.8 (3.2)	15.4 (3.6)	5.5	2.3, 8.8	1.7
Oxford Positive Self Scale – Character score	7.7 (2.1)	11.8 (2.4)	4.1	1.1, 6.7	2.0
Warwick Edinburgh Mental Well-being Scale	38.0 (7.6)	49.2 (8.2)	11.2	8.0, 14.3	1.5
Brief Core Schema Scale – Positive Self	6.3 (2.9)	12.6 (6.2)	6.3	2.0, 10.5	2.2
Brief Core Schema Scale – Negative Self	7.6 (4.3)	3.4 (2.9)	–4.2	–0.3, –8.0	1.0

Table 2. Satisfaction with Phoenix VR self-confidence therapy

How would you rate the quality of the virtual reality therapy you have received? *n* **(%)**

Excellent	Good	Fair	Poor
9 (81.8%)	2 (18.2%)	0	0

To what extent has virtual reality therapy helped you feel more self-confident? *n* **(%)**

Yes, it helped a great deal	Yes, it helped a bit	No, it didn't really help	No, it seemed to make things worse
7 (63.6%)	4 (36.4%)	0	0

What did you think of the number of virtual reality therapy sessions that you received? *n* **(%)**

	Too many sessions	Just the right number of sessions	Too few sessions
	0	8 (72.7%)	3 (27.3%)

Was the member of staff supporting you with the VR therapy helpful? *n* **(%)**

Yes, they were very helpful	Yes, they were somewhat helpful	No, they didn't really help	No, they were very unhelpful
11	0	0	0

How likely are you to recommend virtual reality therapy to friends and family if they needed similar care or treatment? *n* **(%)**

Extremely likely	Likely	Neither likely or unlikely	Unlikely	Extremely unlikely
3 (27.3%)	8 (72.7%)	0	0	0

In an overall, general sense, how satisfied are you with the virtual reality therapy you have received? *n* **(%)**

Very satisfied	Mostly satisfied	Indifferent or mildly dissatisfied	Quite dissatisfied
7 (63.6%)	4 (36.4%)	0	0

that things could be enjoyed – that could facilitate making changes in the real world did seem to be realized. Phoenix was described by a participant as a 'stepping stone' to getting back to being engaged in meaningful activity. Many patients renewed contact with friends, re-engaged with hobbies, and increased their baseline of daily activity. Being able to easily use the VR programme itself was also a boost for several patients. The popularity of the intervention was shown by high uptake of the sessions and the positive satisfaction ratings. Over the time of the intervention the participant group overall had very large improvements in positive self-beliefs and large improvements in psychological well-being. There was also a large reduction in negative

Table 3. Endorsement of Oxford-VR Side Effects Checklist (O-VRES) items (ranked by frequency)

	No (*n*)	Yes (*n*)
Negative effects		
I couldn't concentrate on my session because I was constantly thinking about what else might be happening in the room	10	1
The headset made me feel trapped/claustrophobic and I had a panic attack	10	1
I couldn't fully engage in the session because I was constantly thinking about crashing into something	10	1
Using the headset gave me a lasting headache	11	0
Using the headset strained my eyes so I couldn't see properly	11	0
In the days after using VR, I couldn't tell the difference between the computer VR world and the real world	11	0
As a result of using VR, I was really confused about what was real and what was not real	11	0
After my session, I was really concerned that the headset had messed with my thoughts	11	0
Wearing the headset made my voices worse for the rest of the day (not applicable for 3 patients)	8	0
While using VR, I felt so sick that I had to stop (six participants were administered a copy of the questionnaire that did not include this item)	5	0
The people in VR were so creepy that I did not want to continue with the therapy	11	0
Going into the VR environments made me even more worried about other people	11	0
Wearing the headset caused me pain and discomfort for quite some time after the session had finished	11	0
After using VR, the everyday world felt very unreal	11	0
After using VR, I felt very disconnected from the real world	11	0
After wearing the headset, I felt so unsteady that I had difficulties walking	11	0
After my session, I got worried and fearful about what the headset had done to me	11	0
For hours after using VR, I felt sick/unwell	11	0
While I was wearing the headset, I walked into something and injured myself	11	0
Wearing the headset left me with worrying/distressing marks on my face for quite some time	11	0
The virtual coach was very unhelpful and put me off the therapy	11	0
I couldn't concentrate on my session because I was constantly thinking about what the headset might be doing to me	11	0
Going into the VR environments made me have panic attacks	11	0
The therapy got too hard, too quickly, and I felt defeated	11	0
While I was wearing the headset, I fell and injured myself	11	0
VR made me throw up	11	0
After using VR, I began to see disturbing things that other people couldn't see	11	0
Positive effects		
I felt proud of myself for being able to use the VR	2	9
Receiving this new and high-tech therapy made me feel valued	1	10
Using the VR equipment made me feel optimistic	2	9
The headset felt comfortable	2	9
Using the VR equipment made me feel excited	1	10
Using the VR equipment made me feel really special	5	6

self-beliefs. In this early phase testing there was certainly a clear signal of potential efficacy for the intervention on the target of developing positive self-beliefs in order to improve psychological well-being. There was no evidence of significant harm from the intervention. Ten participants had no experience of any side-effects. One participant experienced three brief side-effects but still showed large improvements in the outcomes. The results are very encouraging.

There are several important limitations in these proof of concept data. The study had no control condition, so it cannot be known whether any improvement was due to the VR therapy, rather than recovery with time. The degree to which time in VR or therapist contact resulted in improvement also cannot be determined, although we consider both as important. In this early stage study the intervention was supported by a clinical psychologist in order to observe the therapy in action to inform the development of the therapy manual. In future we expect that Phoenix can be supported by a broad range of mental health staff, including peer-support workers and assistant psychologists. The small number of sessions is likely to make the

intervention cost-effective for healthcare services. We would expect services to provide a headset for patients (which at the time of the study had a cost of £300). There was also no study of potential mechanisms of action of the intervention. We hypothesized that the intervention would change positive self-beliefs in order to improve psychological well-being but this direction of effect was not studied, although the larger changes in positive self-beliefs does support such an interpretation. One participant did not provide any outcome data, which may have skewed the estimates, although this person did attend all the weekly meetings and was reporting improvements to the psychologist. A further limitation was that the assessments were not conducted by blind assessors. There was also no test of whether improvements were maintained after the end of treatment. However, these proof of concept data for Phoenix VR self-confidence therapy clearly exceed the *a priori* criteria for proceeding to a randomized controlled evaluation. The trial has been prospectively registered (ISRCTN10250113) (Freeman *et al.*, submitted).

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