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# Virtual shopping: A viable alternative to direct assessment of real life function?

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ABSTRACT

*Objective:* Real-life function is markedly impaired in schizophrenia and is an important outcome for interventions, but direct assessment is time consuming and resource intensive. Virtual reality (VR) enables assessment using simulation, akin to real life (RL), but allowing greater experimental control, reliability, and a more timely assessment. This study explores whether VR simulation predicts RL performance in supermarket shopping and how both relate to underlying cognitive abilities.

*Method:* Forty three people with DSM-IV schizophrenia were included in the study. Participants were required to shop for items using a self-directed search in both RL and VR. In each task, accuracy (number of correct items) and efficiency (time taken and number of aisles entered) were measured. IQ, executive function, working memory, spatial memory and social cognition were also assessed.

*Results:* Specific correlations were found between RL accuracy and VR accuracy, and between RL and VR efficiency measures. Multiple regression analyses indicated that VR efficiency measures contributed significant unique variance to RL efficiency outcomes, in addition to that explained by background cognitive measures, with a final model predicting 58% of variance in RL efficiency.

*Conclusions:* VR functional shopping measures may enhance predictions of real life performance, over and above existing cognitive test procedures, and provide a more time-efficient method for evaluating real life outcomes.



## 1. Introduction

The core features of schizophrenia (DSM-IV) include impairments in functioning across community, social and occupational domains, posing a high cost to the individual, their families and societies (McCrone et al., 2010). Recovery of everyday function is limited, with disability increasing substantially in chronic schizophrenia (Greenwood et al., 2005; Wunderlink et al., 2009; Green et al., 2000). Impaired cognition contributes up to 40% of the variance in functional outcome (Velligan et al., 1997; Green et al., 2000), with cognitive remediation therapies (CRT) having only moderate effect sizes for enhancing performance across cognitive domains and in everyday life (Penades et al., 2006; McGurk et al., 2009; Wykes et al., 2007, 2011; Wykes and Huddy, 2009).

There is a need to increase our understanding of the mechanisms of functional change, in order to better target cognition and every day function, to improve outcome in psychosis. Nevertheless, our understanding of functional outcome is limited, in part by inadequacies in available measurement tools (Wykes and Huddy, 2009; Wykes, 1994; Wykes and Spaulding, 2011). Fewer trials incorporate function measures compared to cognition measures, and those that do, use direct objective measures, such as employment, education and independent living (Thornton et al., 2010), that are affected by a range of societal and economic factors; alternatively broad, subjective self- or informant-report measures are used, that are open to reporter bias.

A small number of procedures have been developed that assess real world performance directly (McKibbin et al., 2004). The supermarket shopping task is one such task (Greenwood et al., 2005), requiring participants to shop in a local supermarket, whilst an observer records accuracy and efficiency. Investigations with this task have begun to elucidate underlying mechanisms of functional impairment, but use is limited by the time and complexity of real-life observation. Indeed, there are few brief, direct standardized assessments that are easily administered and validated against real-life function. In this context, Virtual reality (VR) may provide more readily implemented functional capacity measurement (Bowie et al., 2006), having already been used to assess a variety of everyday performances, including for example, assessment of medication management, social competence, anxiety, thinking patterns, and memory, using different environments such as a VR apartment, street, tube-train, library, park, maze and a VR supermarket to assess function in different clinical groups (Baker et al., 2006; Kurtz et al., 2007; Park et al., 2009a, 2009b, 2011; Ku et al., 2006; Kim et al., 2007; Broome et al., 2013; Zanyi et al., 2009;

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Freeman et al., 2003, 2005, 2010; Hanlon et al., 2006; Spieker et al., 2012; Wilkins et al., 2013a, 2013b; Weniger and Irle, 2008; Sorkin et al., 2006, 2008; Josman et al., 2009; Landgraf et al., 2010).

VR has been shown to successfully simulate shopping, as indicated by the Virtual Reality Functional Capacity Assessment Tool (VRFCAT) simulated VR shopping task, which comprises accuracy and efficiency (time) measures, and is validated in a USA psychosis sample against both cognitive and functional performance (Ruse et al., 2014). The task shows promise as a VR assessment of functional capacity. However, some studies suggest there is differential performance in VR tasks and compared to real life performance, dependent on the nature of the spatial environment and associated cognitive processes (Wilkins et al., 2013a, 2013b; Landgraf et al., 2010). No psychosis studies have validated VR performance against real life (RL) performance using tasks with the same procedural demands.

Accordingly, the current study used a VR supermarket task in conjunction with a RL supermarket shopping task, to investigate (i) whether associations exist across different types of VR shopping measures (accuracy, time and efficiency), and separately across the RL shopping measures; (ii) whether VR performance is associated with equivalent RL performance; (iii) whether VR assessment adds additional explanatory power to the prediction of RL performance over and above other cognitive measures, (iv) the manner in which RL and VR performance is related to measured cognitive functioning and (v) whether negative symptoms contribute to this performance in VR and/or RL. RL and VR shopping were measured alongside key cognitive performance measures and social cognition. Based on previous research, we predicted that some processes (working memory and strategy use) would be related to both RL and consequently also VR performance, whilst other processes would relate only to RL performance (e.g. social cognition) or VR performance (e.g. visuospatial memory).

## 2. Method

### 2.1. Participants

Participants were a referred sample of 50 people with DSM-IV Schizophrenia, aged 18–65 years, with premorbid IQ above 70, English as a first language, no neurological problems or head injury, and no current substance abuse, recruited from community and specialist inpatient and out-patient services. All participants gave informed consent, with ethical approval obtained from the Joint South London and Maudsley and Institute of Psychiatry NHS Research Ethics Committee (Reference 05/Q0706/46).

Forty-three people completed all the performance measures. Their mean age was 39.5 (SD = 11.9; range: 21–63) and 22 were male. Their mean PANSS (Kay et al., 1987) rated symptoms were as follows: positive 14.6 (SD = 6.5; range: 7–28); negative 13.4 (SD = 5.5; range: 8–27), and total 57.8 (SD = 18.6; range: 32–103).

### 2.2. Design

A cross-sectional within-subjects design was employed. Participants were allocated to complete either the RL or VR task first, followed by the remaining shopping, cognitive and symptom assessments. Cognitive measures were selected for their previous relationship to supermarket shopping (Greenwood et al., 2005) or their predicted differential relationship to the RL or VR environment.

### 2.3. Measures

#### 2.3.1. Cognitive measures

Premorbid intelligence was estimated using the National Adult Reading Test—Revised (Nelson and Willison, 1991), and current IQ using the short-form Wechsler Abbreviated Scale of Intelligence (Wechsler, 1999a).

Additional cognitive testing included: Working memory — the Letter Number Span Task (scaled score) (Wechsler, 1999b); visuospatial memory — the Wechsler Memory Scale III Visual Reproduction task (Wechsler, 1999b); spatial strategy — the Behavioural Assessment of the Dysexecutive Syndrome Key Search Task (profile score) (Wilson et al., 1998); response initiation — the Phonological Fluency test (Spreen and Benton, 1977); and social cognition — Intention Inference Test (Sarfati et al., 1997).

#### 2.3.2. Shopping measures

*2.3.2.1. Virtual Reality Supermarket Shopping Test.* This task, designed by Dr Susan Cobb and colleagues (University of Nottingham) and adapted by Professor Robin Morris, was supported by Superscape and presented on a computer. It was specifically selected to simulate the previously employed real-world task, measuring accuracy and efficiency of performance. The participant entered a VR supermarket, with graphically presented shelving and arrays of goods by category in different aisles. A shopping list was presented on paper to cue selection of 10 appropriate items or pieces of information (such as the price of runner beans). A joystick was used for navigation, with clicking to select goods, which were then placed in the trolley. Avatars mimicked a real-life shopping environment. Participants first completed a navigation exercise through a walled maze to practice moving in the VR environment. Accuracy was measured by the total number of correct items selected. Efficiency was measured by the time taken to complete the task, and the number of aisles entered above the minimum required, when using the most efficient route.

*2.3.2.2. Real Life Supermarket Shopping Test.* This task, derived initially from The Test of Grocery Shopping Skills (Hamera and Brown, 2000; Rempfer et al., 2003) is described in detail elsewhere (Greenwood et al., 2005). It was chosen because of its good psychometric properties (r = .60–.99 for test–retest, parallel form and inter-rater reliability), and its stated value to people with schizophrenia. It was adapted to be culturally appropriate and generalizable within a UK population. As in the VR task, participants used a shopping list to select 10 items of the correct size and cheapest price, this time in a real supermarket. All normal shopping strategies, such as requesting help from staff, were allowed. As with the VR task, the same accuracy and efficiency measures were used.

### 2.4. Statistical analysis

Pearson's correlations were used to explore association between variables and Cronbach's alpha to explore the internal consistency of the RL and VR measure types. Within-subject t-tests explored whether there were performance differences across the RL and VR tasks.

Additionally, a series of multiple regression models were used to explore the associations between cognition and both RL and VR function measures and the role of negative symptoms. Variable selection and testing was carried out using a forced entry model: all cognitive predictors were entered first, followed by the VR measures. In the final model, all non-significant predictors ($p > 0.05$) were removed and the model was re-fitted. IQ score was then added to the final models as a control variable and the significance re-evaluated.

## 3. Results

Table 1 provides cognitive data. Group means lay within the average-low average range, with a wide distribution across all measures from extremely low to superior range.

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