

Executive Function Deficits in Patients with Schizophrenia

Kumari Neelam, Prakash Jai

ABSTRACT

Background: The cognitive dimension most widely studied in schizophrenia is executive function. Some of the specific abilities that fall under this rubric include abstraction, planning, mental flexibility, response inhibition, self monitoring, evaluation and decision making. There is strong evidence that neuropsychological impairment is related to deficits in everyday functioning abilities among persons with schizophrenia. **Aim:** The present study attempts to measure executive dysfunctions in patients with schizophrenia. **Method:** By using purposive sampling technique, 30 patients of schizophrenia were chosen according to ICD 10 DCR criteria along with a normal control group of 30 subjects. GHQ-12 was used as screening tool for normal control subjects and participants who scored below 2 were included in normal control group. Executive functioning was assessed among all the participants of experimental group as well as normal control group by using CTMT, WCST and Cognitive Symptoms Checklist (Executive Function Scale). **Result:** The schizophrenic patients demonstrated executive functioning deficits in comparison to normal control subjects on Comprehensive Trail Making Test as they took more time to complete all the trails and on Wisconsin Card Sorting Test as they produced lesser number of correct response, committed more errors, exhibited high number of perseverative responses, perseverative errors and non perseverative errors, low number of conceptual responses, took more trails to complete first category and were not able to maintain set. Impairment was also found on other domains of executive functioning related to activities of daily living like processing speed, initiation, sequencing, planning and reasoning. **Conclusion:** In comparison to normal participants, schizophrenia patients exhibited significant dysfunction in executive functioning and hence in activities of daily living.

Key Words : Executive Function, Schizophrenia, Activities of daily living

INTRODUCTION

Cognitive impairment is recognized as core characteristic of schizophrenia. Executive function is an important cognitive domain. Executive functions include the capacity to formulate goals, plan and organize goal directed behavior, carry out goal directed behavior fully and effectively and monitor and self correct one's behavior as needed (Lezak, 1987). Because of inconsistencies in conceptualizing and operationalizing the construct, the nature of executive dysfunction is nebulous. Deficit in executive performance is well established in schizophrenia. Schizophrenia patients have varying grades of impairment in their executive functioning which results in difficulties during extended and multifaceted interpersonal interactions. Executive impairment affects various cognitive processes including initiation, sustained attention, switching and flexibility, disinhibition, attention allocation and planning (Chan et

al; 2006a). It has also been demonstrated by various studies that schizophrenic patients tend to perform more poorly than normal controls in neuropsychological tests sensitive to frontal lobe lesions, such as Wisconsin Card Sorting, verbal fluency, and trail making (Chan et al. 2006b). Performance on neuropsychological measures of executive skills seems to be associated with differences in certain types of psychiatric symptoms among schizophrenia patients, i.e; those patients with greater executive impairment tend to have more severe or stable negative symptoms, and may have less independence in at least some aspects of everyday functioning. Frontal dysfunctions such as disturbed planning, lack of inhibition, contextual inappropriate responses, reduced cognitive flexibility, poor problem solving, have been commonly described in schizophrenia (Krabbendam et al., 1999; Mahurin et al., 1998; Pantelis et al., 1997). The functional neuroimaging studies also suggest that schizophrenia patients lack normal patterns of frontal

activation while performing these executive tasks. Schizophrenia patients may lack the ability to organize brain activity efficiently in response to have minimal demands for executive control (Taylor, 1996). However the real ecological impact of these neuropsychologically measured deficits is not known.

Recent empirical research has consistently demonstrated that although psychopathological symptoms disrupt patient's lives, deficits in cognitive functioning have the strongest influence on their overall level of independent functioning. The severity of neuropsychological deficits seems to be a determinant of functional outcome of schizophrenia patients but neuropsychological evaluation does not provide specific information about how cognitive impairment influences activities of daily living, i.e; deficit in which cognitive domain affect which behavior. Patients with schizophrenia who are impaired on measures of executive functions have difficulty adapting to the rapidly changing world around them.

The present study has been undertaken with the aim to study the executive function deficits in patients with schizophrenia in comparison to normal control subjects.

MATERIAL AND METHOD

The sample consisted of 30 patients selected as per ICD 10 DCR criteria for schizophrenia from different in patient department of Ranchi Institute of Neuro-Psychiatry and Allied Sciences, Ranchi and 30 normal control subjects. Inclusion criteria for the former included patients in the age group of 25 to 45 years and having atleast 8 years of schooling. Purposive sampling technique was used for selecting the sample. The General Health Questionnaire 12 (Goldberg & Williams, 1988) has been used as a screening tool for detecting psychiatric disorders among respondents in normal control group. Subjects scoring more than 2 were screened out. Then Comprehensive Trail Making Test (Reynolds, 2002) and Wisconsin Card Sorting Test (Heaton et al. 1981) have been administered to assess the executive functioning in the group of schizophrenia patients and normal control subjects. Executive function subscale of Cognitive Symptom Checklist (O' Hara et al. 1993) was administered to elicit information about difficulties in daily living due to impaired executive functioning. Independent sample t test was used to compare the performance of clinical group and normal controls on CTMT, WCST and Executive Function subscale of Cognitive Symptom Checklist.

RESULT AND DISCUSSION

Table 1: Showing Performance of Schizophrenia Patients and Normal Control Subjects on Comprehensive Trail Making Test

Subjects Variables	Schizophrenia Patients (N=30)		Normal Controls (N=30)		't' Value
	Mean	SD	Mean	SD	
Time Taken for Trail 1	141.93	24.21	48.17	22.70	15.47**
Time Taken for Trail 2	146.87	30.16	52.20	14.70	15.45**
Time Taken for Trail 3	184.10	32.67	61.37	17.83	18.06**
Time Taken for Trail 4	193.23	34.02	52.63	16.78	20.30**
Time Taken for Trail 5	239.23	64.53	73.30	23.03	13.26**
Total Time Taken	905.40	137.05	286.76	71.38	21.93**

** significant at 0.01 level

Obtained data have been scored using standard procedure for further analysis. It has been found that the mean age of schizophrenia patients and normal control group was 31.77 ± 4.73 years and 31.33 ± 5.65 years respectively. Further mean education was found to be 10.73 ± 1.85 years for schizophrenia patients and 10.53 ± 1.63 years for normal control participants.

Table-1 shows the performance of both the groups on comprehensive trail making test. Significant statistical differences has been found on time taken for trail 1 (Schizophrenia Patients: $M=141.93 \pm 24.21$; Normals: $M=48.71 \pm 22.70$; $t=15.47$, $p>0.01$), trail 2 (Schizophrenia Patients: $M=146.87 \pm 30.16$; Normals: $M=52.20 \pm 14.70$; $t=15.45$, $p>0.01$), trail 3 (Schizophrenia Patients: $M = 184.10 \pm 32.67$; Normals: $M= 61.37 \pm 17.83$; $t = 18.06$, $p>0.01$), trail 4 (Schizophrenia Patients: $M= 193.23 \pm 34.02$; Normals: $M=52.63 \pm 16.78$; $t=20.30$, $p>0.01$), trail 5 (Schizophrenia Patients: $M=239.23 \pm 64.53$; Normals: $M=73.30 \pm 23.03$; $t=13.26$, $p>0.01$) and total time (Schizophrenia Patients: $M=905.40 \pm 137.05$; Normals: $M=286.67 \pm 71.38$; $t=21.93$, $p>0.01$) underlying impairment in visual scanning, visual search, sequencing, divided attention and ability to shift cognitive set among schizophrenia patients as compared to normal control subjects. Similar results have been obtained by several researchers. Wolwer and Gaebel (2002) concluded that poor performance on trail making test in schizophrenia patients indicated insufficient sequencing, problems in planning and execution. Wolwer and Gaebel (2003) have also reported impaired planning strategies in patients with acute schizophrenia which mainly accounted for patients poor performance on trail making test, which

Table-2: Showing Performance of Schizophrenia Patients and Normal Control Subjects on Wisconsin Card Sorting Test

Subjects WCST Variables	Schizophrenia Patients (N=30)		Normal Controls (N=30)		't' Value
	Mean	SD	Mean	SD	
Number of Trials Administered	123.84	13.15	101.70	19.52	12.07**
Correct Responses	58.66	21.48	88.73	13.93	3.47**
Error committed	65.13	6.37	12.56	26.79	10.45**
Percent Errors	51.30	19.94	14.56	4.81	9.80**
Perseverative Responses	43.06	36.05	4.46	2.73	5.84**
Percent Perseverative Responses	37.43	28.53	5.43	2.95	6.10**
Perseverative Errors	38.36	28.71	4.46	2.73	6.43**
Percent Perseverative Errors	32.63	23.93	5.43	2.95	6.17**
Nonperseverative Errors	26.63	20.41	8.43	6.22	4.67**
Percent Non perseverative Errors	20.96	15.66	17.06	23.02	5.76**
Conceptual Level Responses	35.43	26.34	64.93	6.58	5.95**
Percent Conceptual Level Responses	29.96	24.61	79.93	8.31	10.53**
Number of Categories Completed	2.00	2.02	5.60	0.00	10.86**
Trials to Complete First Category	59.03	51.46	12.76	4.05	4.90**
Failure to Maintain Set	1.73	1.79	0.36	0.88	3.72**

** significant at 0.01 level

might be a nosologically specific, trait-like characteristic, probably related to neural dysfunctions involving the prefrontal cortex. Wolwer et al. (2003) have reported impaired visuomotor integration in patients with acute schizophrenia, which mainly accounted for patients poor test performance. In another study Mahurin et al. (2006) found that schizophrenia patients made significantly more errors, particularly tracking errors, suggesting a greater degree of cognitive disorganization during trail making performance.

Performance of both the groups on WCST has been given in table-2. For completing the six sorting principles of WCST, more number of trials were administered on schizophrenia patients ($M=123.84\pm13.15$) than normal control subjects ($M=101.70\pm19.52$) and the difference was found to be statistically significant ($t=12.07, p>0.01$) suggesting impaired executive functioning in the former group. Similar results have been obtained by Raffard et al (2009). Schizophrenia patients produced lesser number of correct responses ($M=58.66\pm21.48$) and committed more errors ($M=65.13\pm6.37$) than that of normal control subjects ($M=88.73\pm13.93; t=3.47, p>0.01$) suggesting faulty planning and impaired cognitive flexibility among the clinical group. Similarly due to impaired abstract thinking, schizophrenia patients have given more perseverative responses ($M=43.06\pm36.05$) as compared to normal control group ($M=4.46\pm2.73; t=5.84, p>0.01$).

Perseverative errors were also high in schizophrenia patients (Schiz: $M=38.36\pm28.71$; Normals: $M=4.46\pm2.73; t=6.43, p>0.01$) which was due to problem in shifting set and working memory. Similar trend was found for non perseverative errors too (Schiz: $M=26.63\pm20.41$; Normals: $M=8.43\pm6.22; t=4.67, p>0.01$) which suggest inability to utilize available feedback to correct future response. Similar findings has been observed by Divya et al (2007). Low number of conceptual responses were also exhibited by schizophrenia patients (Schiz: $M=35.43\pm26.34$; Normals: $M=64.93\pm6.58; t=5.95, p>0.01$). Lesser number of categories were completed by schizophrenia patients ($M=2.00\pm2.02$) than normal control subjects ($M=5.60\pm0.00; t=10.86, p>0.01$). Similar findings were demonstrated by Jai Prakash et al (2005), Sabhesan & Parthasarathy (2005) and Divya et al (2007). The number of trials taken to complete first category was high in the clinical group of schizophrenia patients (Schiz: $M=59.03\pm51.56$; Normals: $M=12.76\pm4.05; t=4.90, p>0.01$). Failure to maintain set was also high in schizophrenia group ($M=1.73\pm1.79$) than normal control group ($M=0.36\pm0.88; t=3.72, p>0.01$). In another study, compared to normal controls, patients with schizophrenia performed significantly worse on Wisconsin Card Sorting Test ($P=0.004$ for administered trails; $P=0.025$ for perseverative responses) indicating significant deficit in attention, psychomotor performance, working memory and cognitive flexibility among schizophrenic patients (Wobrock et al., 2009). The above findings are also consistent with the results of Divya et al. (2007) and Bhatia et al. (2009).

Performance of schizophrenia patients and normal control subjects on executive function sub scale of cognitive symptom checklist has been reflected in Table -3. Statistically significant difference were found on all the variables of executive function scale namely processing speed (Schiz: $M=5.07\pm1.23$; Normals: $1.57\pm0.94; t=12.41, p>0.01$), initiation (Schiz: $M=3.00\pm0.79$; Normals: $M=0.63\pm0.90; t=12.54, p>0.01$), self correction (Schiz: $M=3.53\pm0.90$; Normals: $M=0.13\pm0.35; t=19.32, p>0.01$), mental flexibility (Schiz: $M=3.27\pm0.94$; Normals: $M=0.17\pm0.38, t=16.69, p>0.01$), planning (Schiz: $M=5.06\pm1.55$; Normals: $M=0.33\pm0.60, t=15.56, p>0.01$), sequencing (Schiz: $M=4.50\pm1.22$; Normals: $M=0.30\pm0.59; t=16.89, p>0.01$), problem solving (Schiz: $M=5.43\pm0.43$; Normals: $M=1.25\pm0.68, t=19.24, p>0.01$), organization (Schiz: $M=5.73\pm1.66$; Normals: $M=1.20\pm0.81, t=13.46, p>0.01$) and reasoning (Schiz: $M=8.00\pm0.98$; normals: $M=1.36\pm0.76; t=29.18, p>0.01$)

underlying difficulties in performing activities of daily living among schizophrenia patients due to impairment in executive functioning. Findings of the present study has been supported by Semkowska et al. (2004). They observed that schizophrenia patients showed defective abilities in retaining contextually organized events, poor selective and divided attention capacities, difficulties in making self generated strategies and in organizing sequential thinking which could contribute to an inefficient outcomes in activities of daily living.

Table-3: Showing the Performance of Schizophrenia Patients and Normal Controls on Executive Function Subscale of Cognitive Symptom Checklist

Executive Function Variables	Schizophrenia Patients (N=30)		Normal Controls (N=30)		*t' Value
	Mean	SD	Mean	SD	
Processing Speed	5.07	1.23	1.57	0.94	12.41**
Initiation	3.00	0.79	0.63	0.90	12.54**
Self Correction	3.53	0.90	0.13	0.35	19.32**
Mental Flexibility	3.27	0.94	0.17	0.38	16.69**
Planning	5.06	1.55	0.33	0.60	15.56**
Sequencing	4.50	1.22	0.30	0.59	16.89**
Problem Solving	5.43	0.43	1.25	0.68	19.24**
Organization	5.73	1.66	1.20	0.81	13.46**
Reasoning	8.00	0.98	1.36	0.76	29.18**

** significant at 0.01 level

Further analysis of activities of daily living through a standardized behavioral scale revealed that executive dysfunctions in schizophrenia may specifically affect activities of daily living like more omissions when choosing the menu, more sequencing and repetition errors during the shopping task and more planning, sequencing, repetition and omission errors during the cooking task. Tyson et al. (2008) also found that abstract tests of cognitive function do not indicate which cognitive function could affect what specific aspect of daily function and here lies the importance of ecologically valid tests of attention and executive function (e.g; Behavioral Assessment of the Dysexecutive Syndrome Test) in defining how cognitive deficits in schizophrenia relate to everyday functioning and quality of life. Iampietro et al. (2012) after comparison of schizophrenia groups based on measures of various executive function abilities on everyday action errors concluded that people with schizophrenia demonstrate variable pattern of executive function deficits, and distinct aspects of these executive function deficit patterns of poor mental control abilities which may be associated with everyday functioning capabilities.

CONCLUSION

Schizophrenia patients showed deficits in executive functioning in comparison to normal controls on all five visual searches and sequencing tasks of CTMT and on all measures of WCST. The impairment in different aspects of executive functioning also have its implication on real world functioning.

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Authors:

1. **Ms. Neelam Kumar**
Ph. D. Scholar,
Department of Clinical Psychology,
Ranchi Institute of Neuro Psychiatry
& Allied Sciences (RINPAS), Ranchi.
2. **Dr. Jai Prakash**
Additional Professor,
Department of Clinical Psychology,
Ranchi Institute of Neuro Psychiatry
& Allied Sciences (RINPAS), Ranchi.

Corresponding Author

Dr. Jai Prakash
Additional Professor,
Department of Clinical Psychology,
Ranchi Institute of Neuro Psychiatry
& Allied Sciences (RINPAS), Ranchi.
Cell No. 919934582290
E-mail: drjaiprakashrinpas@rediffmail.com

