



Virtual reality functional capacity assessment in schizophrenia: Preliminary data regarding feasibility and correlations with cognitive and functional capacity performance



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ABSTRACT

Introduction: Assessment of functional capacity is an intrinsic part of determining the functional relevance of response to treatment of cognitive impairment in schizophrenia. Existing methods are highly and consistently correlated with performance on neuropsychological tests, but most current assessments of functional capacity are still paper and pencil simulations. We developed a computerized virtual reality assessment that contains all of the components of a shopping trip.

Methods: We administered the Virtual Reality Functional Capacity Assessment Tool (VRFCAT) to 54 healthy controls and to 51 people with schizophrenia to test its feasibility. Dependent variables for the VRFCAT included time to completion and errors on 12 objectives and the number of times that an individual failed to complete an objective. The MATRICS Consensus Cognitive Battery (MCCB) and a standard functional capacity measure, the UCSD Performance-Based Skills Assessment-Brief (UPSA-B), were administered to the patients with schizophrenia. **Results:** Patients with schizophrenia performed more poorly than healthy controls on 10/11 of the time variables, as well as 2/12 error scores and 2/12 failed objectives. Pearson correlations for 7 of 15 VRFCAT variables with MCCB composite scores were statistically significant.

Conclusion: These results provide support for the possibility of computerized functional capacity assessment, but more substantial studies are required.

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1. Introduction

Schizophrenia is marked by substantial impairments in everyday functioning in multiple domains (Harvey and Bowie, 2005). Achievement of functional milestones in areas such as full-time employment, independence in residence, and social functioning is reduced compared to both healthy people and other severe mental illnesses such as bipolar disorder (Harvey et al., 2010). Candidates for the causes of these impairments include cognitive deficits, impairments in the ability to perform the skills required to achieve success in everyday, negative symptoms and depression, health variables, and a variety of social, cultural, and environmental factors.

A recent development in research on the determinants of disability in schizophrenia has been performance- (Harvey et al., 2007) and interview-based (Keefe et al., 2006) measures of Functional Capacity (FC). Studies of performance-based assessments of

FC have found that impairments on these measures predict failures to achieve milestones in vocational, residential, and social domains (Mausbach et al., 2010; Mausbach et al., 2013) in schizophrenia and bipolar disorder populations (Bowie et al., 2010; Depp et al., 2012). Whether everyday functioning is defined either by milestone achievement (Gould et al., 2012) or by ratings generated by high-contact informants (Bowie et al., 2008), impairments on measures of FC have typically been found to be more proximal to everyday functional deficits than cognitive impairments. Further, the correlation between performance on FC measures and neuropsychological (NP) tests has been remarkably consistent and substantial, typically $r = 0.60$ or greater (Leifker et al., 2011).

The importance of valid and efficient assessment of FC has been increased by the requirement of the US Food and Drug Administration (FDA) that all studies attempting to demonstrate improvements in cognitive functioning induced by pharmacological or cognitive remediation means also provide evidence of functional relevance by “co-primary” measures (Buchanan et al., 2005; Buchanan et al., 2010). In a study of people with schizophrenia, performance-based

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assessments of FC, specifically the UCSD Performance-Based Skills Assessment (UPSA; Patterson et al., 2001) and the Test of Adaptive Behavior in Schizophrenia (TABs; Velligan et al., 2007), demonstrated substantially higher correlations with NP test performance than patient self-reports derived from interview-based measures (Green et al., 2011). Although use of high-contact informants, particularly clinicians, yields correlations with NP performance consistent with performance-based measures of FC (Keefe et al., 2006), many people with schizophrenia may not have access to high-contact clinicians (Patterson et al., 1997) and the use of informants other than close-contact caregivers or clinicians may yield questionable results (Poletti et al., 2012; Sabbag et al., 2011).

Functional capacity measures have also demonstrated high levels of test-retest reliability, minimal practice effects, and minimal missing data in large-scale clinical trials (Keefe et al., 2011). Despite these multiple strong features, there are some limitations to the current set of FC measures. These measures are delivered in a paper and pencil format, which is not practical for remote delivery or for simultaneous assessment of multiple cases. With the advent of remotely deliverable cognitive remediation therapy (CRT), in-person assessment of functional gains may not always be possible. Further, these measures are comprised of several functional tasks that are not required consistently across different cultures and do not have alternate forms (Velligan et al., 2012).

In an attempt to enhance the assessment of FC we have developed a computerized, immersive, and potentially remotely deliverable FC assessment referred to as the Virtual Reality Functional Capacity Assessment Tool (VRFCAT). The VRFCAT consists of a tutorial and 6 versions of 4 mini scenarios that include navigating a kitchen and planning a trip to the grocery store, catching a bus to a grocery store (selecting the correct bus and paying the correct fare), purchasing food at the grocery store, and returning home on a bus. Thus, this assessment strategy captures several of the functional domains of other FC measures: transportation, finances, household management, and planning. Further, the alternate forms are a unique feature of this assessment and the scenarios have the potential to be rapidly updated and cross-culturally adapted.

There have been previous efforts made to create computerized FC assessments. There is a long history of these tasks being used in aging populations in order to simulate functional demands that include either use of computer or interactive voice menus (Czaja and Sharit, 2003). Computerized FC assessments have also previously been employed in schizophrenia. For instance, a computerized version of the UPSA was recently developed, although this assessment currently requires an in-person examiner (Moore et al., 2013). Virtual reality assessments aimed at delusions of persecution have been developed as well (Freeman, 2008). Further, Kurtz et al. (2007) developed a medication management assessment with a virtual apartment. These previous assessments are different from the current one because of the sequential, multi-task demands of a simulated shopping trip and the goal of wide coverage of functional domains in the VRFCAT.

In this paper we present the preliminary results from the development and initial feasibility study of the VRFCAT. The VRFCAT was administered to both healthy individuals and people with schizophrenia. In addition, schizophrenia patients were assessed with the MATRICS Consensus Cognitive Battery (MCCB) and the UCSD Performance-Based Skills Assessment-Brief (UPSA-B). This study was conducted in sequence, with the healthy control (HC) group assessed first in order to understand the feasibility of the task and the schizophrenia patients examined later. Therefore, the samples were not selected to be “matched” on demographics and there are some differences between the samples. Our analyses examined the differences in performance between the HC group and people with schizophrenia, as well as the correlations between a standard paper and pencil functional capacity measure (UPSA-B), cognitive

performance (composite scores on a modified version of the MCCB), and performance on the VRFCAT in people with schizophrenia.

2. Methods

2.1. Subjects

Two different samples of subjects were compared. During the development phase, 102 healthy controls from Durham, North Carolina, were recruited. As this was a feasibility study only, a formal assessment of psychopathology was not performed although subjects were asked if they had received previous mental health treatment. The subjects were tested with 1 of 6 randomly selected versions of the assessment and then asked to return for re-test with a different randomly selected version 7–14 days later. All research participants provided signed, informed consent, and this research study was approved by the Western IRB. Healthy control subjects received \$20.00 per visit for their time and effort in completing the VRFCAT. Ninety of those 102 returned for testing with a different version of the application. Due to an initial data management problem that was later rectified, only 69 of the 90 who returned had complete data sets. During our initial analysis of the data, two application errors were identified: First, we observed that one of the versions of the VRFCAT yielded significantly outlying data and did not perform in an equitable way to the other versions. As a result, we excluded this version from all subsequent analyses. Second, we identified a programming error resulting in inaccurate collection of the time to complete Objective 12. This variable was therefore excluded from subsequent analyses. In addition, two significant outliers were discovered and removed from data analysis, resulting in a HC sample size of $n = 54$.

The patient sample was collected from one of the two sites participating in the Validation of Everyday Real-world Outcomes (VALERO) study, phase 2. All patients were recruited and assessed at the University of Miami Miller School of Medicine. All patients provided signed, informed consent, and this research study was approved by the local IRB. During the initial analysis of the data, one significant outlier was discovered and removed. In addition, four patients were removed from analysis due to rater administration errors, resulting in a patient sample size of $n = 51$.

All patients with schizophrenia were administered the Structured Clinical Interview for the DSM-IV (SCID; First et al., 1995) by a trained interviewer, and diagnoses were subjected to a consensus procedure. Participants were excluded if they had a history of traumatic brain injury with unconsciousness > 10 minutes, brain disease such as seizure disorder or neurodegenerative condition, or the presence of any DSM-IV-TR diagnosis on Axis I that would exclude the diagnosis of schizophrenia. None of the patients were experiencing their first psychotic episode. In order to capture a broad array of patients, substance abuse was not an exclusion criterion for patients but anyone who appeared intoxicated was rescheduled. Inpatients were not recruited, but patients resided in an assortment of unsupported, supported, or supervised residential locations. Patients received \$25.00 for their time and effort above and beyond their compensation for participation in VALERO-II.

2.1.1. Procedure

All participants were examined with the VRFCAT. All patients were also examined with a performance-based assessment of NP abilities and FC. The VRFCAT was administered to patients after completion of a comprehensive assessment of a variety of aspects of cognition and everyday functioning, which is partially reported here.

2.1.2. VRFCAT description

The VRFCAT was developed in order to measure four different functional abilities: checking for the availability of items to complete

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