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Original Research Article

Neuropsychological dysfunction in schizophrenia: a study of executive functioning, vigilance and abstraction

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ABSTRACT

Background: Schizophrenia is a chronic psychiatric disorder characterized by profound disturbances in cognition, perception and behaviour. This study examines neuropsychological dysfunctions in adult schizophrenic patients, specifically focusing on executive functioning, vigilance and abstraction. To assess deficits in neuropsychological domains among adult schizophrenic patients and compare them with healthy controls.
Methods: A prospective, matched control group design was used, comprising 30 adult schizophrenic patients and 30 healthy controls matched for socio-demographic variables. neuropsychological assessments included Bhatia's short battery of performance test for intelligence, symbol cancellation test and the similarity Test. Descriptive statistics, t-tests and correlation analyses were used for data interpretation.
Results: Schizophrenic patients demonstrated significant impairments in executive functioning, vigilance and abstraction compared to healthy controls. Deficits were evident in working memory, cognitive flexibility, problem-solving, sustained attention and abstract reasoning, reinforcing the role of frontal lobe dysfunction in schizophrenia.
Conclusions: The study highlights marked neuropsychological deficits in schizophrenia, emphasizing the need for targeted cognitive rehabilitation strategies. Addressing these impairments through structured interventions may improve functional outcomes and overall quality of life in patients.

Keywords: Abstraction, Cognitive deficits, Executive functioning, Frontal lobe, Matched control study, Neuropsychological dysfunction, Schizophrenia, Vigilance

INTRODUCTION

Schizophrenia is a chronic psychiatric disorder marked by pervasive cognitive dysfunction that significantly impairs daily functioning and quality of life.[1,2] These neurocognitive deficits encompassing processing speed, attention, working memory, verbal learning, executive function and social cognition often manifest before the first psychotic episode, remain stable across the illness course and show minimal response to standard antipsychotic treatment.[3-6] Epidemiological data indicate that 40% of individuals with schizophrenia exhibit significant cognitive impairment on objective testing.[7,8] First-episode patients demonstrate deficits comparable to chronic cases, confirming that these impairments are trait-like rather than a consequence of illness chronicity or medication effects.[4,9] A meta-analysis of cognitive trajectories following psychosis onset found little change over time, further supporting their status as enduring vulnerabilities.[10] Cognitive dysfunction strongly predicts functional outcomes such as independent living, employment and social relationships, often more so than positive or negative symptoms.[5] Deficits in attention and executive control hinder planning and problem-solving, while memory impairments obstruct skill acquisition and social adaptation.[11] Consequently, cognitive remediation and pro-cognitive pharmacotherapies have become key targets for enhancing overall recovery.[6] A cross-sectional

study in India reported that nearly three-quarters of schizophrenia patients showed measurable cognitive impairment, correlating with poorer social and occupational functioning.[12] First-episode Indian patients likewise exhibit significant deficits tied to negative symptom severity and insight.[13] Furthermore, individuals at genetic high risk in India display early deficits in attention and working memory, suggesting windows for early intervention.[14] This study focuses on three core domains executive functioning, vigilance (sustained attention) and abstraction to clarify their roles in overall cognitive dysfunction and inform the development of targeted interventions in both global and Indian contexts.

METHODS

A prospective matched control group design was used to assess neuropsychological dysfunction in schizophrenia. Thirty literate adults (18–45 years) diagnosed with schizophrenia per ICD-10 were recruited consecutively from inpatient and outpatient departments of Gautam Hospital, Jaipur. A control group of 30 healthy volunteers was matched on age, sex, education, marital status, socio-economic status, religion and occupation; controls scored below the clinical cut-off on the Self-Reporting Questionnaire–20 (SRQ-20). Sample size was determined by the available clinical population, enrolling all eligible schizophrenia patients (n=30) and matching them to 30 controls. Inclusion criteria for the experimental group were age 18–45 years meeting ICD-10 diagnostic criteria for schizophrenia literacy; and provision of written informed consent (or proxy consent from a family member if the patient lacked capacity). Control group inclusion criteria were age≥18 years literacy absence of self-reported physical or mental illness in the participant or first-degree relatives; and SRQ-20 score below the clinical threshold. Exclusion criteria for both groups included comorbid psychiatric, neurological or severe medical conditions and inability to complete psychological testing.

The data collection period spanned from February 2024 to November 2024. Following approval from the Institutional Ethics Committee (Ref No. /SGVU/IEC/JPR/2024/004 dated 29 August 2024), study objectives were explained to participants (and family members when appropriate) and written informed consent was obtained. Sociodemographic data were recorded using a standardized schedule, after which participants completed Bhatia's Short Battery of Performance Test for Intelligence, the Symbol Cancellation Test and the Similarity Test in two sessions on the same day. Data was collected and confidentiality were strictly maintained.

Tools for data collection

Semi-structured interview schedule

A semi-structured interview schedule was developed to collect socio-demographic and clinical data, including age, sex, caste, education, marital status, occupation, religion and residence (urban/rural). This tool supported participant profiling and appropriate group matching. Content validity was established (CVI=0.92). Internal consistency in our sample was acceptable (Cronbach's α=0.78) and inter-rater reliability across two independent raters was high (κ=0.81).[17]

Bhatia's short battery of performance test of intelligence for adults

This standardized Indian tool was used to assess executive functioning. It includes two subtests: Koh's Block Design Test, where participants recreate geometric patterns using coloured blocks within a time limit, assessing visuospatial skills, planning and motor coordination. Alexander's Pass Along Test, which involves moving coloured blocks to replicate patterns without lifting them, measuring sequencing and cognitive flexibility. This battery is validated and is widely used in Indian clinical settings.[18] In prior validation, split-half reliability was 0.88 and test–retest reliability over two weeks was 0.85 and internal consistency across both subtests was α=0.90.[18]

Symbol cancellation test

Adapted from Rosvold's continuous performance test, this tool assessed sustained attention and vigilance. Participants completed four progressively complex trials of symbol cancellation. Performance was evaluated based on time taken, correct responses and omission/commission errors.[19] The test–retest reliability for the test after one week was r=0.83. Internal consistency across the four trials was α=0.87. Construct validity was demonstrated by a negative correlation with omission errors (r=–0.64).[19]

Similarity test

This test was used to assess abstraction and participants explained similarities between twelve pairs of words. Responses were scored from 0 to 2, with higher scores indicating abstract thinking. The test was discontinued after four consecutive incorrect answers. Inter-rater reliability (two blind raters) was excellent (ICC=0.89). Internal consistency was α=0.82. Scores showed a strong positive correlation with the Category Fluency Test (r=0.68), indicating good concurrent validity.[20]

Self-reporting questionnaire-20 (SRQ-20)

The SRQ-20, developed by the WHO, screened control participants for psychiatric morbidity. The 20-item yes/no format assessed common psychological symptoms. A cut-off score of 5/6 was used to ensure inclusion of only psychologically healthy individuals. The SRQ-20 had good internal reliability (α=0.78).[16,21]

Statistical analysis

All statistical analyses were conducted using SPSS software version 28.0, utilizing both descriptive and

inferential statistics. Descriptive analysis was conducted to summarize the demographic and clinical characteristics of the participants. Inferential statistics included independent samples t-tests to compare means of neuropsychological variables between the experimental and control groups. Pearson's correlation coefficient was used to analyze the relationships between executive function, vigilance and abstraction within the schizophrenic group. The significance level was set at both 0.01 and 0.05.

RESULTS

The study's quantitative analysis focused on comparing the neuropsychological performance of the schizophrenic group to that of the control group, highlighting differences in cognitive abilities across executive functioning, vigilance and abstraction. The result of this study has been presented on the following headings. The study compared adult schizophrenic patients with normal individuals. Both groups were similar in age (mean difference=1.33, not significant), gender (90% male, 10% female), education, marital status and socio-economic status. However, they differed significantly in occupation, with a higher proportion of unemployed individuals among schizophrenics (43.33%) compared to controls, who were mainly employed (66.67%). The schizophrenic and control groups were demographically matched except for employment (43% of patients vs. 33% of controls were unemployed). Among patients, 87% had paranoid schizophrenia, onset was most common at 26–35 years and mean illness duration was 56.7 months. Schizophrenic participants demonstrated marked abstraction deficits on the similarity test ($p<0.001$) (Table 1), significant executive-function impairments on Bhatia's short battery (block design, pass-along and full-scale IQ all $p<0.001$; mean Full-Scale IQ 78.76 vs. 108.16 in controls) (Table 2) and pronounced vigilance deficits on the symbol cancellation test longer completion times and lower scores across all four trials ($p<0.01$), higher omission and total errors ($p<0.01$) and greater commission errors significant in trial III ($p<0.01$) and trial IV ($p<0.05$) (Table 3). Within patients alone, performance declined over successive trials with increasing time, decreasing correct responses and more errors, especially in Trials III–IV highlighting processing-speed and sustained-attention impairments under prolonged demand (Table 4). Finally, across trials II–IV, better abstraction and executive function were associated with enhanced vigilance, as higher pass-along and full-scale IQ and Similarity Test scores correlated positively with correct responses and negatively with all error types.[7,18] (many $p<0.01/.05$) (Table 5).

Table 1: Abstraction: scores on similarity test of schizophrenics and normal.

Scores	Schizophrenics (n=30)	Schizophrenics (n=30)
Mean	10.7	18.5
SD	4.73	2.71
t' value	9.03*	

**p>0.001.

Table 2: Executive Function: Mean scores of schizophrenic and normal subjects on Bhatia's Battery (SDs are given in parentheses).

Scales	Schizophrenics (n=30)	Normal (n=30)	t values
Block-Design	73.53 (12.63)	99.60 (14.15)	8.31*
Pass-Along	84.03 (12.39)	116.06 (11.72)	10.95*
Full Scale	78.76 (10.63)	108.16 (10.97)	11.62*

**p>0.001.

Table 3: Vigilance: mean scores of both groups on symbol cancellation test (SDs are given in parentheses).

Trials	Dimensions	Schizophrenics (n=30)	Normals (n=30)	t' values
I	Time	152.56 (60.21)	90.23 (19.20)	5.53*
	Scores	42.56 (6.16)	46.46 (1.40)	3.49**
	Error omission	5.36 (6.16)	1.53 (1.40)	3.42*
	Error commission	1.50 (6.20)	0.006 (0.25)	1.26
	Error total	6.86 (9.06)	1.60 (1.35)	3.35*
II	Time	228.83 (64.08)	147.56	6.69**
			-29.02	
	Scores	82.46 (8.88)	90.90 (2.05)	5.08*
	Error omission	10.50 (8.85)	1.93 (2.05)	5.12*
	Error	0.33 (1.21)	0.003 (0.18)	1.32
	Commission			
	Error total	10.60 (9.16)	1.96 (2.07)	4.96**

Continued.

Trials	Dimensions	Schizophrenics (n=30)	Normals (n=30)	t' values
III	Time	201.00 (88.35)	92.33 (27.84)	7.21**
	Scores	35.73 (11.97)	44.50 (0.73)	3.98*
	Error omission	7.93 (10.58)	0.50 (0.73)	3.83**
	Error	4.00 (7.74)	0.20 (0.81)	2.73**
	Commission			
	Error total	11.80 (17.26)	0.66 (1.18)	3.60*'
IV	Time	247.40 (86.26)	173.33	4.04**
			-38.37	
	Scores	8.83 (3.93)	16.20 (2.21)	9.46%
	Error omission	11.16 (3.88)	3.80 (2.21)	9.65%
	Error	4.90 (10.63)	0.80 (0.99)	2.11*
	Commission			
	Error total	16.06 (11.81)	4.60 (2.58)	5.30*

**p>0.01&*p>0.05.

Table 4: Vigilance: mean scores of schizophrenics on symbol cancellation test (SDs are given in parentheses).

Dimensions	Trial I	Trial Il	Trial III	Trial IV
Time	152.56	228.83	201	247.4
	-60.21	-64.08	-88.35	-86.26
Scores	42.56 (6.16)	82.46 (8.88)	35.73	8.83
			-11.97	-3.93
Error omission	5.36 (6.16)	10.50 (8.85)	7.93	11.16
			-10.58	-3.88
Error commission	1.50 (6.20)	0.33 91.21)	4.00 (7.74)	4.9
				-10.63
Error total	6.86 (9.06)	10.60 (9.16)	11.8	16.06
			-17.26	-11.81

Table 5: Abstraction, executive function and vigilance: (correlation of scores on similarity test and bhatia battery with the scores on symbol cancellation test).

Trials	Dimensions	Sub-scales of Bhatia battery			Similarity test
		Block design	Pass along	Full scale	
I	Time	-0.21	-0.19	-0.24	0.04
	Scores	0.03	0.09	0.03	-0.06
	E. O.	0.02	-0.1	-0.04	0.05
	E. C	0.01	-0.02	-0.01	-0.03
	E. T.	0.02	-0.08	-0.04	0.01
II	Time	-0.24	-0.3	-0.32	-0.18
	Scores	0.25	0.50**	0.44*	0.42
	E. O.	-0.25	-0.5	-0.44*	-0.42°
	E. C	0.23	0.15	0.23	-0.43°
	E.T.	-0.21	-0.49*	-0.41*	-0.49
	Time	-0.31	-0.47	-0.46%	-0.19
III	Score	0.36%	0.22	0.34	0.40°
	E. O.	-0.41*	-0.27	-0.41*	-0.49**
	E. C	-0.44*	-0.31	-0.44*	-0.42*
IV	E. T.	-0.45*	-0.3	-0.44*	-0.49*
	Time	-0.03	-0.03	-0.03	0.11
	Score	0.34	0.59*	0.55"*	0.42*
	E. O.	-0.34	-0.59"	-0.55*	-0.43*
	E. C.	-0.29	-0.27	-0.34	-0.36*
	E.T.	-0.38°	-0.44*	-0.49*	-0.47"

**P> 0.01 & *P> 0.05. Key: E. O.= Error Omission; E. C.= Error Commission; and E. T.= Error Total.

Table 6: Socio-demographic characteristics: homogeneity of both groups in age, sex, education, occupation, marital status and socio-economic status.

Socio-demographic variables	Schizophrenics (n=30)	Normal (n=30)	Statistics
Age (in years)			**t value**
Mean	28.26	28.90	1.33^
SD	7.68	7.00	
Sex (%)			X2 values
Male	27 (90)	27 (90)	0.00^
Female	3 (10)	3 (10)	
Education (%)			
Under SLC	7(23.33)	8 (26.67)	0.286^
SLC	10 (33.33)	9 (30)	
Inter. level	4 (13.33)	5 (16.67)	
Bachelor level	9 (30)	8 (26.67)	
Occupation (%)			
Student	7(23.33)	6 (20)	8.176*
Employed	10 (33.33)	20 (66.67)	
Unemployed	13 (43.33)	4 (13.33)	
Marital status (%)			
Married	15 (50)	15 (50)	0.00^
Unmarried	15 (50)	15 (50)	
Socio-economic status (%)			
Low	12 (40)	10 (33.33)	28^
Middle	18 (60)	20 (66.67)	

^ Not Significant, *p>0.05.

DISCUSSION

The present study compared neuropsychological functioning between adult schizophrenic patients and a matched healthy control group, focusing on abstraction, executive function and vigilance. Both groups were closely matched on age (~28 years), sex, education, marital status and socio-economic status suggesting premorbid cognitive functioning in schizophrenic patients may have been relatively preserved except for employment, as a greater proportion of patients were unemployed. While the literature generally reports equal sex distribution in schizophrenia, the present sample included a higher proportion of males due to purposive sampling. Within patients, 86.7% had paranoid schizophrenia, onset was most common between 18 and 25 years, 30% reported a positive family history of mental illness and mean illness duration was 56.7 months.

Neuropsychological evaluation revealed significant impairments across all domains: on the Similarity Test, patients scored markedly lower, indicating abstraction deficits often linked to frontal lobe dysfunction; on Bhatia's Battery (Block Design, Pass-Along and Full-Scale IQ), they demonstrated significant executive-function deficits in planning, problem-solving and cognitive flexibility; and on the Symbol Cancellation Test, they exhibited longer completion times, lower accuracy and increased omission and total errors particularly on complex trials highlighting sustained-attention and response-inhibition challenges. These attentional deficits are consistent with prior research implicating right hemispheric and parietal lobe dysfunction in schizophrenia.[11] Correlational analyses showed that higher educational attainment was associated with better abstraction and vigilance performance, whereas marital status correlated negatively with executive and attentional measures. Older age and longer illness duration predicted slower response times and more errors, suggesting progressive cognitive decline.[8,12]

No significant differences emerged between paranoid and non-paranoid subtypes, indicating that these neuropsychological deficits are pervasive across diagnostic categories.[7] In particular, deficits in abstraction and executive control may hinder patients' ability to adapt to novel situations, manage daily living tasks and maintain occupational roles. Collectively, these findings reinforce the widespread nature of cognitive dysfunction in schizophrenia particularly in abstraction, executive control and vigilance and underscore the critical need for targeted cognitive rehabilitation and supportive interventions to improve adaptive functioning in daily life.[5,8]

This study has several limitations. Firstly, there was no control over the illness phase during test administration; patients in acute, chronic or remitting phases were all included, which may have impacted neuropsychological performance.[2] Additionally, pharmacological variables were not controlled, meaning that the potential cognitive effects of medication were not accounted for.[14] Another limitation is that the experimental and control groups were

not matched in terms of occupational status, a factor that could influence cognitive functioning. Finally, only three domains of neuropsychological functioning were assessed, potentially overlooking other cognitive deficits relevant to schizophrenia. Addressing these limitations in future research may provide a more comprehensive understanding of neuropsychological dysfunctions in schizophrenic patients.[12]

CONCLUSION

The present study highlights significant neuropsychological dysfunctions in adult patients with schizophrenia, specifically in the domains of executive functioning, vigilance and abstraction. Schizophrenic patients performed significantly poorer than matched controls across all cognitive measures. Impairments were closely associated with demographic factors such as education, marital status, age and duration of illness. Furthermore, strong interrelationships were observed among deficits in executive function, attention and abstraction, suggesting possible shared underlying neural mechanisms, particularly involving frontal and right hemisphere dysfunction. These findings underscore the need for routine neuropsychological assessment in schizophrenia for better clinical management and rehabilitation planning.

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