The Cognitive Behaviour Therapist (2025), vol. 18, e22, page 1 of 20
doi:10.1017/S1754470X25000108

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ORIGINAL RESEARCH

The development and pilot testing of VR-SOAP, a modular virtual reality treatment for improving social activities and participation in early psychosis

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(Received 8 July 2024; revised 11 February 2025; accepted 12 February 2025)

Abstract

Background: Young adults with a psychotic disorder often experience difficulties in social functioning. We developed a modular virtual reality treatment to improve social activities and participation by targeting common causes of social functioning difficulties in patients with a psychotic disorder (VR-SOAP). This paper details the development of this intervention, encompassing a piloting phase.
Method: Using an iterative Scrum method with software engineers, clinicians, researchers, and individuals with lived experience of psychosis, we developed a treatment protocol along with a software prototype. Subsequently five patients with a psychotic disorder, aged 18–40, and three therapists, piloted VR-SOAP. Feasibility was assessed by means of interviews and session forms. Acceptability was evaluated along the seven domains of the Theoretical Framework of Acceptability (i.e. affective attitude, burden, ethicality, intervention coherence, opportunity costs, self-efficacy, and perceived effectiveness).
Results: The final protocol consisted of the following modules and targets: *1. Motivation and Pleasure* (negative symptoms); *2. Understanding Others* (social cognition); *3. Safety and Trust* (paranoid ideations and social anxiety); *4. Self-Image* (self-esteem and self-stigma); *5. Communication* (communication and interaction skills). Modules were piloted by the participating patients and therapists. The modules proved feasible and showed a high degree of acceptability on all seven domains of the acceptability framework.
Conclusion: The modular VR-SOAP treatment protocol and prototype was acceptable and feasible for therapists and patients. The primary recommendation for enhancement underscores the need for flexibility regarding the number of sessions and the content.

Key learning aims

(1) Understanding the development and structure of a novel modular CBT treatment in VR.
(2) Learning to use specific VR modules to target negative symptoms, social cognition, paranoid ideations, social anxiety, self-esteem, and communication skills.
(3) Gaining insights into the feasibility and acceptability assessments of a novel modular CBT treatment in VR.

Keywords: feasibility; modular treatment; psychosis; social functioning; virtual reality

Introduction

People with a psychotic disorder often experience difficulties in social functioning (Burns and Patrick, 2007). Although many individuals achieve symptomatic remission (17–78%) (AlAqeel and Margolese, 2013), the majority still struggle with impaired social functioning and low societal participation (Madeira *et al.*, 2016). A recent meta-analysis investigating the course of social functioning over time in individuals with a psychotic disorder found only small improvements in vocational functioning, pro-social behaviour, activities, and independence (de Winter *et al.*, 2022). Similarly, current psychosocial interventions yield only moderate effects on social functioning (Kurtz and Mueser, 2008a; Wykes *et al.*, 2008). Consequently, more effective interventions are needed to address the challenges faced by individuals with a psychotic disorder in maintaining their social roles.

However, social impairments of individuals with psychotic disorder can arise from different causes. For example, negative symptoms and deficits in social cognition are found in a substantial proportion of individuals with a psychotic disorder (Madeira *et al.*, 2016; Rocca *et al.*, 2014) while for others, social functioning is impacted by paranoid ideations or social anxiety (van Dam-Baggen and Kraaimaat, 1999). Additionally, low self-esteem and self-stigma may play a role in social functioning (Gureje *et al.*, 2004). Moreover, social skills have been demonstrated to be strong predictors of social functioning (Halford and Hayes, 1995). Furthermore, factors contributing to social difficulties are inter-related, e.g. negative symptoms mediate the association between social cognition and social functioning (Madeira *et al.*, 2016). Therefore, treatments should address the multifaceted and heterogeneous nature of social functioning difficulties (Maj *et al.*, 2021; Peters, 2014).

One approach to take this heterogeneity into account is to personalize treatments by structuring treatment components into separate modules (Chorpita *et al.*, 2005). The resulting modular treatment consists of multiple self-contained modules that can connect to other modules synergistically but can also function independently (Chorpita *et al.*, 2005). Customizing the treatment based on individual needs could be beneficial as it may be valuable for a wider variety of patients (Addington and Gleeson, 2005), and potentially increases patient engagement (Freeman *et al.*, 2019). Most importantly, modular treatments may outperform treatments focusing on a single aspect (Weisz *et al.*, 2012).

Still, even when a treatment is well adapted to varying individual needs, patients often struggle to apply the skills learned during therapy in their everyday lives (Kopelowicz *et al.*, 2006; Rus-Calafell *et al.*, 2014). Addressing social interaction difficulties in a real-life setting can be challenging due to practical limitations (Kopelowicz *et al.*, 2006). To overcome these practical limitations, the emergence of virtual reality (VR) provides a promising solution with significant potential for improving psychosocial interventions for psychotic disorders (Freeman *et al.*, 2017; Rus-Calafell *et al.*, 2017; Valmaggia *et al.*, 2016; Veling *et al.*, 2014).

To meet the need for ecologically valid, personalized treatments that address multiple determinants of social functioning problems, we developed a novel modular VR treatment for enhancing social activities and participation of young people with a psychotic disorder (VR-SOAP). This study aims to describe the development of VR-SOAP, including the selection of module domains, the development of the treatment protocol and software prototype, and the piloting of the intervention to assess its acceptability and feasibility.

Method

The development of VR-SOAP began with a scoping literature review to identify key determinants of social functioning (Muijsson *et al.*, 2020). To translate these determinants into a modular

https://doi.org/10.1017/S1754470X25000108 Published online by Cambridge University Press

treatment protocol and software prototype, the team utilized the Scrum method. Finally, to test the feasibility of VR-SOAP, a pilot study was conducted.

The developmental process is further detailed below.

Selection of module domains

First, possible determinants contributing to social interaction difficulties in individuals with a psychotic disorder were identified (Meins *et al.*, 2023). Based on a scoping literature review, negative symptoms, social cognition, paranoid ideation and social anxiety, self-esteem and self-stigma and social skills were selected as key determinants of problems in social functioning (Baumeister *et al.*, 2003; Freeman *et al.*, 2001; Freeman *et al.*, 2007; Gonzalez-Blanco *et al.*, 2019; Grady and Keightley, 2002; Kring and Barch, 2014; Mairs *et al.*, 2011; Paz *et al.*, 2017; Rocca *et al.*, 2014). The selected determinants are depicted in Fig. 1.

Development of treatment protocol

Modules 2, 3 and 5 were derived from existing treatments (Nijman *et al.*, 2022; Pot-Kolder *et al.*, 2018). For modules 1 and 4, we drew on existing therapies for negative symptoms and self-image, as well as VR techniques. For example, the self-criticism avatar in module 4 was adapted from AVATAR therapy (Ward *et al.*, 2020), and a 'cheering catwalk' was based on the aggression catwalk (see 'The VR-SOAP prototype' section below for details on module content). Additionally, individuals with lived experience were closely involved in shaping these modules throughout development.

Collaboration with individuals with lived experience

Five individuals with lived experience of psychosis were recruited through clinicians. Two brainstorming sessions were held to guide treatment development. In the first session, we sought their insights on what would be helpful in treatment, particularly regarding negative symptoms (module 1) and self-esteem (module 4). We discussed their experiences with these issues and their needs.

In the second session, we reviewed concept modules (i.e. draft versions of the modules) and gathered their feedback on exercises and VR environments. This feedback further shaped the protocol and new VR environments. Additionally, three of these individuals participated in separate brainstorming sessions to refine role-play scenarios in module 5. Updates were shared through online meetings due to COVID-19. During these meetings, the new VR environments and protocol were showcased.

Scrum method

The team used the Scrum method to translate determinants of social functioning difficulties into a modular treatment protocol with accompanying software. The Scrum method is an agile approach for multi-disciplinary complex development work. This method involves working in small, iterative increments, integrating experimentation and continuous feedback loops (Hron and Obwegeser, 2018). The Scrum team included researchers, of which three were clinicians, individuals with lived experience of psychosis, and software engineers.

The Scrum team met approximately every month during the development period. During the first Scrum meetings, requirements of virtual environments and scenarios were discussed, based on previous studies, existing *Social Worlds* software and the process described above. Also, software engineers from CleVR BV discussed possibilities and challenges for developing the additional VR modules (1 and 4). Next, CleVR BV developed the first prototype. In a series of

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meetings, they presented new versions, received feedback from the other Scrum team members and iteratively revised the software until reaching consensus. An example is module 4, session 3, where a VR scenario was sought to experience positive social feedback. An existing street environment and available avatars were used to develop a 'cheering catwalk'. The avatars' appearance and behaviour were critically discussed and iteratively adapted.

Software development

The VR-SOAP prototype was built upon the existing software package *Social Worlds*, developed by CleVR BV. This software consists of animated interactive virtual social environments (a café, shopping street, office, living room, supermarket, park, and bus) created with Unity 3D. Participants navigate through these environments using a controller, while wearing an Oculus Rift head-mounted display, featuring an HD resolution of 2160×1200 and a 110-degree field of view. Therapists, represented as avatars, communicate with patients using a voice-distorted microphone and have control over the avatars' movements and gestures. The development of VR-SOAP focused on enhancing this software with additional features.

Piloting the treatment protocol and software prototype

Participants and procedure

Five patients with a psychotic disorder, who were not involved in the development phase, were recruited from two mental healthcare facilities (GGZ Drenthe, The Netherlands, University Centre of Psychiatry of the University Medical Centre Groningen). Recruitment lasted until each module was piloted at least once. Hence a small sample sufficed. Throughout the study, all patients continued to receive standard care. Inclusion criteria were a diagnosis of a psychotic disorder according to *DSM-5*, reduced social engagement, and age between 18 and 40. Exclusion criteria were an estimated IQ below 70, insufficient Dutch language proficiency, and photosensitive epilepsy. Participants received €15 for the interviews. Eligible patients were informed of the study by their treating clinician (psychiatrist, psychologist, or nurse specialist). Subsequently, they received additional information from the research team. Prior to inclusion in the study, written informed consent was obtained.

In addition to patients, three therapists participated in this pilot study. One therapist was both part of the research team and an experienced VR therapist providing treatment. The other two therapists underwent training in the treatment protocol during a 3-day training program. All therapists were psychologists trained in cognitive behavioural therapy.

To ensure high protocol fidelity, monthly supervisions were conducted to identify and address any deviations. These meetings with the therapists were used to reflect on session progress and challenges. Deviations such as skipped exercises or technical issues were recorded in workbooks and discussed in bi-weekly research meetings to inform adaptations of the protocol.

Assessment

Feasibility is defined as the practicality of implementing an intervention and includes the following indicators: acceptability, recruitment, retention, adherence, protocol fidelity and engagement (Arain *et al.*, 2010; Stewart *et al.*, 2020). Acceptability of the intervention was evaluated via semi-structured interviews with participants and therapists utilizing the Theoretical Framework of Acceptability (TFA) (Sekhon *et al.*, 2017). This framework encompasses the following domains: affective attitude, burden, ethicality, intervention coherence, opportunity costs, self-efficacy, and perceived effectiveness. Interview guides were developed along these seven domains to ensure a thorough assessment of the intervention's acceptability (Pavlova *et al.*, 2020; Sekhon *et al.*, 2017; Sekhon *et al.*, 2018).

Recruitment and retention were tracked by monitoring who started the treatment and who dropped out. Adherence and protocol fidelity were assessed by carefully reviewing detailed session

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forms to identify and address deviations from the treatment protocol. Lastly, engagement was assessed through interviews and sessions forms. Engagement includes participants' participation in sessions and the extent to which learned strategies were applied in between sessions. Engagement is considered an important aspect of feasibility (Stewart *et al.*, 2020) and predictor of treatment outcomes (Realpe *et al.*, 2020).

Analysis

Qualitative directed content analysis (DCA) was applied on the interviews conducted with participants and therapists (Hsieh and Shannon, 2005). The analysis was directed by the seven domains of the TFA (Sekhon *et al.*, 2017). Themes that recurred or were relevant to the intervention were coded and organized along each domain using the open-source software package *Qualcoder*, version 3.0. To ensure the reliability of the findings a second evaluator followed the same procedure, after which findings were compared and discussed, until consensus was reached (Engdahl et al., 2021).

Results

The VR-SOAP prototype

Introductory sessions (sessions 1–2) and supplementary materials of VR-SOAP

In the first two sessions, participants discuss their social interaction difficulties and set treatment goals (e.g. initiating a conversation with a stranger). At the end of session 2, the therapist and patient jointly choose two out of the initial four modules as not all determinants apply to the individual. The choice of modules is primarily guided by their alignment with the difficulties hindering the attainment of the established goals. Additionally, therapists are supported in selecting modules by a baseline score report, information of the referrer and a one-on-one intervision session with the research team. Module 5 is fixed due to its fundamental role in enhancing social functioning. Each module has four sessions of one hour each. An overview of sessions is shown in Table 1. Modules are depicted in Fig. 2.

Each module includes brief psychoeducation, various strategies for participants, as well as a note folder for at-home exercises, reflective questions, and the goals participants wish to achieve.

General structure

Sessions generally begin with an evaluation of the previous session, which includes a discussion of homework. In the first session of each module this is followed by psychoeducation. All sessions within the modules involve an explanation of strategies and the role-play to practise these strategies. Role-play exercises are conducted in VR, followed by reflection and a discussion of homework tasks. Homework assignments were tailored to each module (e.g. noting positive elements and tracking mood in the negative symptoms module).

Module 1: Motivation and Pleasure

Of all social functioning determinants, negative symptoms are most strongly related to social functioning (Madeira *et al.*, 2016; Rocca *et al.*, 2014). Many people with a psychotic disorder experience difficulties initiating and sustaining goal-directed behaviour, contemplating the anticipated pleasure of potential outcomes, and gauging the required effort to obtain these outcomes. In particular avolition and anhedonia are predictive of social functioning impairments (Barkus, 2021; Schlosser *et al.*, 2015). Based on the Positive Emotions Program for Schizophrenia (PEPS) (Favrod *et al.*, 2019; Nguyen *et al.*, 2016), and behavioural activation theory (Cuijpers *et al.*, 2007; Mairs *et al.*, 2011; Mazzucchelli *et al.*, 2009), module 1 aims to enhance motivation (avolition) and pleasure (anhedonia).

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Table 1. Overview of VR-SOAP session structure

Session	Title	Content
1	Introduction and goal setting	Discuss social interaction difficulties, set treatment goals
2	Refining goal setting module selection	Choose 2 out of 4 modules based on individual needs, supported by baseline score report
3	Optional module 1	Content based on chosen module (Motivation and Pleasure, Understanding Others, Trust and Safety, or Self-Image)
4	Optional module 1	Continuation of content based on chosen module
5	Optional module 1	Continuation of content based on chosen module
6	Optional module 1	Continuation of content based on chosen module
7	Optional module 2	Content based on chosen module (Motivation and Pleasure, Understanding Others, Trust and Safety, or Self-Image)
8	Optional module 2	Continuation of content based on chosen module
9	Optional module 2	Continuation of content based on chosen module
10	Optional module 2	Continuation of content based on chosen module
11	Interacting with others	Personalized role play exercises based on daily social interactions
12	Interacting with others	Continued personalized role-plays
13	Interacting with others	Further personalized role-plays
14	Interacting with others	Finalize personalized role-plays

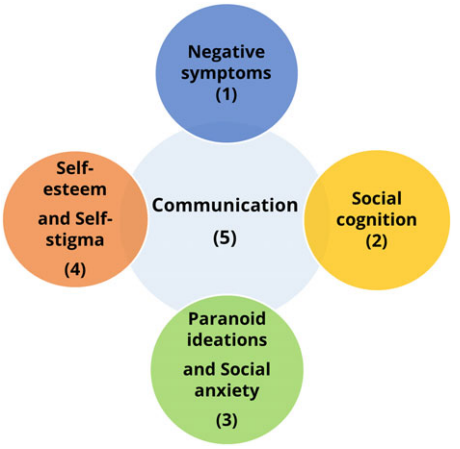

Figure 1. The five domains of VR-SOAP (Meins *et al.*, 2023).

In session 1, the participant is guided through a virtual shopping street and asked to attend to positive elements and accompanying physical sensations. During sessions 2 and 3, the participant engages in role-playing exercises to recall positive memories and anticipate pleasurable experiences. In session 4, the participant mimics the body language of positive avatars and eventually applies all previously learned strategies in a virtual role-play to activate an inactive virtual character.

Module 2: Understanding Others

The significance of social cognition in facilitating social recovery in individuals with a psychotic disorder has gained recognition in recent years (Grady and Keightley, 2002). Based on Dynamic Interactive Social Cognition Training in VR (DiSCoVR) (Nijman *et al.*, 2022), module 2 focuses

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on emotion recognition, interpretation of social situations and theory of mind. In sessions 1 and 2, participants practise reading emotions in VR. In sessions 3 and 4, the participants watch social scenarios in VR and are asked to indicate thoughts, feelings, and behaviour of virtual characters to encourage mentalization. Erroneous answers prompt avatars to provide more explicit hints about their mental state. In session 4, patients practise with different domains of social cognition in personalized role-plays based on their daily life.

Module 3: Trust and Safety

Social withdrawal often occurs due to paranoid thoughts and social anxiety (Freeman, 2016). To address this, sessions 1–4 employ exposure exercises and behavioural experiments designed to help participants gradually relinquish safety behaviours. Module 3 is based on cognitive behavioural therapy for individuals with a psychotic disorder in VR (VR-CBT) (Pot-Kolder *et al.*, 2016; Pot-Kolder *et al.*, 2019).

Module 4: Self-Image

Individuals with a psychotic disorder have significantly lower self-esteem than the general population (Silverstone and Salsali, 2003). Negative self-esteem has been associated with the concealment of thoughts and feelings (Baumeister *et al.*, 2003), a strong reduction in interpersonal closeness after conflict, and a tendency to avoid social contact (Paz *et al.*, 2017). Therefore, module 4 focuses on positive experiences and qualities, and on challenging self-criticism. Additionally, patients practise a self-assured body posture. Module 4 integrates elements from competitive memory training (COMET), psychomotor therapy (PMT), schema therapy, and the positive diary method known as 'Witboek' (De Neef, 2010).

In session 1, the participant practises being compassionate to a self-critical friend in a role-play exercise. In session 2, the therapist role-plays two avatars: one, voicing the patient's self-critical thoughts towards the other, the protector. After observing the first round, the participant takes on the role of the protector, resisting and arguing against personal verbalized critical thoughts.

The therapist incrementally shrinks the avatar's size, with each step reflecting the patient's resistance, until the avatar is prompted to walk away defeated. Session 3 involves a role-play exercise addressing the positive self, followed by passing by a row of virtual characters applauding the participant while giving compliments (i.e. a cheering catwalk). In session 4, the participant can select any of the previous exercises, followed by practising a self-assured body posture while ordering drinks in a bar. Additionally, between sessions of module 4, participants track their positive experiences using a diary ('Witboek').

Module 5: Interacting with Others

Under-developed social skills can lead to social withdrawal and reduced participation in leisure and community activities (Kurtz and Mueser, 2008b). Module 5 therefore focuses on enhancing social skills (e.g. asking questions, acting assertively) and practising situations (e.g. a conversation with a friend or a birthday party) directly relevant to the participant. Throughout this module, participants engage in personalized role-play exercises based on social interactions in their daily life. The module is based on social skills training (Kopelowicz *et al.*, 2006; Kurtz and Mueser, 2008b; Rus-Calafell *et al.*, 2014).

Piloting VR-SOAP

Participants

After five participants were included, each module had been selected at least once. Demographics are depicted in Table 2.

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Figure 2. Top left: shopping streets with added positive elements of module 1. Top right: emotion recognition exercise of module 2; translated display: surprised, happy, afraid, angry. Bottom left: exposure exercise of module 3. Bottom right: self-criticism avatar of module 4.

Feasibility

Recruitment. In total, nine participants were approached by the research team. Four of these participants did not take part in the study for the following reasons: other treatments were more suitable, impending completion of standard treatment, unavailability of the therapist, feeling too overwhelmed.

Retention. There were no drop-outs.

Adherence

Participants took, on average, 22 weeks ($SD = 52$ days, range 119 days) to complete all sessions. For the first participant, therapy was deferred for 6 months after session 1 due to COVID-19 measures. There was more than one week in between 11% of all sessions (8/70). Sessions lasted, on average, 61.5 minutes ($SD = 2.04$ minutes), with 19.4 minutes ($SD = 4.48$ minutes) spent in VR.

Participants' goals, established in sessions 1 and 2, did not change during therapy and were aligned with the intended purpose of VR-SOAP. Participants set multiple goals, with all but one being related to general social interaction. The largest category of goals set (45% of the total number of goals) concerned communication skills (e.g. initiating/maintaining a conversation), followed by goals directly related to social contacts (i.e. to make a new friend, 28% of the total number of set goals). The remainder of goals pertained to the improvement of activities (e.g. to join a sports club) or something else (e.g. recognizing emotions).

Protocol fidelity

The most frequent protocol deviation was non-adherence to homework assignments (main reason: forgotten), which occurred in between 25% of sessions (18/70). In total, therapists deviated from the protocol only twice during the sessions. In both instances, the sessions were conducted without VR. Technical issues were reported in 5.7% (4/70) of the sessions.

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Table 2. Demographics and clinical participant characteristics of the sample ($n = 5$)

Variables	Value
Demographic	
Age, years (*SD*)	27 (1.51)
Gender	
Male, *n* (%)	5 (100)
Level of education	
Senior general secondary education, *n* (%)	1 (20)
Secondary vocational education, *n* (%)	4 (80)
Years in school, mean (*SD*)	19.60 (1.67)
Paid employment	
Employed, *n* (%)	2 (40)
Unemployed, *n* (%)	1 (20)
Student non-working, *n* (%)	2 (40)
Hours worked per week, mean (*SD*)	13.60 (19.10)
Work history (years), mean (*SD*)	8.80 (4.92)
Substance use	
Alcohol (glasses per week), mean (*SD*)	4 (4.24)
Clinical diagnosis	
Schizophrenia, *n* (%)	1 (20)
Psychotic disorder, not otherwise specified, *n* (%)	3 (60)
Substance-induced psychotic disorder, *n*	1 (20)
Hospitalization	
Never hospitalized, *n* (%)	1 (20)
Previously hospitalized, *n* (%)	4 (80)
Number of (past) psychotic episodes, mean (*SD*)	1.40 (0.55)
Illness duration, mean (*SD*, years)	2.3 (1.10)
Medication	
Atypical anti-psychotics, *n* (%)	3 (37.50)
Anti-depressants, *n* (%)	1 (12.50)
Benzodiazepines, *n* (%)	1 (12.50)
Phenothiazines, *n* (%)	1 (12.50)
Not using medication, *n* (%)	2 (25)

Data are presented as means (*SD*) or *n* and percentage.

Acceptability

VR-SOAP was generally found acceptable across all domains of the acceptability framework. Participants and therapists reported a positive attitude towards the intervention (affective attitude), a clear understanding of the intervention (intervention coherence), effectiveness (perceived effectiveness), alignment with their values (ethicality) and ease of execution (self-efficacy). However, participants mentioned trade-offs had to be made (opportunity costs) and highlighted time pressure as a burden. The results are further detailed below for each acceptability construct.

Affective attitude

The intervention was generally perceived as positive by both participants and therapists, and various benefits were mentioned. Typically, the role-playing games were seen as valuable, as one participant mentioned:

> '*Yes, I definitely see the positive side to it. You can create situations that you would otherwise have to imagine or something, which makes empathizing or talking to a cashier for example more difficult.*' [A003]

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Most participants found the VR scenarios well-tailored to their needs:

> '*I was able to practise well with the situations I had difficulty with, especially social situations like in the bar and living room. I also practised with work situations. The therapist was able to determine the level of difficulty well.*' [B003]

Technical issues, particularly issues with the voice transformation, were mentioned by therapists and participants as a recurrent hindrance. As the participant added:

> '*Occasionally, there were difficulties with the technical aspects. It is important to mention, for example, the voice distorter – if she* [therapist] *was supposed to sound like a woman, the voice was very high and squeaky. If she* [therapist] *was supposed to sound like a man, the voice was too deep.*' [B003]

Other participants added that the voice of the therapist could still be heard in the background. This was found particularly problematic if the therapist voiced the self-critique of the participant as an avatar.

Summing up, aside from technical difficulties, participants mainly expressed a positive attitude towards the intervention.

Burden

Participants perceived the therapy as challenging, but not burdensome, as it specifically addressed behaviours and beliefs they were struggling with:

> '*Standing close to others and talking. That was the most intense. After that, the pressure was off, and I could do it.*' [B003]

Another such aspect mentioned:

> '*I had to initiate the conversation myself and I didn't know what to say.*' [B002]

For therapists, managing the therapy within the available time was a significant challenge:

> '*It was quite challenging. You have one hour, and that's not enough. You need more time to prepare, to figure out what to do and what you need. Eventually, maybe less time would be needed.*' [Therapist 1]

This suggests that while additional time may be necessary in the initial phase, this demand may decrease with experience. Still, participants also experienced time pressure:

> '*Anyway, I found the time often rushed actually. It wasn't very often that I was able to fill in all those questions* [at the end of the session] *properly. During the last module, we really had too little time. We also had to come up with situations during the sessions,* [. . .] *and then practise with the situation.*' [A003]

Overall, VR-SOAP appears challenging for participants, but not overly burdensome. However, time pressure is a persistent challenge for therapists and patients.

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Ethicality

Ethicality refers to the extent to which the therapy is compatible with the participant's value system (Sekhon *et al*., 2017). One participant suggested that VR-SOAP is valuable for those with psychotic disorders due to their experience of social isolation:

> '*I think that it is valuable for many people. This is because having a psychosis often leads to social isolation.*' [A001]

Other participants shared this view and provided further details on the underlying reasons:

> '*Being socially insecure, especially due to the voices* [auditory hallucinations]*, has become very significant. This was caused by the rumours that I heard around me. As a result, I lost my sense of social competence.*' [B003]

Some participants mentioned that the usage of technology made the intervention well-suited, associating it with gaming.

> '*The treatment suited me well as a person. I am familiar with gaming, and this is a gaming environment.*' [A006]

Overall, the ethicality of VR-SOAP was apparent, as the therapeutic targets closely resonated with the imperative to alleviate social isolation following psychosis.

Intervention coherence

The extent to which participants comprehend the intended purpose of the therapy is referred to as intervention coherence (Sekhon *et al*., 2017). Participants and therapists mentioned various purposes, from reaching personal goals to overall recovery. However, the majority identified enhancing social connections, particularly through role-playing exercises, as the primary goal. As one participant put it:

> '*Helping people with social contacts*' [B002]

Therapists further emphasized the importance of role-plays:

> '*The overall goal is social functioning, and these role-plays are essential I believe*' [Therapist 3]

Generally, both therapists and participants perceived the therapy as a cohesive whole, as opposed to separated modules. As one therapist pointed out:

> '*I do believe that the treatment is an integrated whole. Things come back, but you also integrate them.*' [Therapist 1]

Another participant elaborated further on the integration of modules.

> '[. . .] *Nice build-up of safety behaviour, then self-image, culminating in interacting with others. Starting with being among people, walking alone through a shopping street for the first time* [. . .]' [B003]

Taken together, VR-SOAP was perceived as an easy-to-understand, cohesive intervention to improve social contacts via role-playing games.

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Opportunity costs

Opportunity costs refer to the degree to which benefits, profits, or values must be given up to participate in the intervention (Sekhon *et al.*, 2017). Opportunity costs mainly revolved around the commitment required from both therapists and patients to the structured, goal-oriented intensive program.

> '*With my first participant I had enough time, but with my second participant, there wasn't enough time, as this participant also had cognitive issues*' [Therapist 2]

> '[. . .] *the patient also liked to talk, preferably with feedback on the week. You have to work very purposefully, and one hour is not enough, 1.5 hours, 75 minutes would be more appropriate*' [Therapist 3]

This could imply opportunity costs as the inability to fully consider and accommodate the individual needs of patients. This was further elaborated by the therapist:

> '. . . *he found it complicated that we were so goal-directed. He was used to me first discussing how things had gone. We couldn't talk about what he had done that week and experienced, there was no room for deviation.*' [Therapist 3]

Aside from feeling rushed, participants did not mention any sacrifices that had to be made.

Overall, the therapy requires therapists, particularly in the beginning, to invest more time, and both therapists and patients to make a trade-off of personal contact and reflection for goal-directed exercises in VR.

Perceived effectiveness

Perceived intervention benefits varied, with role-playing games and personalized scenarios most frequently highlighted:

> '*Being more vulnerable and asking more questions. Sharing something spontaneously from yourself.*' [A001]

This view of the main effect of VR-SOAP was equally shared by therapists:

> '*Practising conversations extensively is by far the most important* [. . .] *conversations in different contexts and with different personalities.*' [Therapist 2]

However, none of the participants reported increased frequency of social activities, contacts, or participation levels, which was the goal of the intervention:

> '*I talk a bit more. For example, I still do volunteer work in* [city] *and then I also talk a bit more with people.*' [A001]

> '*I still engage in safety behaviour, I don't do much about it . . . Safety behaviour fits with who I am . . . Though I do know better what questions I can ask* [in a conversation]' [B002]

The therapists elaborated on the participants' level of social functioning as follows:

> '*The participants do feel more self-confident. They feel that they can rely on themselves. However, they have not yet taken any real steps towards doing so. The focus is now on feeling*

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competent. VR-SOAP is a step towards the larger goal of having more social contacts.' [Therapist 1]

Additionally, therapists, but not participants, found the number of sessions, in particular of module 4, too short.

'*Self-image* [module] *is too brief. Oh, it's a pity that it's already over, you briefly touched upon the critical voice* [. . .]' [Therapist 1]

Overall, the perceived effects of VR-SOAP differed in magnitude, domain, and appreciation, but ultimately were most pronounced as perceived social self-efficacy. Additionally, the length of therapy, in particular for module 4, was perceived by some as insufficient.

Self-efficacy

The therapists praised the protocol, although minor technical challenges were identified:

'*Well, it* [the protocol] *is already very good. You just need to figure out a few details like which software to click on* [. . .]' [Therapist 3]

'*I think you could also do the perspective switch, which I wanted to do, but then I didn't remember how to do it technically.*' [Therapist 3]

'*I could make more use of it* [the technology]. *There are all kinds of options that I actually use very little because I don't know how.*' [Therapist 1]

Part of the intervention involves practising acquired strategies between sessions. However, participants varied in their success following up at-home exercises:

'*Every week it was difficult to practise. Then I would procrastinate* [. . .], *and subsequently forget it.*' [A006]

Those who did successfully practise did so by embedding it in their ongoing activities, as opposed to creating new situations to practice.

'*I didn't do the exercises at home, I did them with colleagues. With friends, in situations, I don't know, I was consciously working on it.*' [A003]

This seems to suggest that the main issue with practice during the week was the organizational aspect of it. Additionally, therapists considered the number of strategies challenging for patients:

'[. . .] *I found there were a lot of strategies, which relied heavily on cognitive abilities. Don't expect someone to remember everything.*' [Therapist 2]

All in all, both therapists and participants felt confident in participating in the therapy. Attention to technical skills remains necessary for therapists. Practising the many strategies was difficult for participants but could be mitigated by incorporating the practice into daily life.

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Engagement

Engagement refers to the extent to which participants are actively involved and invested in the intervention (Realpe *et al.*, 2020). Overall, patients and therapists demonstrated varying levels of engagement. Participants reported positive experiences and found the VR sessions engaging and helpful for practising social interactions. For example:

> '*The role-playing games were useful. They closely matched my current situation and helped me practise social skills.*' [A003]

A lack of immersion was rarely mentioned. One therapist noted:

> '*It feels very real for the participants, and you can customize everything. You have to overcome a hurdle, but ultimately you are really talking to someone else.*' [Therapist 1]

However, as mentioned under self-efficacy, nearly all participants faced challenges in maintaining consistent engagement with homework exercises.

Overall, engagement during sessions was generally robust. However, outside of the sessions it was hindered by participants' difficulties in consistent practice.

Discussion

This study described the comprehensive development of VR-SOAP, including the selection of module domains, the process of developing the treatment protocol and software prototype, and the piloting of the intervention to assess its feasibility. Following the development of the VR-SOAP treatment protocol and software prototype, five participants underwent the therapy and were interviewed afterwards. Additionally, all three therapists were interviewed. Feasibility was assessed using interviews and session forms. Acceptability was evaluated along the domains of the TFA (Sekhon *et al.*, 2017).

No drop-outs occurred, suggesting the therapy is tolerable. Moreover, the intervention showed a high degree of acceptability on all seven dimensions of the acceptability framework. Participants and therapists found the intervention simple to comprehend, beneficial, and aligned with their values. They expressed a positive attitude towards the intervention, particularly regarding the role-play exercises. Participants generally felt engaged with the therapy and therapist. The therapy was perceived as effective in multiple domains, ultimately on social efficacy.

Feasibility was generally good with no systematic deviations from the treatment protocol, other than the inconsistent in-between session practice. During sessions, exercises and tasks could be completed within the allotted session time, although with notable time pressure. Moreover, therapists indicated the need for at least 30 minutes of additional time to prepare and conclude sessions. Technical difficulties were mentioned, particularly with the voice distortion. Additionally, there were occasional lengthy intervals between sessions, spanning multiple weeks, which may affect treatment continuity.

Main suggestions for improvements

Although VR-SOAP is considered feasible, the intervention might benefit from adjustments. Firstly, sessions were considered content-dense and goal-directed. Consequently, limited time to address the participant's current needs prevailed. This finding raises a notable point, given that the treatment approach was designed specifically to align more closely with individual needs. A key consideration lies in the flexibility of the intervention, that despite modularity, retains a fixed structure. Modules consist of four sessions with assigned exercises. VR-SOAP exhibits a more

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rigid structure in comparison with other modular treatments, like the Feeling Safe program for psychotic disorders (Freeman *et al.*, 2016), or SEBASTIAN for autism (Wood *et al.*, 2021), which allow for some variation. This rigidity may result in time pressure and hinder providing adequate intervention dosage for severe symptoms in one domain, while potentially delivering unnecessary intervention in another (Wood *et al.*, 2021). These concerns arose in interviews, as such that module 4's brevity led one participant to propose swapping its content with that of module 5.

Still, although participants felt more socially confident, only limited quantifiable changes in primary social domains (contacts, activities, participation) were reported in the interviews. Although COVID-19 restrictions might have played a role, comments from therapists and participants suggest a competence–performance gap (Birchwood *et al.*, 1990). This could potentially be attributed to the relatively short duration of the therapy, given that the typical length of CBT for psychotic disorders is approximately 20 sessions in 6 months (Addington and Gleeson, 2005). However, it is important to consider that many of the set goals focused on social skills rather than expanding one's network or activities.

All in all, VR-SOAP could benefit from considering more flexibility in treatment content and session count to better accommodate individual needs and optimize treatment outcomes.

A second concern is that participants did not consistently practise between sessions, which has been proven crucial for therapy effectiveness (Frawley *et al.*, 2023; Rector, 2007). Several factors have been related to affect compliance: low motivation, trouble taking initiative, and a lack of energy; factors that, in part, reflect characteristics of the disorder (Kurtz and Mueser, 2008a). Moreover, a reluctance to practise could stem from deeply rooted dysfunctional attitudes participants might have retained towards their capabilities. These attitudes have been shown to hinder the application of newly acquired social skills and have been suggested to be more proximal to real-life functioning than actual social skills (Horan *et al.*, 2010). Addressing these attitudes (e.g. 'If I fail at my work, I fail as a person') might stimulate real-life practice more effectively, and consequently enhance the generalizability of newly acquired skills and behaviours (Rector, 2004). Module 1 (negative symptoms) and module 3 (addressing dysfunctional beliefs/behaviours) could fulfil a role in increasing willingness and readiness to practise, thereby promoting the generalization of skills. Most importantly, and in line with suggestions from therapists, module 4 (self-esteem), and specifically the self-critique avatar, might be repeated more often as well. Utilizing these modules to stimulate real-world practice could improve therapy outcomes. Future interventions may benefit from these and additional support mechanisms to enhance engagement.

Technical issues, notably audio difficulties, emerged as a significant hindrance during interviews, impacting role-plays. This may impact the sense of immersion and could cause conflation of statements made by the avatar with the therapist's opinion.

Lastly, this paper describes the development and evaluation of the first version of the intervention and software protocol. Feedback collected during the pilot phase informed a later version of the protocol but was not applied in this initial version to maintain consistency.

Limitations

Our primary focus was not on conducting rigorous qualitative research but on developing the intervention, which could have compromised the thoroughness of our bias control measures. While the TFA guided the interview themes, and a second evaluator was involved in the qualitative analysis, other measures to control bias were not in place (Cope, 2014; Thirsk and Clark, 2017). As a result, the reliability and validity of the qualitative findings might have been affected, potentially leading to an over-emphasis on certain themes or an under-representation of others (Lincoln and Guba, 1985).

As the primary aim of the study was to develop a novel intervention, a small sample sufficed to pilot the treatment protocol and prototype, resulting in a limited generalizability. Notably, the initial participants may vary from subsequent ones, possibly due to higher motivation levels.

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Although the inclusion of therapists enhanced the diversity of perspectives, a larger sample of patients and therapists is necessary to extend results and generalize findings. This also pertains to the assessment of effectiveness. To this end a randomized controlled trial (RCT) is currently in progress

Next steps

Based on the results of this pilot study, we have initiated a pragmatic RCT to investigate effectiveness (for study protocol, see Meins *et al.*, 2023). Additionally, preparations are being made for making VR-SOAP available in routine mental healthcare. If the results of the RCT are positive, the additional VR-SOAP software modules will be integrated in the current *Social Worlds* software. CleVR BV already provides this CE-certified software to mental health institutes, along with ongoing service, support, and regular updates. VR-based psychological treatments are approved by the Dutch National Health Care Institute as insured care, which facilitates future implementation in regular care.

Conclusion

This study showed that key determinants of social functioning difficulties in patients with psychotic disorder can be translated into a modular VR treatment. Additionally, it showed that the treatment protocol for such a novel modular VR therapy was feasible, and that it was acceptable for patients and therapists.

VR-SOAP represents a promising first step in improving the social functioning of individuals with a psychotic disorder. While the current findings suggest improvements in perceived self-efficacy, further research is needed to determine whether these gains generalize, translate into observable improvements in social functioning, and support broader implementation across settings.

Key practice points

(1) A modular approach, like VR-SOAP, may effectively address social functioning difficulties in psychosis by targeting specific symptoms with interconnected modules.
(2) The inclusion of role-playing exercises in real-life scenario simulations in VR might enhance the applicability and effectiveness of treatment.
(3) Flexibility in the number of sessions and module content might help accommodate individual patient needs and optimize treatment outcomes.
(4) Collaborating with individuals with lived experience of psychosis can significantly enhance the treatment.

Further reading

Chorpita, B. F., Daleiden, E. L., & Weisz, J. R. (2005). Modularity in the design and application of therapeutic interventions. *Applied and Preventive Psychology*, *11*, 141–156. https://doi.org/10.1016/j.appsy.2005.05.002

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Data availability statement. Neither the session forms nor the interview data collected during this study are publicly available in order to protect the privacy and confidentiality of the participants and therapists.

Acknowledgements. We would like to extend our gratitude to the therapists and patients for their valuable contributions to piloting the new therapy. A special acknowledgment goes to the patients with lived experience whose insights have significantly contributed to the development of VR-SOAP.

Author contributions. **Ivo Meins:** Conceptualization (supporting), Data curation (lead), Formal analysis (lead), Investigation (equal), Methodology (equal), Project administration (lead), Supervision (supporting), Writing - original draft (lead), Writing - review & editing (lead); **Elise van der Stouwe:** Conceptualization (lead), Formal analysis (supporting), Funding acquisition (supporting), Investigation (equal), Methodology (equal), Project administration (supporting), Supervision (lead), Writing - original draft (equal), Writing - review & editing (equal); **Dauw Muijsson-Bouwman:** Conceptualization (lead), Investigation (supporting), Project administration (supporting), Writing - original draft (supporting), Writing - review & editing (supporting); **Saskia Nijman:** Conceptualization (equal), Investigation (supporting), Methodology (supporting), Writing - original draft (supporting), Writing - review & editing (supporting); **Rinesh Misier:** Formal analysis (equal), Investigation (equal), Project administration (supporting), Writing - original draft (supporting), Writing - review & editing (supporting); **Wim Veling:** Conceptualization (lead), Data curation (supporting), Formal analysis (supporting), Funding acquisition (lead), Investigation (equal), Methodology (supporting), Project administration (supporting), Supervision (supporting), Writing - original draft (equal), Writing - review & editing (equal); **Gerdina Pijnenborg:** Conceptualization (lead), Data curation (supporting), Formal analysis (supporting), Funding acquisition (lead), Investigation (equal), Methodology (supporting), Project administration (supporting), Supervision (supporting), Writing - original draft (equal), Writing - review & editing (equal).

Financial support. This work was supported by the Dutch Organization for Scientific Research (Nederlandse Organisatie voor Wetenschappelijk Onderzoek or NWO, grant number: Aut.17.003.6617).

Competing interests. The authors declare no potential competing interests.

Ethical standards. All participants provided written consent to participate in the study and for their anonymized data to be published. The trial has been approved by the Medical Ethical Committee of the University Medical Center Groningen (METc file number: 2019.562, ABR: NL71197.042.19). The study adhered to the ethical guidelines established by the University Medical Center Groningen (UMCG), The Netherlands.

Use of artificial intelligence (AI) tools. We used ChatGPT-3.5 during the writing process to improve the readability and language of this manuscript. This was done under human oversight, and the authors carefully reviewed the output before submission. The tool used was ChatGPT-3.5, version dated 2024.

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Cite this article: Meins IA, van der Stouwe ECD, Muijsson-Bouwman DC, Nijman SA, Baidjnath Misier R, Veling W, and Pijnenborg GHM (2025). The development and pilot testing of VR-SOAP, a modular virtual reality treatment for improving social activities and participation in early psychosis. *The Cognitive Behaviour Therapist* 1–20. https://doi.org/10.1017/S1754470X25000108