



The relationship between change in cognition and change in functional ability in schizophrenia during cognitive and psychosocial rehabilitation



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ABSTRACT

While a wealth of studies have evaluated cross-sectional links between cognition and functioning in schizophrenia, few have investigated the relationship between change in cognition and change in functioning in the context of treatment trials targeted at cognition. Identifying cognitive skills that, when improved, predict improvement in functioning will guide the development of more targeted rehabilitation for this population. The present study identifies the relationship between change in specific cognitive skills and change in functional ability during one year of cognitive rehabilitation. Ninety-six individuals with schizophrenia were assessed with a battery of cognitive measures and a measure of performance-based functioning before and after cognitive training consisting of either drill-and-practice cognitive remediation or computer skills training. Results revealed that while working and episodic memory, problem-solving, and processing speed skills all improved during the trial, only improved working memory and processing speed skills predicted improvement in functional ability. Secondary analyses revealed these relationships were driven by individuals who showed a moderate level ($SD \geq 0.5$) of cognitive improvement during the trial. These findings suggest that while a variety of cognitive skills may improve during training targeted at cognition, only improvements in a subset of cognitive functions may translate into functional gains.

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1. Introduction

Cognitive impairment in individuals diagnosed with schizophrenia is both widespread and severe. The most sensitive instruments estimate that over 75% of patients present with some form of cognitive impairment (Harvey, 2013), and some studies suggest that nearly all patients may sustain some degree of cognitive decline when premorbid IQ is accounted for (e.g., Ammari et al., 2014; Kurtz et al., 2011).

Poor functional status, including problematic self-care, reduced quantity and impaired quality of social interactions, and difficulty engaging in recreational activities and performing in the work place, remains one of the most treatment-resistant components of schizophrenia. Demonstrated links between cognitive skills and functioning, including estimates that neurocognition accounts for 20–60% of the variance in functional outcome (Green et al., 2000, 2004a), have served as a rationale for the development of novel

behavioral interventions targeted at cognition, such as cognitive remediation (CR; e.g., Wykes et al., 2014). However the mechanism of treatment effects, more specifically the degree to which cognitive change, as a function of these treatments, relates to change in functioning, remains understudied.

Investigating the relationship between dynamic change in neurocognition and change in functional capacity during treatment will help clarify the true nature of the relationship of treatment-related improvements in cognition and functioning in schizophrenia and guide future approaches to rehabilitation. Nine studies to our knowledge have evaluated the relationship of change in cognition to change in functioning in the context of targeted cognitive and psychosocial interventions for schizophrenia (Brekke et al., 2009; Cook et al., 2013; Eack et al., 2011; Fiszdon et al., 2008; Hogarty et al., 2006; Penadés et al., 2010; Reeder et al., 2004, 2006; Wykes et al., 2012). The relationship between changes in cognition and changes in functioning is most profitably explored in trials of CR, where improvements in cognitive skills are likely to be largest.

Three recent studies, employing different approaches to CR,

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have investigated this relationship (Eack et al., 2011; Fiszdon et al., 2008; Wykes et al., 2012). Studying 150 individuals with schizophrenia assigned to either cognitive remediation and work therapy or work therapy alone, Fiszdon et al. (2008) measured several aspects of cognition and functioning, using the quality-of-life scale (QLS), over three time points of six months each. The authors found that improvements in memory during the trial predicted improvements in QLS scores. Paradoxically, however, decreases in performance on measures of executive function predicted improvements in QLS scores. In a related study, Wykes et al. (2012), with a sample of 49 people with schizophrenia assigned a work coach and treated with CR, reported that planning improvements were associated with improved work quality but that other aspects of cognition that improved in response to CR, specifically cognitive flexibility and working memory, were unrelated to work quality improvements.

In a third study, Eack et al. (2011) examined 58 individuals of early-course schizophrenia treated with 60 hours of cognitive training and 40 hours of group-based social cognitive training over two years. The authors found that improvements in executive-function and social cognition partially mediated effects of their program on functional ability. Functioning in this study was measured by several instruments that relied on observer rating.

Taken together, these three studies have all provided support for a relationship between cognitive improvement and functional improvement but areas identified across studies, and the magnitude and direction of these relationships have differed. There are two potential explanations for variability in study results. First is the effect of adjunctive psychosocial rehabilitation on the nature of the relationship of cognitive and functional change. Two of the three studies (Fiszdon et al., 2008; Wykes et al., 2012) investigated work therapy, which may produce such large and direct effects on functioning that relationships between cognition and function may be obscured. Second, many studies to date have relied on observer-rated measures of functioning. A strength of these measures is that they more closely map onto true levels of community function, but a limitation is that change on these measures may be difficult to detect in the context of brief treatment trials, with factors extrinsic to the study, such as individual differences in the availability of peers for relationship development and availability of relevant paid work opportunities, influencing the degree of change on these measures.

In the current study we sought to build on previous work in three ways, using a substantial sample ($n=96$) of people with schizophrenia treated with two programs of cognitive training (drill-and-practice CR or computer skills training) that have demonstrated effects on cognitive skills (Kurtz et al., 2007, 2015). First, we selected a performance-based instrument of capacity, the University of California at San Diego Performance-Based Skills Assessment (UPSA-Brief), that involves direct observation of patient performance on activities of daily living in a testing setting to offer an index of functional ability in response to cognitive training and psychosocial rehabilitation (Mausbach et al., 2008, 2011). No similar study, to our knowledge, has selected a performance-based measure of adaptive living skills as an index of function, which would appear to be ideally suited to the detection of change in skills across a brief, treatment trial interval. Second, we differentiated between individuals showing small and moderate levels of improvement in cognition and those showing little or no improvement. Building on work by Wykes et al. (2012), we tested a moderated mediation model that identified whether individuals reaching a certain threshold of cognitive improvement might be responsible for the relationship present between cognition and functioning. Individual differences in response to cognitive training have been well-documented (Medalia and Richardson, 2005). Similar studies measuring change in cognition and functional

status have grouped participants with small changes in cognition and those with substantial change together, despite evidence that patients with substantial neurocognitive improvement are the ones that drive most observed improvements in function (Brekke et al., 2009). Finally, previous studies have not assessed the specificity of reported cognition–function relationships by accounting for estimates of pre-morbid verbal IQ in their analyses. We measured pre-morbid verbal IQ and examined whether this ability affected the relationship between improvements in specific cognitive skills and functional capacity.

In the present study, two models were assessed: mediation (improvements in cognition explain improvements in functioning) and moderated mediation (cognitive improvements explain functioning improvement only after a certain threshold of cognitive improvement is achieved). We hypothesized that: (1) change in functional ability would be mediated by change in select domains of cognition, even when accounting for estimates of premorbid verbal IQ, and that (2) the relationship between cognitive and functional change would be driven by those individuals showing at least moderate improvement in overall cognition ($SD=0.5$).

2. Materials and methods

2.1. Participants

Participants consisted of 117 community-dwelling individuals diagnosed with schizophrenia or schizoaffective disorder as assessed by the Structured Clinical Interview for DSM-IV (SCID; First et al., 1995). All procedures met relevant institutional approval and all participants gave written informed consent to participate. Individuals were excluded from the study if they possessed: (a) uncorrected visual or auditory impairments, (b) neurological illnesses other than schizophrenia, (c) developmental disability, (d) evidence of mental retardation as evidenced by a history of services, (e) current substance abuse, or (d) lack of fluency in English. The majority of patients were recruited from schizophrenia rehabilitation programs at The Institute of Living (IOL) in Hartford, Connecticut ($n=96$), MidState Medical Center in Meriden, CT ($n=4$), and InterCommunity ($n=17$), a community mental health clinic in East Hartford, CT. This study was a secondary analysis of existing data sets collected as part of two randomized controlled trials assessing the efficacy of cognitive remediation therapy (Kurtz et al., 2007, 2015).

All participants were enrolled in one of two treatment groups: computer skills training or drill-and-practice cognitive remediation therapy. A detailed description of these treatments is offered in previous publications (Kurtz et al., 2007; Kurtz et al., 2015). Participants at The IOL were also treated with a rich array of rehabilitative services including skills training, motivational exercise groups, psychoeducation, and vocational counseling on a three-day-per-week basis. Participants at InterCommunity and MidState were treated with a subgroup of these psychosocial therapies. All participants were assessed on neurocognitive and functional outcome measures at the start of cognitive remediation or computer skills training and a second time upon completion of these interventions, a mean 10.3 months later ($SD=4.71$). Ninety-six out of 117 individuals (82.1%) completed cognitive training and all neurocognitive and functioning assessments at baseline and follow up. There were no statistical differences in age, race and ethnicity, education, and other demographic variables between completers and non-completers. Demographic characteristics of all participants are displayed in Table 1. The sample was made up of individuals of various races and ethnicities (70.9% Caucasian, 16.2% African-American, 10% Hispanic, 3% Asian-American, and 2% other).

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