Schizophrenia Research 144 (2013) 51–62

Contents lists available at SciVerse ScienceDirect

Schizophrenia Research

journal homepage: www.elsevier.com/locate/schres

A virtual reality-based vocational training system (VRVTS) for people with schizophrenia in vocational rehabilitation

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ARTICLE INFO

Article history:
Received 15 August 2012
Received in revised form 23 November 2012
Accepted 17 December 2012
Available online 26 January 2013

Keywords:
Cognitive
Rehabilitation
Vocational
Virtual reality

ABSTRACT

Employment provides schizophrenic patients with a positive identity and hope. Cognitive impairments have been suggested to slow down the progress in work rehabilitation. The purpose of this study was to investigate the efficacy and effectiveness of VR as a cognitive intervention for enhancing vocational outcomes. 95 inpatients with schizophrenia were randomly assigned to a virtual reality-based vocational training group (VRG), a therapist-administered group (TAG) and a conventional group (CG). Twenty-five of them in each group had completed the study. Their performances were evaluated, before and after interventions, by Brief Neuropsychological Cognitive Examination, Digit Vigilance Test, Rivermead Behavioural Memory Test, Wisconsin Card Sorting Test (WCST) and Vocational Cognitive Rating Scale. Patients in the VRG were found to perform better than patients in the TAG and CG in cognitive functioning, as shown by the WCST-percentage of error ($F(2, 72) = 7.146$, $p<0.001$) and the WCST-percentage of conceptual level response ($F(2, 72) = 8.722$, $p<0.001$). The post-hoc test revealed that the VRG showed a better performance than both the TAG ($p=0.03$) and the CG ($p<0.001$) in the WCST-percentage of error. The VRG also showed a better performance than patients in both the TAG ($p=0.01$) and the CG ($p<0.001$) in the WCST-percentage of conceptual level response. The VRG also showed a better self-efficacy score than CG. Both VRG and TAG showed a better work performance as reflected by the on-site tests. Further studies on the use of VR in schizophrenia rehabilitation and for vocational success are discussed.

1. Introduction

During the recovery journey in people with schizophrenia, employment is one of the most indispensable and essential elements that provide people with a positive identity and hope. Apart from the typical psychiatric problems (American Psychiatric Association, 1994), more studies have begun to explain their problems in cognitive aspects (Davidson et al., 1996; Temkin et al., 1999). Special cognitive problems can be related to attention (Cornblatt et al., 1999), memory (Bowen et al., 1994; Corrigan et al., 1994) and executive functions (Green, 1996; Green et al., 2000). These impairments in schizophrenia were found to severely hamper daily functioning and showed significant concurrent and predictive relationships with functional outcomes in patients with schizophrenia (Green, 1996). Cognitive impairment in people with schizophrenia may slow down the progress in work rehabilitation (Green, 1996; Green and Nuechterlein, 1999; Velligan et al., 2000). Thus, reducing the effect of this rate-limiting cognitive factor (Liberman, 1996; Tsang et al., 2010) was hypothesized to improve work rehabilitation outcomes and ultimately employability in people with schizophrenia (Hogarty et al., 2004; McGurk and Mueser, 2006).

To date, virtual reality has been widely used for a variety of neurological conditions (Burge et al., 2009; Yip and Man, 2009) with proven evidence of efficacy and effectiveness in attention enhancement, memory rehabilitation (Rose et al., 1998) and executive function improvement (McGeorge et al., 2001). Virtual reality applications can also be applied in the psychiatric field. It has shown promising results when working with specific mental problems such as the treatment of phobias (North et al., 1998), body image disturbances (Riva et al., 1998) and autism (Strickland, 1997). Preliminary findings have demonstrated a clear positive transfer effect from virtual to real training (Riva, 2002; Zhang et al., 2003; Lam et al., 2004; Yip and Man, 2009). Virtual reality has the advantage of providing a virtual work environment with the potential for infinite repetitions of the same work skills training tasks (Kahan, 2000; Hodges et al., 2001). It also enables sensory

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http://dx.doi.org/10.1016/j.schres.2012.12.024

presentations, task complexity and response requirements, and the nature and pattern of feedback can be easily modified according to patients' impairments, before they enter a more demanding and complicated real work environment (Rizzo et al., 1997; Wilson et al., 1997). Additionally, VR also addressed the motivation problem in people with schizophrenia. In the VRVTS, a top-down approach within a working context was adopted that was distinct from conventional cognitive training programs. Top-down approaches that simultaneously emphasize the training of multiple cognitive domains, with different procedures and strategies, can be highly individualized to promote task engagement (Medalia et al., 2001). Enabling patients to maintain task engagement is an important element in psychiatric rehabilitation. Furthermore, the working context of the training environment was perceived as being highly relevant to the users' perspective compared to component-based cognitive training. Choi et al. (2010) further enhanced the expectancy–value theory (Fishbein and Ajzen, 1975) and suggested that when people valued the tasks as being meaningful and useful for reaching their future goals, they were more intrinsically motivated to learn and possibly benefited more from the learning task.

The present study adopted theory-driven training strategies and one of the training programs was enhanced by the use of virtual reality (VR), a cutting-edge computer technology, as an intervention tool. The effectiveness of a new virtual reality-based vocational training system (VRVTS) was evaluated through a randomized clinical trial. Specific research questions to answer were:

a. Did VRVTS enhance cognitive performance in people with schizophrenia?
b. Were there any significant differences among the three groups (virtual reality-based group, therapist-administered group and a conventional group) in terms of cognitive performance, vocational outcomes and work-related self-efficacy?

2. Methods

2.1. Design

This study was a single, blinded, randomized clinical trial which the assessors were blinded to the group assignment. Independent assessors, who did not know the expected results of the training programs, were responsible for the pre-test and post-test outcome assessments at baseline and post-intervention.

2.2. Participants

The participants were patients with schizophrenia who had been diagnosed by psychiatrists as operationally defined by the DSM-IV (American Psychiatric Association, 1994). Consensus in diagnosis would have also been obtained by a psychiatric specialist. They were inpatients who attended a vocational rehabilitation program by the Main Occupational Therapy Service Team of the Occupational Therapy Department at Castle Peak Hospital, Hong Kong. There were various reasons of hospitalization. It could be relapse or unmanageable behavioral problem in the community. Duration of hospitalization was about 6–8 weeks for acute patients and about 15 weeks for extended care. The dose of antipsychotic treatment also varied. It depended on the severity of the patients. As all the participants were referred from the Rehabilitation wards, they had been rated on Brief Psychiatric Rating Scale (BPRS). Their average score of BPRS was 31 (SD = 6), indicating a normal or mild psychotic symptoms. They were assumed to be comparable in symptomatology in this study.

The selection criteria were:

- Patients with a diagnosis of schizophrenia
- Patients who attended vocational rehabilitation services at the Castle Peak Hospital
- Chinese ethnicity of both genders
- Age between 18 and 55 years old
- Able and willing to provide informed consent to participate in the study.

The exclusion criteria were:

- Patients with physical handicaps, for example blindness
- Patients who had undergone electroconvulsive therapy (ECT) during the past 12 months
- Patients who had had an episode of drug abuse during the past 30 days
- Patients with a history of mental retardation or other neurological diseases and developmental disabilities.

Moreover, we did not include detailed record of chlorpromazine equivalent dosage of antipsychotic medication and the types of medication that the patients received at the time of this study. This may lead to questioning about the possible side effect of medication influencing performance. However, it is still controversial about the effect of medication on cognitive function. Various studies compared the first (neuroleptics) and second-generation agents (atypical antipsychotic) and the results are non-conclusive. There is support that the second-generation agents have better cognitive effects compared to first generation, but the overall effect sizes are modest (Keefe et al., 1999; Harvey and Keefe, 2001). On the other hand, it was suggested that atypical antipsychotics produce a mild remediation of cognitive deficits in schizophrenia and specific atypical have differential effects within certain cognitive domain (Woodward et al., 2005). Further studies found that neuroleptic and the anticholinergic drugs that are given to treat extrapyramidal syndromes can have marked cognitive-impairing effects in patients with schizophrenia. Another argument shared that drug-free patients with schizophrenia or patients who have never been prescribed any neuroleptic or anticholinergic medication also demonstrated significant cognitive impairment (Blanchard and Neale, 1994; Saykin et al., 1994; McCreadie et al., 1997). Nonetheless, a meta-analysis reviewed the effects of conventional neuroleptic treatment on cognition in schizophrenia and a different result was revealed (Mishara and Goldberg, 2004) Typical antipsychotic medication provides modest to moderate gains in multiple cognitive domains. In this study, whether participants who took typical or atypical antipsychotics, it was found that, after randomization, participants in VRG, TAG and CG showed no significant difference in the baselines of taking typical or atypical antipsychotics.

As ANOVA suggested testing the possible differences among the outcome measures of the three groups, the sample size was estimated according to related literature (Cohen, 1988) and using the software “Power Analysis and Sample Size for Windows” v. 6.0, or PASS (Analysis and Size, 2006), accordingly. For ANOVA, using three groups, with an input of alpha = 0.05, beta = 0.2 (or power = 0.8) and an estimated effect size of 0.4, the sample size for each of the groups was estimated to be 22 (for an effect size of 0.3, n = 37). To account for possible attrition or refusal cases, a group size of 30 was initially put forward as the minimum size (a total of 90), anticipating a medium to large effect size. In the end, only 75 participants were able to complete the treatment and assessment process. The reasons for dropouts in each group were mainly the early discharge of patients, discontinued intervention or incompletion of the assessment due to a deteriorated mental state or behavioral problems (see Fig. 1). Thus, a total of 75 patients were successfully recruited in the VR-based training