A virtual reality-integrated program for improving social skills in patients with schizophrenia: A pilot study

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ABSTRACT

Background and objectives: Social skills training (SST) intervention has shown its efficacy to improve social dysfunction in patients with psychosis; however, the implementation of new skills into patients’ everyday functioning is difficult to achieve. In this study, we report results from the application of a virtual reality (VR) integrated program as an adjunct technique to a brief social skills intervention for patients with schizophrenia. It was predicted that the intervention would improve social cognition and performance of patients as well as generalisation of the learned responses into patient’s daily life.

Methods: Twelve patients with schizophrenia or schizoaffective disorder completed the study. They attended sixteen individual one-hour sessions, and outcome assessments were conducted at pre-treatment, post-treatment and four-month follow-up.

Results: The results of a series of repeated measures ANOVA revealed significant improvement in negative symptoms, psychopathology, social anxiety and discomfort, avoidance and social functioning. Objective scores obtained through the use of the VR program showed a pattern of learning in emotion perception, assertive behaviours and time spent in a conversation. Most of these gains were maintained at four-month follow-up.

Limitations: The reported results are based on a small, uncontrolled pilot study. Although there was an independent rater for the self-reported and informant questionnaires, assessments were not blinded.

Conclusions: The results showed that the intervention may be effective for improving social dysfunction. The use of the VR program contributed to the generalisation of new skills into the patient’s everyday functioning.

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1. Introduction

Ameliorating social impairment has become one of the most important challenges when treating patients with schizophrenia (Mueser & McGurk, 2004). In the past, according to the problem-solving framework, this social dysfunction was described as the conjunction of disabilities in social cognition (which refers to the mental operations and capacities that underlie social interactions (Green et al., 2008)) and social competence (which refers to communication skills, e.g., the verbal and nonverbal communication skills that allow successful execution of interpersonal interactions (Dickinson, Bellack, & Gold, 2007)). The social cognition component, appears to be aggravated by the individual’s cognitive deficits (Green, Kern, & Heaton, 2004), affective symptomatology (Lysaker & Salyers, 2007) and difficulties in metacognition (Brüne, Abdel-Hamid, Lehmkämper, & Sonntag, 2007; Chan & Mak, 2012).

However, social performance may be environmentally determined by factors such as opportunities, support systems and enhancements (Brekke, 2007). Functional outcomes (or social functioning) are the result of both cognition and performance (Bromley & Brekke, 2010).

Social skills training (SST) interventions (focussing separately on the two above-mentioned components or on both components simultaneously) aim to improve the patient’s social functioning and are one of the treatments of choice in schizophrenia spectrum disorders. Most recent clinical trials have explored the ability of this intervention to improve patients’ social functioning (Bellack, Mueser, Gingerich, Agresta, 2004; Granholm, Been-Zeev, & Link, 2009; Granholm et al., 2005; Horan et al., 2009, 2011; Roberts & Penn, 2009; Rus-Calafell, Gutiérrez-Maldonado, Ortega-Bravo, Ribas-Sabate, & Caqueo-Urízar, 2013). The SST intervention impacts the social cognition domain, specifically emotion perception.
(Horan et al., 2011; Roberts & Penn, 2009), anergia (Horan et al., 2009), independent living skills (Granholm et al., 2005), negative symptomatology and social discomfort (Rus-Calafell et al., 2013). Nonetheless, the improvement and implementation of new social behaviours in the patient’s daily life remains difficult to achieve.

Frequently, the SST intervention is applied in a group format, which allows the participants to practise with others, but the intervention can also be delivered in an individual format (Hogarty et al., 1991; Liberman & Eckman, 1989). According to Penn et al. (2004), the number of individual psychotherapy approaches for schizophrenia are increasing, particularly those approaches based on cognitive–behavioural models (Garety, Fowler, & Kuipers, 2000). Individual psychotherapy approaches may better target patients’ social needs and goals and can place greater emphasis on interpersonal context and the social consequences of symptoms (Tarrier & Calam, 2002). Social anxiety, negative symptoms and poor insight may hamper the involvement of schizophrenia patients in group therapy. Another treatment characteristic of the SST is that it is delivered, like most of the interventions in mental health, in the clinical setting (e.g., consultation, day hospital), which lacks the “real” characteristics of the social situations (e.g., environmental stimulus, sounds or unknown people). Although practitioners formerly used environments that were not interactive (intervention session, 2008), the evidence supporting the generalisability of psychosocial skills training from the clinical setting to everyday life is far weaker and has received less attention than it deserves (Scott & Dixon, 1995).

For clinicians, observing and practising the patient’s social skills in a natural social interaction/environment could prove useful, and such practices would facilitate the generalisation of the learned responses into the individual’s daily life. However, the naturalistic observation can be time-costly for the clinician and likely highly intimidating for the patient (especially if the clinician must be immersed in the everyday life of the outpatient). Virtual Reality (VR) has emerged as a tool to overcome this limitation of the usual application of the SST intervention. Virtual reality can be defined as technology that integrates real-time computer graphics, sounds and other sensory input to create a computer-generated world, in which the user can interact (Gregg & Tarrier, 2007). VR has been shown to be effective in the treatment of mental health problems and psychotherapy delivery (Gregg & Tarrier, 2007; Riva, 2005). The ecological validity of VR remains in the precise presentation and control of dynamic perceptual stimuli, and virtual environments provide valid assessments and situations that combine the veridical control of laboratory measures with the verisimilitude of everyday experiences (Parsons, 2011). Therefore, VR environments can evoke responses in a participant that are very similar to those occurring in natural environment. Consequently, a patient’s reactions can be evaluated so as to lend stronger credibility to the sense that true data is being produced (Rosqvist et al., 2006). In a meta-analysis by Powers and Emmelkamp (2008), the authors conclude that virtual reality exposure is highly effective in treating specific phobias and other anxiety disorders (including social phobia) in comparison with inactive (control) and active (relaxation) control conditions.

Although it is typically used as an exposure technique for specific phobias, VR has been recently applied with encouraging results to the study and treatment of schizophrenia. Early studies using this technology with psychosis aimed to explore positive symptoms, such as delusions and paranoia, with non-clinical populations (Freeman et al., 2003, 2005) and clinical (Forneils-Ambrojo et al., 2008; Freeman, Pugh, Vorontsova, & Antley, 2010; Valmaggia et al., 2007). In a recent review, Freeman (2008) analysed seven applications of this technology for schizophrenia: the symptom assessment, establishment of symptom correlates, identification of predictive variables, investigation of the differential prediction of symptoms, identifying environmental predictors, tests of putative casual factors and developing treatment. With respect to treatment development, some clinical studies have explored the use of VR for the rehabilitation and psychotherapy of schizophrenia patients: to improve medication management skills (Kurts, Baker, Pearlson, & Astur, 2007), for cognitive remediation therapy (daCosta & Carvalho, 2004) and to improve conversational and communication skills (Ku et al., 2007; Park et al., 2009, 2011). In their 2009 clinical study, Park et al. included a VR program in addition to a social skills training intervention. However, the VE program was a group intervention, and the main purpose was to enhance motivation and enrolment in the group therapy. Furthermore, their sample was composed of inpatients, and it is with outpatient cases and in stability periods that SST and other group-based social interventions are more effective and can assist the individual in correctly implementing and practicing social competence skills. Social skills training intervention using VR has also been applied in patients with autistic spectrum disorders (Mitchell, Parsons, & Leonard, 2007) and has produced encouraging results in reasoning and theory of mind.

We developed a brief social skills intervention for schizophrenia outpatients with social functional impairments (Rus-Calafell et al., 2013). In our previous study, we observed significant improvements in negative symptomatology, social discomfort, social withdrawal and interpersonal communication after treatment, and these benefits were maintained at 6-month post-treatment (Rus-Calafell et al., 2013). However, as mentioned previously, the effect of the intervention on the implementation of new behaviours in the patients’ daily life, an increase in pro-social and leisure activities, and skill acquisition was limited. Therefore, we decided to develop a VR program to 1) enable accessibility to those patients who refused to participate in group therapy; and 2) use an ecologically valid tool, the VR system, to train social skills and improve the generalisation of the learned responses in the patients’ daily lives. To the best of our knowledge, the present pilot study is the first to integrate a virtual reality program into an individual cognitive-behavioural social skills program intervention. The main hypotheses of the present study were as follows: 1) intervention would result in a reduction in negative symptoms and psychopathology; 2) participants’ social skill performance would improve whereas self-reported social discomfort and social anxiety would decrease after the treatment; 3) participants’ social functioning in their natural setting would improve after the intervention; 4) participants would exhibit a pattern of learning in the three target behaviours (committed errors in social perception, correct assertive behaviours and time spent in a conversation) practised in VR program.

2. Method

2.1. Participants

Fifteen patients were enrolled, and twelve completed the study. First, twenty outpatients from the Adult Mental Health Service of Igualada (Catalonia) were contacted and offered the individual social skills training intervention. All of the patients met the DSM-IV-TR (2004) criteria for schizophrenia or schizoaffective disorder and had been clinically diagnosed by their current treating psychiatrist. Of these patients, 15 agreed to participate and were enrolled in the study. The inclusion criteria were as follows: to be between 18 and 55 years old; and to exhibit a deficit in social skills and/or social functioning as indicated by the current clinical psychologist or psychiatrist. There were three exclusion criteria: to have a diagnosis of substance abuse and/or drug consumption; to be already involved in any other intervention for improving social skills (such as group therapy or social-oriented therapy); and to...
have a comorbid neurological disorder. All patients were clinically stable and had not been hospitalised at a psychiatric institution within the past six months. Three of the participants abandoned the study because they missed more than 3 consecutive sessions; their reported reasons were as follows: illness, schedule incompatibilities and forgetfulness. Thus, the final sample was made up of twelve participants \((n = 12)\).

2.2. Procedure

The Ethics Committee of the General Hospital of Igualada (Catalonia) reviewed and approved the present study’s protocol. Participants were selected and contacted through the mental health multidisciplinary team and referred to the clinical psychologist in charge of the study. In the first individual session with the social worker/nurse, inclusion and exclusion criteria were reviewed; the study and treatment information were provided to the patients, and they signed a prior consent inform. Subsequently, the pre-assessment test battery was administered to the patient by the clinical psychologist. It is important to note that an informant (a patient’s relative/friend) was selected to complete the Social Functioning Scale; this scale was also explained and given to the informant in this first session. Each participant was given a schedule detailing all of the therapeutic sessions programmed with the therapist. Before commencing the therapy, patients attended four thirty-minute baseline-sessions in which they practised with the VR program and in which the therapeutic alliance was enhanced (any social-oriented or cognitive-behavioural techniques were applied during these preliminary sessions). During these four preliminary sessions, the subsequent content was covered: brief review of the patient’s clinical history (using the self-reported history and clinical notes), discussion of the main problems and barriers regarding the patient’s daily social functioning, presentation of the hardware and software that would be used in the therapy sessions (including a short demo projection) and several practises with the Soskitrain, but only following the program’s instructions (any indication was given by the therapist). These previous practises with the program were included to control the baseline stability on the VR exercises (see Section 3). The whole therapy was delivered in 16 one-on-one sessions in a clinical consultation at the Adult Mental Health Service (Igualada). If a patient missed more than 3 consecutive sessions, he/she had to abandon the intervention but was allowed to recommence it after the end of the trial. After the complementation of the treatment, the post-assessment was performed, and the patients were given an appointment four months later for the follow-up assessment.

2.3. Treatment

The intervention was based on the manualised protocol of the brief SST of Rus-Calafell et al. (2013) and the therapist’s manual (Rus-Calafell, 2009, unpublished manual), and PowerPoint slides of the intervention were used. At the beginning of the program, each subject also received a user manual that included both the slides and activities between-sessions. The intervention was complemented with the Soskitrain program. This virtual reality program consists of seven activities based on the seven target behaviours proposed by Kopelowicz, Liberman, and Zarate (2006) (Table 1). This novel program allows users to practise social interactions with virtual avatars, encourages progressive learning of the social skills repertoire and provides positive or negative reinforcement. Interestingly, the program uses a random system of presentation of virtual faces, interactions and characters to offer to the participants a wide range of options during all of the sessions and to provide novelty during each session. Special attention was paid to the creation of the facial expressions and morphing of all of the characters to add realistic expressions to the different interactions. Some professionals volunteered to have their voices recorded for the dialogues, and they paid great care to the affect of every statement. The therapist can observe the patient’s real-time manifestations, modify and manipulate environments and characters (using an independent keyboard) according to the user’s responses and stop the interactions whenever is necessary to discuss a single situation and its implications. The program also provides the therapist with direct information concerning: committed errors, percentage of correct assertive behaviours and time spent during a conversation (see Fig. 1).

To practise with the program, a laptop with a 15.6-inch monitor and stereoscopic view was used (Acer Aspire 5738 dg). Participants were required to use 3D glasses and headphones. This hardware was selected for its ergonomic design and easy use by the

<table>
<thead>
<tr>
<th>Skill</th>
<th>Purpose</th>
<th>Activity/Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social perception</td>
<td>To improve emotion recognition capability.</td>
<td>Facial emotion recognition task choosing between 7 facial emotions (happiness, sadness, fear, anger, disgust, surprise and neutral).</td>
</tr>
<tr>
<td>Processing social information</td>
<td>Correct interpretation of other expressions and intentions. Generation of alternative thoughts.</td>
<td>Two-way interactions with a cashier and a barman with different emotional states (happy, sad, angry and ambiguous).</td>
</tr>
<tr>
<td>Responding and sending skills</td>
<td>Use of verbal (passive, aggressive and assertive) and non-verbal communication.</td>
<td>Identification of correct patterns of non-verbal communication (e.g., eye contact, physical space, posture and gestures). Accurate recognition and use of the three communication styles in different people (e.g, a security guard in a museum or a waitress in a restaurant).</td>
</tr>
<tr>
<td>Affiliative skills</td>
<td>To increase expressing affection, personal opinions and needs to family and friends.</td>
<td>Making and receiving compliments to or from the others.</td>
</tr>
<tr>
<td>Assertive communication</td>
<td>To learn specific assertive techniques to deal with discrimination or manipulation situations and improve self-confidence.</td>
<td>Two-way conversations with a manipulating friend trying to take advantage of the participant. Changing the roles, the participant has to convince his/her friend to do something and guess the anti-manipulating technique he is using to refuse it.</td>
</tr>
<tr>
<td>Instrumental role skills</td>
<td>To improve interactional skills in social situations to increase likeability (e.g. making requests, saying no and purchasing some drinks).</td>
<td>Two-way conversations with staff and people in a pub with specific instructions in saying no to some proposals, request and purchase specific things.</td>
</tr>
<tr>
<td>Conversational skills</td>
<td>To improve skills for starting, maintaining and finishing a conversation. To increase time expended in a conversation to reduce social anxiety and implement pleasantness.</td>
<td>One-to-one conversations with a man or woman to speak about different topics (e.g., sports, cinema, food, travel), encouraging the subject to keep on going in a conversation.</td>
</tr>
</tbody>
</table>

Table 1

Brief description of the VR integrated program (Soskitrain) 7 activities.
The therapy took place across sixteen “one-on-one” sessions, conducted twice a week over eight weeks. Each session lasted approximately 60 min and was divided into two parts: the first 30 min to discuss the content of the SST intervention and the remaining was devoted to practicing with the VR programme. Due to this structure of the intervention, the learning of the skills was scaffolded: first, the more basic skills were consolidated (e.g., facial emotion recognition and social processing), and finally the more complex skills (such as maintaining conversations) were achieved. This type of intervention also permitted repeated practice, in addition to learning, which is considered essential to ensure the assimilation of these interpersonal skills (Kopelowicz et al., 2006). The entire intervention was delivered by M.R. and supervised by J.R.

Positive symptoms were not discussed in the sessions, and all participants were continued to attend their treatment as usual (individual sessions with a psychiatrist, a social worker, and a psychologist).

2.4. Measures

2.4.1. Psychopathology

2.4.1.1. Positive and negative symptoms scale (PANSS; Kay, Fiszbein, & Opfer, 1987; Spanish version of Peralta & Cuesta, 1994). This scale evaluates positive and negative symptoms, as well as general psychopathology. Each item is scored from 1 (absence of psychopathology) to 7 (extremely severe). The scale exhibits good internal consistency: α = 0.62 for the positive subscale; α = 0.92 for the negative subscale; and α = 0.55 for the general psychopathology subscale.

2.4.2. Social performance and anxiety

2.4.2.1. Assertion inventory (AI; Gambrill & Richey, 1975; Spanish validation of Martin et al., 2012). This is a self-reported questionnaire in which the subject must indicate the degree of discomfort on a 5-point scale that ranges from 1 (none) to 5 (very much) and as well as the probability of displaying the behaviour described in the presented situation on a 5-point scale ranging from 1 (always do it) to 5 (never do it) in 40 different social situations. Two measures are derived from the subject’s answers: discomfort and response probability. The scale is an inverse scale; higher scores indicate poorer functioning. Test–retest reliability for each measure is r = 0.87 and r = 0.81, respectively.

2.4.2.2. Simulated social interaction test (SSIT; Curran, 1982; Spanish version used in Rus-Calafell et al., 2013). This test contains eight brief social interactions that involve disapproval/criticism, social visibility/assertiveness, confrontation/anger expression, hetero-social contact, intimacy/interpersonal warmth, conflict/rejection by parents, interpersonal loss, and positive expression. In each role-playing exercise, a situation is narrated, and the partner delivers a single predetermined prompt. Subsequently, the subject being assessed must deliver a response. The subject’s social skills are scored on an eleven-point Likert scale. Participants receive a social anxiety and a social skills score for each of the eight situations. The average score of the eight scenes provides an overall average score for both molar sub-scales. The assessment was performed during the in vivo interaction. Curran (1982) reported a coefficient of generalisability (naturalistic observations) of the situations varying between r = 0.76 and r = 0.97.

2.4.2.3. Social avoidance and distress scale (SADS; Watson & Friend, 1969; Spanish adaptation of Comeche, Díaz, & Vallejo, 1995). This 28-item self-reported questionnaire aims to assess different aspects of social anxiety, including fear, discomfort, subjective distress and the avoidance of social situations. It provides to the assessors three different measures: level of social anxiety (14 items), avoidance (14 items) and a final total score. Questionnaire scores on the true–false scale range between 0 and 28. For the Spanish adaptation, the test–retest reliability was r = 0.68 (Ruipérez, García-Palacios, & Botella, 2002).

2.4.3. Social functioning

2.4.3.1. Social functioning scale (SFS; Birchwood, Smith, Cochrane, Wetton, & Copestake, 1990; Spanish version of Vázquez-Morejón & Jiménez, 2000). This scale aims to assess seven specific areas of social functioning: withdrawal, interpersonal behaviour, recreation, pro-social activities, independence-performance, independence-competence and employment. The informant-reported version was used, and informants were asked to consider the last three months as the reference period. The internal consistency of the scale ranged from α = 0.45 to α = 0.90; and the test–retest reliability varied between r = 0.66 and 0.88 in all subscales (Vázquez-Morejón & Jiménez, 2000).

2.4.4. Objective scores

The Soskitrain provides a matrix to the therapist that comprises direct scores about patients’ performances in every session.
2.4.1. **Committed errors.** This score comprises the errors made in the facial emotion recognition task. If the patient failed to recognise the emotion (i.e., indicated the incorrect expression in Activity 1) or the interpretation of the avatar's emotional state (Activity 2), that response was counted as an error.

2.4.2. **Assertive behaviours.** This score comprises the number of correct emitted assertive behaviours and the correct identification of assertive, passive and aggressive behaviours/communication styles of others (Activity 3, 4, 5 and 6).

2.4.3. **Time spent in a conversation.** This score comprises the length of the conversation with the avatar in Activity 7.

2.4.5. **Qualitative and VR acceptance assessment.**

At the end of the intervention, participants were asked to complete an anonymous satisfaction questionnaire and rate their acceptance of the VR system. The ratings used a Likert scale ranging from 1 (minimum) to 10 (maximum).

2.5. **Experimental design.**

The present pilot study is a repeated measures experimental design at 3 assessment times: pre-, post- and four-month follow-up for the main outcomes of the study (PANSS, SSIT, AI, SADS, and SFS). Furthermore, for the objective scores reported by the VR program, an additional baseline time was included to control the stability of the practise with the program.

2.6. **Statistical analysis**

IBM® SPSS® Statistics 20 was used to analyse the data. A primary analysis of normality (Shapiro–Wilk test of normality and visual inspection of Q–Q plots) indicated that the main outcome variables were normally distributed. Thus, parametric statistical analyses were applied. Repeated-measures analysis of variance (ANOVA) for each dependent variables was run to explore differences over time (pre-, post- and 4-months follow-up for psychopathology and social functioning variables; and baseline, pre-, post- and 4-months follow-up for objective variables). Violation of sphericity were corrected by the Greenhouse–Geisser adjustment. Subsequently, to identify differences at each time and to evaluate the maintenance of the intervention’s gains, pair-wise comparisons were generated from repeated-measures ANOVA. All of the results were adjusted for multiple comparisons using Bonferroni correction. Effects sizes were calculated using an adaptation of Cohen’s $d$ for within-subjects design (Morris & DeShon, 2002). This method takes into account the dependency between pre- and post-scores. Finally, and only for the measures used to test the hypotheses 1 and 2, reliable change and clinically significant improvement rates were calculated using the Reliable Change Index (Jacobson & Truax, 1991).

### 3. Results

#### 3.1. **Demographic and clinical characteristics**

The demographic characteristics of the sample are summarised in Table 2. There was an approximately equal sex ratio, and all participants were from the same ethnicity. Most of the patients had a diagnosis of schizophrenia (paranoid subtype).

#### 3.2. **Psychopathology results**

A significant time effect was observed on the negative and psychopathology subscales of the PANSS (Table 3). Further comparisons revealed that, for negative symptoms, there was an improvement from pre- to post-treatment with a mean decrease of 9.33 ($p = 0.001$), although their improvements were maintained at the follow-up assessment (both $p > 0.05$). Cohen’s $d$ revealed that the effects sizes were large in both subscales. At post-treatment, all of the participants exhibited a reliable change and ten exhibited a clinically significant change in the negative symptomatology subscale. Similarly, eleven participants exhibited a reliable change and ten exhibited a significant clinical change on the psychopathology subscale.

#### 3.3. **Social performance and social anxiety**

**3.3.1. Assertion inventory**

Time exerted a significant effect on the degree of social discomfort (Table 3). Follow-up analyses revealed that the participants improved their performance from pre- to post-treatment, with a mean difference of 57.00 ($p = 0.000$). However, this improvement was not maintained at follow-up (mean difference between post- and follow-up was 3.58, $p < 0.001$), although their

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**Table 2**

Demographic data and clinical characteristics of the sample.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (SD)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>36.50 (6.01)</td>
<td>12</td>
</tr>
<tr>
<td>Gender %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>7 (58.3%)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>5 (41.7%)</td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>12 (100%)</td>
<td></td>
</tr>
<tr>
<td>Diagnosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schizophrenia (paranoid subtype)</td>
<td>9 (75%)</td>
<td></td>
</tr>
<tr>
<td>Schizoaffective</td>
<td>3 (25%)</td>
<td></td>
</tr>
<tr>
<td>Duration Illness</td>
<td>14.25 (4.61)</td>
<td></td>
</tr>
<tr>
<td>Medication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atypical</td>
<td>3 (25%)</td>
<td></td>
</tr>
<tr>
<td>Typical</td>
<td>4 (33.3%)</td>
<td></td>
</tr>
<tr>
<td>Combined</td>
<td>5 (41%)</td>
<td></td>
</tr>
<tr>
<td>Years Education</td>
<td>13.6 (3.9)</td>
<td></td>
</tr>
</tbody>
</table>

Means (SD); and percentages for those categorical variables.

**Table 3**

Raw pre, post and follow-up scores of the main clinical, cognitive, and functioning variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre-treatment</th>
<th>Post-treatment</th>
<th>Follow-up</th>
<th>F(2, 22)</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>PANSS: Positive</td>
<td>10.62 (0.78)</td>
<td>9.50 (0.50)</td>
<td>9.53 (0.38)</td>
<td>1.67</td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>18.91 (1.32)</td>
<td>11.83 (0.84)</td>
<td>12.58 (0.96)</td>
<td>45.45**</td>
<td>0.75</td>
</tr>
<tr>
<td>Psychopathology</td>
<td>28.67 (1.39)</td>
<td>20.33 (1.18)</td>
<td>20.17 (1.12)</td>
<td>54.82**</td>
<td>0.86</td>
</tr>
<tr>
<td>At: Discomfort</td>
<td>123.50 (6.95)</td>
<td>65.4 (2.45)</td>
<td>70.97 (3.04)</td>
<td>70.79**</td>
<td>0.87</td>
</tr>
<tr>
<td>SSIT: Performance</td>
<td>4.38 (1.19)</td>
<td>5.67 (0.15)</td>
<td>5.39 (0.13)</td>
<td>34.83*</td>
<td>0.23</td>
</tr>
<tr>
<td>Anxiety</td>
<td>6.18 (0.15)</td>
<td>4.39 (0.19)</td>
<td>4.72 (0.15)</td>
<td>39.76*</td>
<td>0.48</td>
</tr>
<tr>
<td>SADS: Avoidance</td>
<td>7.55 (0.81)</td>
<td>4.08 (0.41)</td>
<td>4.17 (0.53)</td>
<td>14.80*</td>
<td>0.58</td>
</tr>
<tr>
<td>Anxiety</td>
<td>9.00 (0.60)</td>
<td>4.16 (0.68)</td>
<td>7.66 (0.54)</td>
<td>83.24**</td>
<td>0.09</td>
</tr>
<tr>
<td>SFS: Withdrawal</td>
<td>10.58 (0.50)</td>
<td>11.83 (0.51)</td>
<td>11.25 (0.44)</td>
<td>4.69*</td>
<td>0.36</td>
</tr>
<tr>
<td>Interpersonal_C</td>
<td>5.75 (0.60)</td>
<td>7.83 (0.27)</td>
<td>7.67 (0.22)</td>
<td>16.08*</td>
<td>0.58</td>
</tr>
<tr>
<td>Independence</td>
<td>25.16 (2.35)</td>
<td>29.75 (1.29)</td>
<td>29.33 (1.28)</td>
<td>7.19</td>
<td></td>
</tr>
<tr>
<td>Competence</td>
<td>30.23 (2.27)</td>
<td>33.58 (1.54)</td>
<td>32.50 (1.30)</td>
<td>3.67</td>
<td></td>
</tr>
<tr>
<td>Recreation</td>
<td>20.08 (4.05)</td>
<td>27.58 (1.41)</td>
<td>26.25 (1.67)</td>
<td>17.38*</td>
<td>0.35</td>
</tr>
<tr>
<td>Pre-social</td>
<td>20.33 (2.40)</td>
<td>30.75 (2.59)</td>
<td>28.75 (1.65)</td>
<td>13.14*</td>
<td>0.39</td>
</tr>
</tbody>
</table>

Note: PANSS: positive and negative symptoms scale; SSIT: simulated social interaction test; AI: Assertion inventory; SADS: Social avoidance and distress scale; SFS: social functioning scale. P-test (df = 2, 22); Means (standard deviations); P-test of the Time effect. SST: social skills training intervention; *: $p < 0.05$, **: $p < 0.01$. 

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scores remained lower than at pre-assessment. At post-treatment, all of the participants exhibited a reliable change, and twelve of them exhibited significant clinical changes.

A significant time effect was also observed for the probability of displaying the assertive behaviour subscale (Table 3). Subsequent pair-wise comparisons revealed a significant difference between the pre- and post-treatment assessments ($M = 55.41, p = 0.000$), and this increase was maintained at follow-up ($p > 0.05$). In this case, all of the participants exhibited a reliable change, and ten of them fell into the category of “improved” (significant clinical change). For these two subscales of the SAQ, the Cohen’s $d$ effects sizes were medium and large, respectively.

### 3.3.2. Simulated social interaction test

A significant time effect was observed on the performance and anxiety subscales of the SSIT (Table 3). Further comparisons revealed that, for the performance, patients improved from pre-to post-treatment, with a mean increase of 1.25 ($p = 0.000$). Patients’ anxiety also improved, with a mean decrease of 1.78 ($p = 0.001$). These changes were maintained at follow-up. Cohen’s $d$ revealed that the effects sizes were small and medium, respectively. At post-treatment, all of the participants exhibited a reliable change in both subscales; nine made a clinically significant change in the performance subscale, and eleven participants exhibited significant clinical change on the anxiety subscale.

### 3.3.3. Social avoidance and distress scale

A significant time effect was observed for both the avoidance and anxiety subscales of the SADS (Table 3). Subsequent pair-wise comparisons indicated that the pre- and post-treatment scores of the avoidance and anxiety subscales were different, with a mean decrease of 3.66 ($p = 0.001$) and 4.83 ($p = 0.000$), respectively. However, these changes were only maintained for the avoidance subscale ($p < 0.05$), not for the anxiety subscale; although their scores remained lower than at pre-assessment, participants’ anxiety increased at follow-up (mean difference between post- and follow-up was 3.50, $p < 0.001$). Furthermore, Cohen’s $d$ revealed medium effect sizes. At post-treatment, eleven participants exhibited a reliable change, and ten exhibited a significant clinical change on the avoidance subscale. On the anxiety subscale, nine participants exhibited a reliable change, and seven of them fell into the “improved” category (significant clinical change).

### 3.4. Social functioning

Moreover, a significant time effect was observed for the social functioning (SFS) variables: withdrawal, interpersonal communication, recreation and pro-social activities (Table 3). Further comparisons revealed an improvement from pre- to post-treatment for withdrawal, with a mean difference of 1.25 ($p = 0.019$); for interpersonal communication, with a mean difference of 2.08 ($p = 0.003$); for recreation, with a mean difference of 7.05 ($p = 0.004$); and for pro-social activities, with a mean difference of 10.41 ($p = 0.001$). All of these gains were maintained at follow-up ($p < 0.05$ for all the significant subscales), and Cohen’s $d$ revealed that the effects size were medium.

### 3.5. Objective scores

Table 4 presents the main effect of time over the three objective scores provided by the VR program. Subsequent comparisons revealed that there were no significant differences between the baseline and pre-treatment scores for any of the variables. Participants exhibited a pattern of improvement in the three variables between pre- and post-treatment (with a mean difference of 3.67 for committed errors ($p = 0.000$); 9.91 for assertive behaviours ($p = 0.000$); and 59.07 for time expended in a conversation ($p = 0.000$)). All of these gains were maintained at follow-up.

### 3.6. Qualitative assessment and VR acceptance

Participants reported a high level of satisfaction concerning the perceived intervention’s benefits ($M = 8.72, SD = 0.33$), the psychologist’s work ($M = 9.5, SD = 0.5$), and for acceptance (nonaversivity) of the VR system ($M = 9.29, SD = 0.73$).

### 4. Discussion

The main purpose of the present study was to explore the effectiveness and utility of a VR program as an adjunct tool to deliver an individual social skill training intervention. The qualitative assessment revealed a high degree of treatment satisfaction and perceived benefits to the participants, as well as high acceptance of the VR system.

According to the results of the first and second hypotheses, after the treatment, participants exhibited a significant decrease in negative symptomatology, psychopathology and social avoidance as well as an improvement in social skill mastery. Moreover, all of these gains were maintained at follow-up. These results are similar to those found in previous studies using the SST-based group-therapy intervention with outpatients (Granholm et al., 2009; Horan et al., 2009, 2011; Roberts & Penn, 2009).

It is well known that both medical and psychological treatments have shown poor results regarding the improvement of negative symptoms (Turkington & Morrison, 2012). However present results coincide with those reported by Grant, Huh, Perivoliotis, Stolar, and Beck (2012), who demonstrated that cognitive therapy can improve this negative symptomatology. These authors suggested that the heart of maintenance of negative symptoms relies on the schema concerning fear of failure. Presumably, the combination of cognitive therapy combined with the continuous practice of the VR program increased the patients’ opportunity to engage in activities that provide them with positive feedback. Following Grant’s hypotheses, this increase in activity and motivation puts the patient more in touch with reality and stimulates the cycle of recovery, allowing the patients to actively confront their daily functioning and, consequently reduces negative symptomatology.
Social discomfort and social anxiety improved after the treatment; however, this gain was not maintained at four-month follow-up but remained lower than the pre-treatment level. The lack of maintenance of this gain may be a reflection of the vulnerability of schizophrenia patients to psychosocial stressors as well as fluctuations of residual positive symptoms. According to the vulnerability-stress model of schizophrenia, vulnerability factors are associated with sensitivity to environmental stressors that increase the individual’s liability to psychosocial and daily stressors (Myin-Germeys & van Os, 2007). Following this model, Horan and Blanchard (2003) used role-playing tests (subjects interacting with a confederate) to investigate mood fluctuations and coping styles during social interactions. These authors demonstrated that, even in laboratory conditions, assertion scenes (involving compromise and negotiation) elicited negative moods and decreased positive moods in patients with schizophrenia, supporting the idea that negative affect and/or maladaptive coping are specific vulnerability factors that amplify stress reactivity in schizophrenia patients. However, even though patients exhibited an increase in social anxiety and discomfort over time, if individuals were equipped with skills to address these psychosocial situations (such as assertion situations, social encounters or stressful emotional climates within families), stressors would be less likely to trigger exacerbations or social decompensations (Ventura & Liberman, 2000). Adding sessions to the treatment or continuation of the repeated exposure to virtual environments (even as patient self-practise at home) could help with social anxiety reduction. The simplicity of the program as well as the ergonomics of the hardware allows clinicians to reinforce the primary treatment of the disease as often as the case requires; in social-stress decompensation periods for instance. Moreover, including the VR program as a routine practice in Mental Health Community Teams and training therapists to use this technology, could improve the recovery process and the patients’ quality of life.

Regarding the third hypothesis, our results demonstrated that patients improved in withdrawal, interpersonal communication, recreation and pro-social activities after the intervention, and these gains were maintained at four months follow-up. According to the model of Bromley and Brekke (2010), which proposes that functional outcomes are the result of both an individual’s capacity and performance, this meaningful improvement of social functioning may be a consequence of the improvement in social cognition and social performance during the intervention. The increased probability of emitting an expressive response (Ai), as well as the improvement in interpersonal communication and engagement in pro-social activities (SFS), proves the generalisation of the learned response to the daily life of the participants. Furthermore, it should be noted that social functioning was assessed by an informant (patient’s relative or friend); therefore, the patient’s improvement was perceived by someone who could observe the individual’s day-to-day functioning in everyday environments.

Interestingly, the results also revealed that participants exhibited a pattern of learning responses of emotion recognition, emissions and identification of assertive behaviours and time expended in a conversation after the use of the SST (Soskiran, Park et al., 2011) also found in their study that conversational skills and assertiveness improved with the incorporation of virtual role-playings to the SST intervention in inpatients. However, they found less benefit of the VR to non-verbal skills. The inclusion to the Soskitrain of specific tasks regarding non-verbal aspects of the social behaviour, such as emotion recognition or identification of non-verbal behaviours, allowed the patient to become more aware of these basic aspects of interpersonal communication. In those specific activities, patients could learn through observation and positive reinforcement from the behaviours of the avatars (Social Learning Theory; Bandura, 1969). The meaningful improvement of time expended in a conversation, along with the reduction of social anxiety and discomfort after the treatment, demonstrates the increase in the patients’ confidence when conversing with others. Using the VR program, the clinician could directly observe the patient’s behaviour during interactions across all of the sessions. In this way, clinicians could discuss and work with the patient’s biases in attributional style (Bentall et al., 2009; Garety & Freeman, 1999) or emotional perception and knowledge (Penn, Corrigan, Bentall, Racenstein, & Newman, 1997) in specific social situations or interactions. This is a potential advantage regarding the need to directly modify and improve the patient’s social impairment and is made possible in that the training is made in a specific context with specific difficulties and in that both the clinician and the patients can address emerging attributions, beliefs or statements that affect social cognition and competence.

As reported by previous authors (Freeman, 2008; Park et al., 2011), patients reported their enjoyment of the use of this new technology system and stated that it enhanced their motivation for the intervention and future treatments.

5. Conclusion

In summary, the proposed intervention was observed to effectively improve negative symptoms, social anxiety and pro-social activities. The present study adds evidence to the existing literature about the effectiveness of the SST to ameliorate these aspects when the patient is enrolled to this socially oriented intervention. In addition, we report novel results about the use of a VR program that allows the patients to practise skills in specific social interactions and provides clinicians a direct observation of the patient’s social behaviour and real-time manifestations in a simulated social environment.

The present study presents several limitations. Firstly, the reported results are based on a small, uncontrolled pilot study. Secondly, although completing demonstrated improvements in their social cognition and performance, there were three participants from the preliminary sample who dropped out of the study. Thirdly, it would have been useful to include other measures for the quality and acceptance assessment that also include aspects such as expectations or satisfaction, similar to the one proposed by Borkovec and Nau (1972). Ultimately, there was only one therapist conducting the intervention and performing the assessments; however, the rater of social, cognitive, and clinical measures was an independent research assistant. The next step will be to conduct a larger, randomised controlled trial to establish the efficacy of the SST with the VR-integrated program compared with other well-established interventions for social skill impairments.

The development and application of affect-computing devices that facilitate real-world testing of contending theories explaining social cognition and social competence may help clinicians and researchers study and treat patients with impairments in these areas. The use of simulated social environments, the interaction with different virtual humans and the possibility of providing immediate feedback to the patients promotes the VR system as one of the most useful tools with which the therapist can train patients in the clinical setting. Continuing advances in VR technology, along with concomitant system-cost reductions, have helped to develop more usable and accessible VR systems that can target a wide range of physical, psychological and cognitive rehabilitation concerns (Rizzo & Kim, 2007).
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