

## SHORT COMMUNICATION

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# Is executive function associated with symptom severity in schizophrenia?

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**Abstract** This paper reports on a study that was designed to investigate the relationship between psychopathology and executive functions in schizophrenia. Correlations were sparse and mostly weak. The most robust finding was the association between letter fluency and negative symptoms; however, most other applied tasks were not associated with symptom level. Our results support previous findings of differential relationships between impaired executive functions and symptom level.

**Key words** executive functions · WCST · positive and negative symptoms · schizophrenia

## Introduction

Cognitive impairment has now been widely acknowledged as a core feature in schizophrenia (Pantelis et al. 1996). These impairments have not only been found in chronic, but also in first episode patients (Hutton et al. 1998, Addington & Addington 2000). Disruption of cognitive functioning is often part of the clinical picture of acute psychosis, yet a substantial number of patients seem not to regain their initial level of cognitive functioning after remission of symptoms (Basso et al. 1998, Reed et al. 2002).

Executive functions appear to be the most widely explored neuropsychological deficits among patients with

schizophrenia. They play a key role when patients face demands and tasks to access outpatient structures. Along with its supposed relationship to frontal abnormalities (Schroder et al. 1995), severity of negative symptoms is often reported to be associated with executive functions (Harvey et al. 1998, Liddle 2000, Nieuwenstein et al. 2001, Perry & Braff 1998, Voruganti et al. 1997). However, although a few authors have either reported a relationship to worse (Perry & Braff 1998, Verdoux et al. 1999) or to better executive performance (Basso et al. 1998), the severity of positive symptoms generally appears to have minimal relationship to the severity of executive deficits (Nieuwenstein et al. 2001, Voruganti et al. 1997).

The present study investigates the differential relationship between severity of psychopathology and executive deficits in an inpatient sample suffering from schizophrenia. Investigating this association may be of crucial help for clinicians' strategies in applying more appropriate rehabilitation services in a time where global processes of de-institutionalization have led to increasing development of outpatient structures over recent years.

## Methods

### Subjects

All participants in this cross-sectional study were recruited from a specialized hospital unit for schizophrenia of the Psychiatric University Hospital Geneva. Patients were between 16 and 38 years of age, had a diagnosis of DSM-IV schizophrenia according to SCID-IV (Structured Clinical Interview for DSM-IV; American Psychiatric Association 1994), presented no history of neurological disorder and no other significant medical condition considered to affect cognitive performance, no history of drug or alcohol dependence or current drug or alcohol abuse, and an IQ of not less than 70. Patients were only included when acute psychotic symptoms had resolved and when plans for discharge had already been made. This strategy aimed to maximize measurement of stable trait-like neuropsychological characteristics and to minimize transient effects associated with acute psychosis.

Symptom level was assessed with the PANSS (Positive and Nega-

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tive Syndrome Scale; Kay et al. 1987) subscales for positive, negative, and general symptoms, as well as with the CDS (Calgary Depression Scale; Addington et al. 1993).

## ■ Assessment of executive functioning

### Wisconsin Card Sorting Test (WCST)

A computerized WCST version was applied according to the standard procedure (Heaton 1981). Categories completed and perseverative errors served as dependent variables. The WCST generally is interpreted in terms of abstraction/problem-solving skills and ability to shift strategies efficiently in response to environmental feedback.

### Trail Making Test (TMT)

The standard procedure (Reitan 1958) was administered. The test is thought to require executive control, specifically flexibility of thinking and a greater demand of working memory.

### Stroop (Stroop 1935)

The score was computed as the reaction time difference between an interference and a non-interference task. The Stroop task has been widely used as a paradigmatic measure of selective attention. The correct performance further requires response flexibility in that an established, more automatic response needs to be inhibited and a different strategy employed.

### Verbal fluency (Benton 1968)

The subjects were instructed to say as many words as possible beginning with the letters F, A and S in three respective 1-minute trials. A 1-minute trial for a semantic category (animals) was also performed. Performance is thought to reflect abilities to organize retrieval in terms of specific cues and to monitor for inappropriate responses, such as perseverative responses or responses that do not fit the cue.

## Behavioural Assessment of Dysexecutive Syndrome (BADS; Wilson et al. 1996)

The BADS consists of six subtests which tap a variety of executive dimensions such as planning and strategic capacities, conceptual flexibility, divided attention and inhibition control. An overall score can be obtained from the sum of each test.

## Results

Twenty-three men and fifteen women were enrolled in this study. The mean age was 24 years ( $SD \pm 7$ ; range 16–38), with a mean NART (Nelson 1982) score of 100 ( $SD \pm 12$ ). 82% were treated with novel antipsychotics, one patient refused medication, and the remaining patients were treated with typical antipsychotics [mean CPZ equivalent dose: 310 ( $SD \pm 207$ , range 62.5–800)]. 53% received anticholinergic medication. Regression equations revealed that neither antipsychotic nor anticholinergic medication was related to measures of executive function.

The mean PANSS scores were as follows: total 67 ( $SD \pm 14$ ), positive 14 (5), negative 21 (6), and general 32 (7). Out of a possible maximum of 27, the mean CDS score of 4.2 (4.2) was rather low.

There was heterogeneity of performance on executive tasks, with a subgroup of patients scoring within normal ranges. Table 1 shows the Spearman rank-order correlation coefficients between indices of executive measures and symptom level.

**Table 1** Spearman rank-order correlation coefficients between indices of executive function and symptoms in 38 inpatients with schizophrenia

	PANSS				CDS
	positive	negative	general	total	
WCST					
%Categories correct	−0.04	−0.24	0.07	−0.08	−0.17
%Perseverative errors	0.03	0.24	−0.07	0.07	0.05
Stroop					
Index B/A (time for interference task/time for non-interference task)	0.37*	0.28	0.48*	0.42*	0.35*
TMT					
Percentiles	0.06	−0.11	0.04	−0.02	−0.24
Verbal fluency					
Semantic categ. (percentiles)	0.11	−0.23	−0.04	−0.13	−0.24
Letters (percentiles)	0.03	−0.64**	−0.42**	−0.49**	−0.26
BADS					
Total score	−0.16	−0.28	0	−0.18	−0.11
Rule Shift Card	−0.12	−0.28	−0.05	−0.22	−0.27
Action Program	−0.02	−0.10	0.04	−0.09	−0.22
Key Search	−0.28	−0.22	−0.07	−0.17	−0.07
Temp. Judgment	0.02	−0.04	0.09	0	0.13
Zoo Map	0.05	−0.19	−0.06	0	−0.10
Mod.Six Elements	−0.15	−0.23	0.02	−0.20	0.00

\* $p < 0.05$ , \*\* $p < 0.01$

WCST Wisconsin Card Sorting Test; TMT Trail Making Test; BADS Behavioural Assessment of the Dysexecutive Syndrome (Wilson et al. 1996); The BADS consists of 6 subtests

## Discussion

Given that each of the utilized tests in our study does not tap the full extent of executive function deficits, but is representative of some major facets of these deficits (Reed et al. 2002), we chose to apply a wide range of executive function tests. Our study suggests that only some measures of executive function are associated with symptom severity. Neither the WCST, TMT, nor BADS was associated with symptom severity. Although a recent meta-analysis has reported statistically significant, but rather weak relationships between negative symptoms and worse performance on the WCST (Nieuwenstein et al. 2001), a few studies have also reported a lack of relationship between symptom severity and WCST performance (Cuesta et al. 1995, Himelhoch et al. 1996). The Stroop showed moderate, positive correlation with positive and general symptoms as well as with depression in our study.

The most robust finding in our study was the association between letter fluency and negative symptoms. Although a recent study reported an inverse correlation between verbal fluency and severity of positive symptoms (Verdoux et al. 1999), several other studies support the influential role of negative symptoms on verbal fluency (Harvey et al. 1998, Voruganti et al. 1997, Liddle 2000).

The findings of our study raise a few issues. First, given their association with symptom severity, Stroop as well as letter fluency may not provide an accurate measure of actual executive functioning, whereas the WCST, BADS, and TMT seem to be advantageous in that they do not depend on symptom severity. Lack of associations in these tests of executive function may have occurred because the included patients were clinically stabilized and in the process of being socially reintegrated. An association between symptom severity and executive function might have become more apparent in clinically less stable patients. Thus, one could propose that, despite some overlaps with degree of symptom severity, executive function deficits may be a core component of schizophrenic cognition and possibly act as a relative independent feature of the disease processes. This is supported by a recent study (Reed et al. 2002) where patients who were psychotic but not schizophrenic showed less impairment in executive function compared to schizophrenics, regardless of the clinical state of both patient groups.

Second, the applied tasks may not only be characterized by varying complexity and, thus, be measuring different aspects of executive functions (Reed et al. 2002), but more complex tasks such as the WCST may be measuring other cognitive dimensions such as attention, memory, or learning capacities, and thus not be pure measures of executive functions (Keefe 1995).

Our study calls for replication with a larger patient sample which may not only allow us to disentangle measures of executive function and establish a possible

hierarchy of task complexity, but also to compare subsamples with different symptom severity.

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