



REVIEW ARTICLE

# Virtual reality for psychosocial remediation in schizophrenia: a systematic review



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Received 8 October 2019; accepted 17 December 2019

Available online 9 January 2020

## KEYWORDS

Virtual reality (VR);  
Social cognition;  
Psychosocial  
remediation;  
Schizophrenia

## Abstract

**Background and objective:** Psychosocial impairment in schizophrenia is related to deficits in functioning and quality of life. Virtual reality (VR) is an interesting tool that has been started to use in remediation therapies. The aim of this study is to carry out a systematic review to describe the state-of-the-art in VR for psychosocial interventions in schizophrenia.

**Methods:** Publications from 1st January 2000 to 1st July 2019 on VR-based interventions for psychosocial remediation in schizophrenia were reviewed in five databases: PubMed, Scopus, PsycINFO, IEEE Xplore and ACM Digital Library.

**Results:** From the initial resulting set of 144 publications, a final number of 7 publications were included. All of them showed positive results in the main target explored. Four studies focused on social skills, two studies were aimed at improving job interview skills and one focused on social cognition. Samples were variable (from a case report to 64 participants). Three studies compared the intervention with a control condition and two studies specified the use of immersive virtual reality.

**Conclusions:** VR offers an interesting and promising therapeutic option for patients suffering from schizophrenia, although more studies are needed to clarify if interventions based on VR are more effective than classical interventions.

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## Introduction

Functional impairment is one of the hallmarks of schizophrenia.<sup>1,2</sup> It has implications for the patient in terms of prognosis and quality of life.<sup>3,4</sup> Functional impairment is largely related to a deterioration in psychosocial functioning. Most theorists agree that psychosocial functioning is a complex construction that encompasses social cognition, social behaviour and social skills during interpersonal interactions.<sup>5</sup> It is essential for the development and maintenance of meaningful relationships and community participation and is indispensable for both physical health and psychological well-being.<sup>6</sup> Psychosocial impairment has been identified as one of the main characteristics of schizophrenia, including a deficit in social cognition and social behaviour/social skills.<sup>7</sup>

Social cognition has been defined as the “mental operations that underlie social interactions, including perceiving, interpreting, and generating responses to the intentions, dispositions, and behaviours of others”.<sup>8,9</sup> Initiatives such as the Social Cognition Psychometric Evaluation (SCOPE) study have defined social cognition as a multidimensional construct which includes four core domains: emotional processing, social perception, attributional style/bias, and theory of mind.<sup>10,11</sup>

Researchers in many fields study social behaviour. It can be defined as all those interactions oriented towards other individuals, including social acts, actions and practices. A social act is any intention, objective, plan or purpose that encompasses another self. Examples of social events would be courtship or buying a gift. Social actions are directed towards the realization of a social act. While its purpose is a social act, the actions are social, whether they involve other beings or not. An example of social action would be that a person becomes beautiful for an appointment. Regardless of the act, the associated actions remain social if they are oriented to the feelings, beliefs or intentions of another, or if they anticipate the acts, actions or practices of another. Finally, there are social practices. These are rules, norms, customs and habits that encompass or anticipate the emotions, thoughts or intentions of another person. An example of social practice would be to shake hands.<sup>12</sup>

Social skills include a series of specific behavioural skills in social interactions, without involving the recognition, control and practice of skills to implement underutilised social cognitive processes.<sup>13</sup> A specific type of social skill is the job interview skill. Job interview is probably the most important tool when selecting candidates and making employment decisions. Therefore, the behaviour of a candidate during the interview can assume an important role in obtaining a desired position.<sup>14</sup> A study revealed that hiring commercial business officials rated the communication skills observed during the interview as the most important factor in the evaluation of a candidate for employment. This ability was ranked above the second factor, academic performance, and received more than twice as many points as the third factor, work experience.<sup>15</sup>

Previous studies have shown that psychosocial interventions in schizophrenia have positive effects on disease symptoms, treatment compliance, rehospitalisation rates,

quality of life, social cognition, social functioning and employment.<sup>16–21</sup>

Psychosocial interventions can be classified into computerised and in-person remediations. Although both can point to the same social cognitive skills, their implementation is different<sup>13,22</sup> and there are no studies comparing the effectiveness of the two modalities. Among computerised interventions, the most recent interventions are based on virtual reality (VR). VR is a powerful tool that provides environments and situations almost similar to reality, dynamic avatars that allow social interaction with the participant and that can be managed to represent different emotional states.<sup>23</sup> VR enables real-time evaluation of emotions, thoughts, behaviours and physiological responses of individuals in a created environment that can be controlled, unlike in real life.<sup>24,25</sup> VR includes different modalities, such as immersive VR, non-immersive VR and augmented reality (AR). Immersive VR is linked to a three-dimensional computer-created environment that is manipulated through helmets, gloves or other devices that capture the position and rotation of different parts of the body. Non-immersive virtual reality allows real-time interaction with different people in spaces and environments that do not really exist without the need for additional devices to the computer. In augmented reality, unlike VR, the world moved by the user is the same surrounding him/her, and virtual objects are added to this world.

In recent years, there has been an exponential increase in the number of publications on the use of digital technology and VR in mental health.<sup>26,27</sup> The main fields of research in VR and psychosis are: studies on safety and acceptability of technology, symptom assessment studies (including: neurocognition, functional capacity, interview and employment skills, social cognition, social competence and positive symptoms) and treatment studies (including neurocognition, interview and employment skills, social cognition, social skills and positive symptoms).<sup>28</sup>

To date, there are no recent review studies that specifically analyse the interventions based on VR for the improvement of psychosocial functioning in patients with schizophrenia. The aim of the present study is to conduct a systematic review of the interventions based on VR for psychosocial remediation in schizophrenia.

## Material and methods

A systematic review on VR-based interventions for psychosocial remediation in schizophrenia.

### Literature search

Five databases used were PubMed (American Psychological Association), Scopus (Elsevier), PsycINFO (American Psychological Association), IEEE Xplore (Institute of Electrical and Electronics Engineers) and ACM Digital Library (Association for Computing Machinery). Unpublished dissertations, conference proceedings and abstracts without full texts available were excluded. The search was limited to the publications available from the selected databases from 1st January 2000 to 1st July 2019.

## Search criteria

Studies for review were identified following a keyword search for the terms ('virtual reality' OR 'VR' OR 'augmented reality' OR 'virtual character') AND ('social skills' OR 'psychosocial' OR 'social cognition' OR 'attributional bias' OR 'attributional style' OR 'social perception' OR 'theory of mind' OR 'emotional processing' OR 'emotion perception') AND ('schizophrenia').

## Inclusion and exclusion criteria

Publications were included in the review if:

- they were based on VR
- the main purpose was the improvement of social cognition or social skills
- they included patients diagnosed with schizophrenia, according to DSM-IV-TR<sup>29</sup>, DSM-5<sup>30</sup> and ICD-10<sup>31</sup> criteria
- they were written in English

Exclusion criteria:

- Grey literature, due to their unclear peer review process: editorials, extended abstracts, tutorials, tool demos, doctoral symposium publications, research abstracts, book chapters, proceedings, keynote talks, workshop reports, and technical reports.
- Systematic reviews, meta-analyses, and survey publications.

## Search process

The steps described in Fig. 1 were followed for the article extraction and selection process. The search string was used

on each of the five reference databases, providing a total number of 144 records. After removing duplicate references ( $n = 63$ ), two researchers filtered the remaining 81 papers in an independent manner through screening the full content of papers. If the researcher was not sure about including or excluding a paper, or there was no agreement between both researchers, the paper was presented to the clinical coordinator of the study for discussion towards a consensus decision. This step resulted in 7 references.

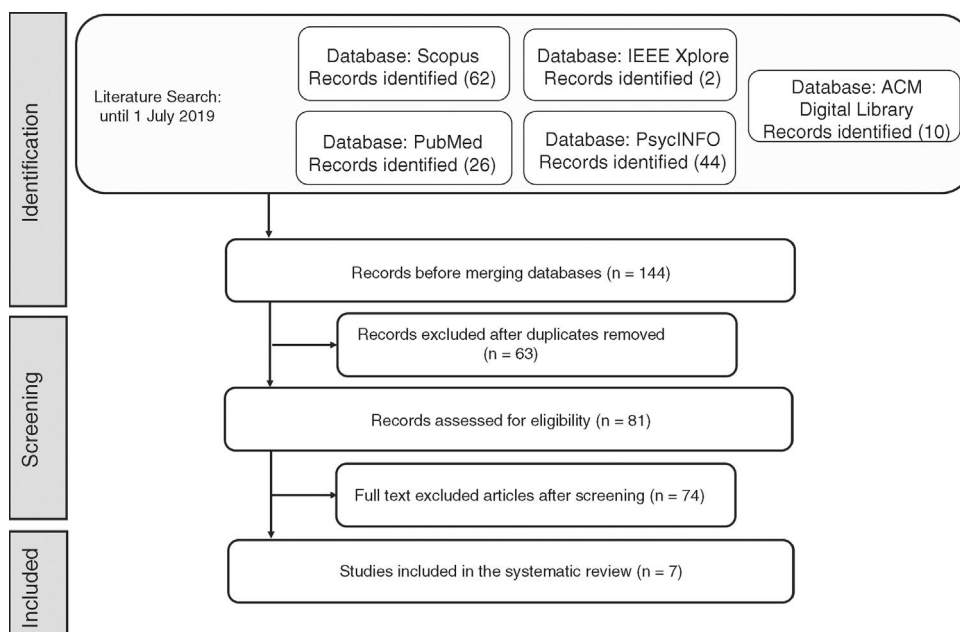
In order to assess that no references were missed during the process, some review papers obtained in our search process were carefully studied.<sup>28,32–34</sup>

## Results

A final number of 7 publications were extracted according to the previously described process. These are detailed in Table 1.

## Description of VR therapies

**Social skills training with virtual reality role-plays (SST-VR)**<sup>35</sup> includes three consecutive workouts: five training sessions on conversation skills (introduce yourself; find a common concern and listen to the other person; start a conversation; hold a conversation and end a conversation), three training sessions on assertiveness skills (make a demand; reject a demand from another person and make a commitment), and two training sessions on emotional expression skills (express positive emotions and express negative emotions). Each session incorporates a therapist model followed by the participant's role play, and then positive and corrective comments from the therapists. The VR system allowed interacting with avatars in an immersive environment during role-playing sessions.



**Figure 1** Steps followed for article extraction and selection process.

**Table 1** VR-based interventions for psychosocial rehabilitation in schizophrenia.

Name of the therapy	Authors, Year	Sample	Duration and intensity	Type of study	Immersive/ non-immersive VR	Therapy targets	Evaluation instruments	Results
<b>SST-VR<sup>35</sup></b> (Social skills training with virtual reality role-plays)	Park et al., 2011	64 patients diagnosed with schizophrenia	10 group sessions in 5 weeks	Randomised control trial Experimental condition: SST-VR (n = 33) Control condition: SST-TR (n = 31)	Immersive VR	Social skills and motivation	Psychopathology: PANSS Social skills: SBS RAS RCS SPSI-R Blind assessors rated vocal, non-verbal and conversational skills	During the training, the SST-VR group showed greater engagement with the training and generalisation of skills. After the training, the SST-VR group improved more in assertiveness and conversational skills, but less in nonverbal skills
<b>Soskitrain36</b> (Social skills training)	Rus-Calafell et al., 2012	1 patient diagnosed with schizophrenia	16 individual one-hour sessions, twice a week over eight weeks	Pre-treatment, post-treatment	Not specified	Social skills and social functioning	Psychopathology: PANSS Social anxiety: SADS Social performance and anxiety: AI Social functioning: SFS	Improvement in facial emotion recognition, social anxiety, conversation time, interpersonal communication, assertiveness and negative symptoms
<b>Soskitrain37</b> (Social skills training)	Rus-Calafell et al, 2014	12 patients diagnosed with schizophrenia or schizoaffective disorder	16 individual one-hour sessions, twice a week over eight weeks	Pre-treatment, post-treatment and four-month follow-up	Immersive VR	Social skills and social functioning	Psychopathology: PANSS Social performance and anxiety: AI SSIT SADS Social functioning: SFS	Improvement in negative symptoms, psychopathology, and social skills. Maintained at follow-up

Table 1 (Continued)

Name of the therapy	Authors, Year	Sample	Duration and intensity	Type of study	Immersive/ non-immersive VR	Therapy targets	Evaluation instruments	Results
<b>Job interview<sup>38</sup> training with Molly Porter</b>	Humm et al, 2014	26 patients diagnosed with ASD 37 patients diagnosed with schizophrenia and 33 patients diagnosed with PTSD	Molly Porter: 5 individual 2 hours sessions Control group: Treatment as usual	Randomised control trial Experimental condition (n = 64) Control condition: waitlist controls (n = 32)	Not specified	Job interview skills	Neurocognitive functioning: RBANS Social cognition: BLERT	Improvement in role-play interviews and self-evaluation
<b>Job interview<sup>39</sup> training with Molly Porter</b>	Smith et al., 2015	32 patients with schizophrenia or schizoaffective disorder	Molly Porter: 5 individual 2 hours sessions Control group: Treatment as usual	Randomised control trial Experimental condition (n = 21) Control condition: waitlist controls (n = 11) 6-month follow-up	Not specified	Job interview skills and employment	Role-playing performance, self-confidence, employment on the following 6 months	The VR group showed a larger improvement of job interview skills and self-confidence after the intervention. At 6-month follow-up participants in the VR groups had higher odds of receiving a job offer
<b>RC2S<sup>40</sup> (Cognitive remediation of social cognition in schizophrenia)</b>	Peyroux & Franck, 2016	2 patients diagnosed with schizophrenia	14 individual sessions of 1 hours 30 to 2 hours duration per week	Pre-treatment, post-treatment and six-month follow-up	Non-immersive VR	Social cognition and social functioning	Psychopathology: PANSS Daily functioning: SERS WEMWBS EAS Facial emotion recognition: TREF Theory of Mind: MASC-VF TOM-15 RMET Attribution style: AIHQ Social perception and knowledge: PerSo <sup>a</sup> Empathy: EQ QCAE	Improvement in the targeted social cognitive processes and positive changes in daily functioning in the long term

Table 1 (Continued)

Name of the therapy	Authors, Year	Sample	Duration and intensity	Type of study	Immersive/ non-immersive VR	Therapy targets	Evaluation instruments	Results
<b>MASI-VR<sup>41</sup></b> (Multimodal adaptive social intervention in virtual reality)	Adery et al., 2018	16 patients diagnosed with schizophrenia	10 individual sessions scheduled approximately twice per week	Pre-treatment and post-treatment	Non-immersive VR	Social skills and social functioning	Severity of general psychiatric symptoms: BPRS Severity of positive and negative psychotic symptoms: SAPS SANS Social functioning: SFS	Improvement in general psychiatric symptoms and negative psychotic symptoms

AI: Assertion inventory; AIHQ: Ambiguous Intentions Hostility Questionnaire; ASD: Autism spectrum disorder; BLERT: Bell-Lysaker Emotion Recognition Task; BPRS: Brief Psychiatric Rating Scale; EAS: Social Autonomy Scale; EQ: Empathic quotient; MASC-VF: Movie for the Assessment of Social Cognition; PANSS: Positive and negative symptoms scale ; PTSD: Post-traumatic stress disorder; QCAE: Questionnaire of Cognitive and Affective Empathy; RAS: Rathus Assertiveness Schedule; RBANS: Repeatable Battery for the Assessment of Neuropsychological Status; RCS: Relationship Change Scale; RMET: Reading the Mind in the Eyes Test; SADS: Social avoidance and distress scale; SANS: Scale for the Assessment of Negative Symptoms; SAPS: Scale for the Assessment of Positive Symptoms; SBS: Trower's Social Behavior Scales; SERS: Self Esteem Rating Self; SFS: Social functioning scale; SPSI-R: Social Problem Solving Inventory- Revised; SSIT: Simulated social interaction test; TOM-15: Theory of Mind-15; TREF: Test de Reconnaissance des Emotions Faciales; WEMWBS: Warwick-Edinburgh Mental Well-Being Scale.

<sup>a</sup> PerSo: This test is currently under validation.

**Soskitrain**<sup>36,37</sup> is a social skills training aimed at everyday situations, such as going to the supermarket, dealing with an angry security guard in a museum or trying to negotiate with a friendly manipulator about who would drive a car to a party. The program consists of two phases. In the first phase, the difficulties of facial recognition of emotions and the processing of social information are addressed. The second phase is aimed at social anxiety and interpersonal skills. The program allows users to practise social interactions with virtual avatars, encourages progressive learning of the social skills repertoire and provides positive or negative reinforcement.

**Job Interview Training with Molly Porter**<sup>38,39</sup> is designed to teach, reinforce, and refresh job-interview skills to adults with mental illness who are actively seeking employment. The system incorporates user-driven educational materials, an interactive role play simulation and formative comments to create a training experience consistent with high fidelity simulations, successful job interviews and adult learning theory. The educational component includes approximately five hours of training materials designed to help students prepare for interviews and complete the other steps necessary to find a job. Some of the topics covered include creating a resume, researching a position, selecting a job that meets individualized needs, deciding what to wear to an interview, selecting appropriate questions to ask, deciding whether or not to disclose a disability, and taking appropriate follow-up steps. The therapy is based on interactive VR simulation of role-playing games combining videos and voice recognition software.

**RC2S**<sup>40</sup> is a comprehensive, individualized social cognitive remediation program that includes paper and pencil tasks and computerized exercises. Each session is divided into four parts. The first includes paper-and-pencil tasks for the patient to develop strategies to analyse social situations, focusing first on basic social cognitive processes and then on higher order social cognitive functions. The second part contains a VR scene in which the goal is to help a character named Tom in a particular social situation. In the third part, the specific social components such as context or non-verbal language are reviewed during the VR simulation scene. Finally, the fourth part includes the determination of a home-based task chosen by the patient in collaboration with the therapist and related to the concrete objectives defined at the beginning of the therapy.

**MASI-VR**<sup>41</sup> is a program that includes the training of nonverbal social skills such as eye contact, facial expression, social distance and more complex skills including how to start conversations, greet people and ask for help or information. For this, the therapy includes avatars in non-immersive VR in three different social contexts (bus stop, shop and cafeteria).

## Samples

The sample size was very variable (from a case report<sup>36</sup> to 64 patients<sup>35</sup>). The study participants suffered from schizophrenia, except in two studies were included in which patients were diagnosed with schizophrenia and schizoaffective disorder.<sup>37,39</sup> One study included patients diagnosed with ASD and PTSD, in addition to patients with

schizophrenia.<sup>38</sup> For the present review only the schizophrenia sample was considered.

Two studies specified that all included participants were clinically stable and had not been hospitalised in a psychiatric institution in the last 6 months.<sup>36,37</sup> One study noted that participants were treated with intensive psychiatric care during two to four weeks and stabilised enough to participate in the study.<sup>35</sup> Only one of the studies that included two participants clarified that one of them was stable after a 5-month hospitalisation.<sup>40</sup> Finally, three studies did not report information about clinical situation of the patients.<sup>38,39,41</sup>

## Duration and intensity of therapies

The number of sessions was variable (5–16 sessions). The duration of the sessions was usually 1–2 hours with a twice a week frequency.

## Type of study

According to the level of scientific evidence, three randomised control trials and four pre-post treatment studies were identified.

Among the three randomised studies, only one study included an intervention in social skills without VR as a control condition.<sup>35</sup> The main difference between the two interventions: Social skills training with virtual reality role-plays (SST-VR vs SST-TR) was the role-playing method. Virtual environments as simulators of the scenes and avatars as actors were used in VR role-plays, whereas verbal, writing, picture, and video supplies were used as simulators of the scenes and SST therapists as the actors in TR role-plays. Thus, except for the materials used in role-plays, there were no differences in the details of training, including time spent for instructions, orientation, and contact with the main therapist. Two randomized control trials compared the experimental condition with the control condition, which included patients on the waiting list to be admitted to the experimental condition.<sup>38,39</sup>

Four pre-post treatment studies were included. One of them included a post-intervention evaluation at 4 months<sup>37</sup> and another included an evaluation at 6 months.<sup>40</sup>

## Immersive / non-immersive VR

Only two studies specified the use of immersive VR.<sup>35,37</sup> One study specified the use of non-immersive VR.<sup>41</sup> The rest did not specify it.<sup>36,38–40</sup>

## Therapy targets

### Social cognition interventions

One work had as its main objective the improvement of social cognition.<sup>40</sup>

### Social skills interventions

Six studies were aimed at improving social skills.<sup>35–39,41</sup> Two articles focused on improving job interview skills<sup>38,39</sup> and one of them analysed the impact on neurocognitive



functioning and social cognition.<sup>38</sup> Three studies evaluated social functioning<sup>36,37,41</sup> and one of them also evaluated the impact on facial emotion recognition.<sup>36</sup>

## Research teams and outcomes

A Korean research team was the pioneer in the design of a therapy for the improvement of social skills in patients with schizophrenia using VR. Park and colleagues designed a therapy called SST-VR, with positive results in assertiveness and conversational skills.<sup>35</sup>

A Spanish research team designed a therapy called Soskitrain, aimed at improving social skills. In 2012, they conducted a preliminary study with a patient diagnosed with schizophrenia.<sup>36</sup> Two years later, they expanded the sample to 16 patients with schizophrenia or schizoaffective disorder and added a follow-up evaluation after 4 months. It was described a significant improvement in negative symptoms, psychopathology, facial emotion recognition and social skills, maintained at follow-up.<sup>37</sup>

An American group has designed a job interview skills training program called "Molly Porter".<sup>38,39</sup> The intervention incorporates user-driven educational materials, an interactive role-play simulation, and formative feedback to create a training experience consistent with high-fidelity simulations, successful job interviews, and adult learning theory. In the first study, the improvement of job interview skills was evaluated, with positive results around this capacity and a superior self-assessment in the experimental condition. The second study also assessed the employment capacity during the next 6 months. The study again showed a greater improvement in job interview skills and self-confidence after the intervention in the experimental condition and, at 6 months of follow-up, participants in the VR groups had higher odds of receiving a job offer.

A French research team designed a therapy called RC2S. It is a comprehensive, individualised, and partly computerised social cognitive remediation program. Its main objective is the improvement of social cognition, evaluating the four cognitive domains (emotional processing, theory of mind, attributional style and social perception) and social functioning.<sup>40</sup> The therapy has been carried out in two patients diagnosed with schizophrenia, with immediate promising results in the targeted social cognitive processes and positive changes in daily functioning at 6 months follow-up.<sup>40</sup>

Another American group designed an intervention aimed at improving social skills and social functioning: MASI-VR. Significant improvement in general psychiatric symptoms and negative psychotic symptoms was shown.<sup>41</sup>

## Tolerability

Only two studies evaluated the tolerability of interventions. Both indicated that the interventions were well tolerated, interesting and motivating for the patients.<sup>35,37</sup>

## Discussion

To our knowledge, this is the first systematic review carried out specifically focused VR interventions for the improvement of psychosocial functioning in patients with schizophrenia.

The study included publications from 1st January 2000 to 1st July 2019. The results show the current situation of this field of knowledge. A total number of 7 papers were selected from the initial 81 non-repeated publications obtained from five databases (PubMed, Scopus, PsycINFO, IEEE Xplore, and ACM Digital Library).

Nowadays, the works are scarce, very recent and the samples are heterogeneous in quantity and quality, without specifying the level of stability of the patients included in the studies. Regarding the level of scientific evidence defined by the US Agency for Healthcare Research and Quality Agency,<sup>42</sup> from the total number of 7 selected papers only 2 papers were classified as having an IB level of evidence (evidence obtained from at least one randomised clinical trial) and 3 references presented an IIB level (scientific evidence obtained from at least one well-designed, quasi-experimental study). Studies that specified the use of immersive virtual reality are limited, probably because immersion is a step beyond the common studies that use VR. Most studies could be classified as social skills interventions, including job interview skills.

The low number of articles can be related to several facts. Today VR is expensive due to the cost of technological means and personnel specialised in the design of scenarios and avatars. In other pathologies such as specific phobias the works are in a more advanced state, partly because they require a simpler VR (e.g. a spider) than for social interaction.<sup>43</sup> In addition, there is an initial reluctance to work with VR in patients with schizophrenia, despite the studies that have been carried out in relation to safety and acceptability of technology, which indicated that VR was found to be easy to use, funny, motivating, interesting and did not generate anxiety in the participants.<sup>28,35,37,44</sup> Finally, publication bias in the face of negative results could be influencing the results obtained.

Despite the low number of publications, all studies obtained promising results around the improvement of social skills and / or social cognition in short-term. Some studies also noted an improvement in general psychopathology, negative symptomatology and daily functioning.

The present review throws new information around the available VR-based therapies for the improvement of psychosocial functioning in schizophrenia. Three studies<sup>36,40,41</sup> that had not been included in other previous reviews<sup>36,40,41</sup> were analysed in our review. Also, the present study provides extra information regarding previous reviews. Each therapy was described and classified considering the level of evidence, the type of VR used (immersive and non-immersive VR) and the content (social cognition, social behaviour and social skills), considering the definition of psychosocial functioning.

The present systematic review has some risks and limitations. One possible limitation in all systematic reviews is related to the selective reporting bias.<sup>45</sup> To minimise such risk, five different databases were used as the source for



the search process: PubMed, Scopus, PsycINFO, IEEE Xplore and ACM Digital Library. These provide a comprehensive list of articles that cover the distinct aspects of this review. In addition, two researchers independently reviewed the article selection process. It is worth noting that it was established that grey literature (e.g., theses, internal reports, etc.) should be excluded from the study. This could threaten the validity of the study, but it must be highlighted that grey literature is mostly published without a rigorous review process.

In summary, VR seems to offer an interesting and motivating therapeutic option for patients suffering from schizophrenia. The possibility of creating ecological environments and avatars that interact with patients and whose expressions and behaviours can be modified in real time, represents a great progress for mental health, especially interesting in the area of psychosocial remediation. In the coming years, the research will shed light on the limitations that exist today.

## Financial disclosure

This work was partially supported by Spanish Ministerio de Ciencia, Innovación y Universidades, Agencia Estatal de Investigación (AEI)/European Regional Development Fund (FEDER, UE) under RECOVER (PID2019-106084RB-I00) EmoBioFeedback (DPI2016-80894-R) and HA-SYMBIOSIS (TIN2015-72931-EXP) grants, by the Instituto de Salud Carlos III (grant PI16/00359; Fondo de Investigaciones Sanitarias/FEDER), by the European Development Regional Fund'' A way to achieve Europe'' (ERDF), by Madrid Regional Government (R&D activities in Biomedicine S2017/BMD-3740 (AGES-CM 2-CM)) and Structural Funds of the European Union.

## Conflict of interest

We have read the journal's policy and the authors of this manuscript have the following competing interests: Dr. R. Rodríguez-Jiménez has been a consultant for, spoken in activities of, or received grants from: Instituto de Salud Carlos III, Fondo de Investigación Sanitaria (FIS), Centro de Investigación Biomédica en Red de Salud Mental (CIBERSAM), Madrid Regional Government (S2010/ BMD-2422 AGES), Janssen-Cilag, Lundbeck, Otsuka, Pfizer, Ferrer, Juste, Exeltis. The other authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Acknowledgements

Spanish Ministerio de Ciencia, Innovación y Universidades, Agencia Estatal de Investigación (AEI) / European Regional Development Fund (FEDER). Instituto de Salud Carlos III. Madrid Regional Government and Structural Funds of the European Union. European Development Regional Fund'' A way to achieve Europe'' (ERDF).

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