Executive function in patients with schizophrenia based on socio-occupational impairment: A cross-sectional study

Delnaz Palsetia, K. Chandrasekhar, M. S. Reddy, Avinash De Sousa¹, Sagar Karia¹
Department of Psychiatry, Asha Hospital, Hyderabad, Telangana, Department of Psychiatry, Lokmanya Tilak Municipal Medical College and General Hospital, Mumbai, Maharashtra, India

Address for correspondence:
Dr. Avinash De Sousa,
Department of Psychiatry,
Lokmanya Tilak Municipal Medical College and General Hospital, Mumbai, Maharashtra, India.
E-mail: avinashdes888@gmail.com

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chizophrenia affects an approximate one person in a hundred and is a chronic, severe, and disabling disorder.¹ Multiple studies have demonstrated that patients with schizophrenia have cognitive deficits that affect cognitive and social functioning. These deficits vary in severity and hamper recovery and quality of life of the patient.² Executive function in schizophrenia encompasses cognitive processes which include problem-solving, ability to sustain attention, multitasking, cognitive flexibility, ability to deal with new stimuli planning, psychomotor speed, and verbal fluency.³

Cognitive flexibility is a trait that tends to overlap with problem-solving and is required to generate and test different approaches to problem-solving in novel situations.⁴ It is tested using the Wisconsin Card Sorting Test (WCST).⁵

**Background:** Executive dysfunction deficit is the functionally most important cognitive deficit noted in schizophrenia. There is a dearth of Indian literature on the subject. The current study aimed at studying these executive functions in patients with schizophrenia in remission. **Methodology:** Sixty outpatients with a diagnosis of schizophrenia as per international classification of diseases-10 criteria; in remission as measured by Positive and Negative Syndrome Scale scores were divided into two groups using the personal and social performance scale. The patients with and without socio-occupational impairment formed the two groups. All patients were administered the Wisconsin Card Sorting Test (WCST), Stroop test, Color Trails Test 1 and 2, Phonemic Fluency (Controlled Oral Word Association Test), and category fluency (animal names test) tests and the tower of London test to ascertain deficits in executive functions. The data obtained were subjected to statistical analysis. **Results:** The two groups were well matched. The group with socio-occupational impairment showed a lesser number of categories completed \( (P = 0.001) \), more perseverative errors \( (P = 0.001) \), and greater percentage of the same \( (P = 0.001) \) on the WCST. Statistically significant differences between both groups were observed for scores on phonemic fluency \( (P = 0.012) \) and category fluency \( (P = 0.049) \) tests as well as the Tower of London test \( (P = 0.021) \). They also showed differences on the Stroop test and Color Trail tests, but this was not statistically significant. **Conclusions:** Performance on executive function tests is significantly correlated with functional outcome. It is important that future studies explore the role of these tests as a marker of socio-occupational impairment in schizophrenia.

**Keywords:** Execution functions, remission, schizophrenia, socio-occupational impairment

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executive) and two subsidiary storage systems, namely the articulatory or phonological loop and the visuospatial sketchpad.[7] The phonological loop and visuospatial sketchpad are typically classified under the larger domain of attention, which selects and operates strategies for maintaining and switching attention and is closely related to executive functioning.[8] The Stroop test has been used in measuring cognitive flexibility and color-word interference trial and is one of the most common measures of response inhibition.[9]

Optimal performance on the fluency task facilitates an organized search of various phonological and semantic networks to generate words.[10] The Controlled Oral Word Association Test (COWAT) is the most extensively used verbal fluency task today.[11] The category fluency task involves asking subjects to name as many items from a single specified category they can, in a span of a minute, the most common category being animals.[12] Damage to the frontal cortex will cause impairments on any fluency measures; however, the task is also influenced by cognitive flexibility, anxiety, and poor volition.[13]

Planning may be defined as the ability to identify and organize the steps and elements needed to carry out an intention or achieve a goal.[14] The most well-known being the Tower of London has been used extensively as measures of planning.[13] The tower test is especially sensitive to damage to the prefrontal cortex and also measures other cognitive functions such as response inhibition, motor speed, and working memory.[16]

Verbal fluency tests are among the most extensively employed measures used to evaluate cognitive functioning following neurological damage, and comprise of associative exploration and retrieval of words based on phonemic or semantic criteria (phonemic and semantic fluency, respectively), usually carried out in the setting of a time constraint.[17] Patients with schizophrenia tend to do badly on word production tasks, such as the Word Fluency Test, COWAT, and Category (Animals) fluency Test compared to healthy comparison subjects, which is generally ascribed to the retrieval difficulties in schizophrenia. Greater semantic fluency deficit is a result of the disruption of the semantic store in addition to general retrieval deficits in schizophrenia.[18,19]

Perception tracking and sustained attention (ability to locate different elements within a predetermined time) are measured by the Color Trail Test 1. The Color Trail Test 2 assesses the same functions and also divided attention and sequencing (i.e., ability to achieve numeric order according to the required task because it demands sequential alternations of colors and numbers.[20]

Patients with schizophrenia demonstrate poor performance on tasks that measure planning capacity as in the Tower of London. Planning capacity involves the goal to be subdivided into subgoals, the subgoals must be placed in the correct sequence, and the single moves must be in the right order to achieve the subgoals.[21]

Neurocognitive deficits serve as a prognostic marker for future functional outcome. These functions are studied because of their close links to negative symptoms and poor functioning in the community.[22] It is important that studies compare the executive function in patients of schizophrenia with and without socio-occupational impairment. This would help target our therapy to improve executive function and in turn improve socio-occupational functioning leading to a better quality of life and recovery.[22,23] There is a dearth of Indian studies on the relationship between impaired cognitive function and functional disability of patients with schizophrenia.[24,25]

The objective of the study was to compare cognitive flexibility, working memory, psychomotor speed, planning and verbal fluency in patients with schizophrenia in remission, with and without socio-occupational impairment. It also aimed to find out if these tests can predict socio-occupational dysfunction.

**METHODODOLOGY**

**Participants**
The present study was a cross-sectional study conducted in the outpatient facility of a tertiary care private psychiatric hospital. The study participants included 60 patients with schizophrenia who visited the hospital between May and December 2014. Hospital Ethics Review Board approved the study before commencement and a written informed valid consent was obtained from patients and legally acceptable relatives.

**Inclusion and exclusion criteria**
The inclusion criteria were patients of either sex between ages of 25 and 45 years with at least 7 years of formal education who satisfied the criteria of schizophrenia according to the International Classification of Diseases-10 (ICD)[26] and in remission based on the Positive and Negative Symptom Scale (PANSS) scores.[27] The criteria used was that the score of each item on Positive, Negative and General Psychopathology Scale of PANSS must be ≤3.

The exclusion criteria were patients who were not in remission, psychiatric diagnosis other than schizophrenia and presence of chronic physical, neurological illness, cerebrovascular accident, head injury, mental retardation
or active medical condition that confounded the diagnosis and interfered with the study and/or unwillingness to participate.

**Demographic data**
A clinical profile sheet was designed to collect sociodemographic variables of the participants and the information regarding the illness which was required for further assessment and statistical analysis.

**International classification of diseases-10**
The diagnosis of schizophrenia anytime during the longitudinal course of illness in the participants was made using ICD-10 criteria.

**Scales used in the study**

1. **Positive and Negative Syndrome Scale** – It is a 30-item inventory scale and used for measuring symptom severity in patients with schizophrenia. Schizophrenia symptoms across three subscales: Positive symptoms (items P1–P7), negative symptoms (items N1–N7), and general psychopathology symptoms (items G1–G16) are present. Each item is scored on a scale ranging from 1 (absent) to 7 (extreme). A higher score represents greater severity. The PANSS was specifically developed to assess individuals with schizophrenia and is widely used in research settings. It is shown to have a good reliability, criterion validity, and construct validity.

2. **Personal and Social Performance (PSP) Scale** – It is a 100-point single-item rating scale, subdivided into 10 equal intervals. The ratings are based mainly on the assessment of patient's functioning in four main areas: (1) socially useful activities; (2) personal and social relationships; (3) self-care; and (4) disturbing and aggressive behaviors. Operational criteria to rate the levels of disabilities have been defined for the above-mentioned areas. The total score exceeds 70 shows a high functioning, while a score below 70 indicates low functioning. Excellent inter-rater reliability was also obtained in less educated workers.

The following aspects were measured in the study:

- Number of categories completed – It is the number of categories (i.e., each sequence of 10 consecutive correct matches to the criterion sorting category) that the client successfully completed during the test. Scores can range from minimum of 0 to maximum of 6
- Perseverative errors – When a client persists in responding to a stimulus characteristic that is incorrect, the response is set to match the perseverated principle and is scored as perseverative. Clients may perseverate to color, form or number. Responses that do not match the sorting principle in effect are scored as errors
- Percent perseverative errors – The total number of perseverative errors divided by the total number of trials administered and multiplied by 100.

The WCST is one of the most extensively used tests of frontal lobe function in clinical and research contexts. It is also one of the most significant for schizophrenia is cognitive flexibility disorders.

**Stroop test (NIMHANS version)**
This assesses attention, psychomotor speed, response inhibition, cognitive flexibility, and working memory. The color names blue, green, red, and yellow are printed in capital letters on a paper. The color of the print occasionally corresponds with the color designated by the word. The words are printed in 16 rows and 11 columns. Stimulus sheet is placed in front of the subject. The subject is asked to read the stimuli column-wise as fast as possible. The time taken to read all the 11 columns is noted down. Next, the subject is asked to name the color in which the word is printed.

This time also the subject proceeds column wise. The time taken to name all the colors is noted down. The reading time and the naming time were converted into seconds. The reading time was subtracted from the naming time to get the Stroop effect score. It can be successfully used
in various settings due to its short administration time, reliability, validity, and ease of administration.\[35,36\]

**The color trail tests 1 and 2**
The color trail 1 test consists of numbers 1–25 that are randomly spread, with odd numbers in pink circles and even numbers in yellow ones. The subject is asked to point to successive numbers in ascending order 1–25. The time taken to complete the test is noted. It measures psychomotor speed.

The color trail 2 test consists of numbers from 2 to 25 are printed twice, one on pink circles and once on yellow circles. These are randomly arranged on the test sheet. The subject is asked to point to numbers in alternating colors with the successive numbers being in the ascending order. The time taken to complete the test is noted. It measures visuospatial working memory, ability to shift strategy, and executive function.

The validity of the color trail test has been documented in a variety of clinical and neuropsychological populations.\[37,38\]

**Phonemic fluency (controlled oral word association test) and category fluency test**
It measures initiation, psychomotor speed, fluency, cognitive flexibility, and working memory.\[39-41\]

- Phonemic fluency – The subject is asked to generate words for 1 min in the case of each consonant starting with the consonant, i.e., F, A, S or in their mother tongue starting with Ka, Pa, Ma. The total number of acceptable new words in 1 min is noted down for each consonant. The average new words generated forms the score.

- Category fluency – The subject is asked to generate the names of as many animals as possible in 1 min. The subject is asked to exclude the names of fish bird and snakes. The number of names generated forms the score.

**The tower of London test**
It measures planning, sequencing, and working memory.\[42\]
The subject is presented with a goal state of arrangement of the three balls on one of the boards which is placed near the examiner. The arrangement of the balls on the other board is the initial state. The subject must arrive at the goal state in the board placed on his side. This can be done with the minimum of 2 moves (for 2 moves problem), 3 moves (3 moves problems), 4 moves (4 moves problems), and 5 moves (5 moves problems). The test has a total of 12 problems. The first 2 problems can be solved with 2 moves, the next 4 problems can be solved with 3 moves, the next 4 problems with 4 moves, and the last 4 problems with 5 moves. In each problem, the time taken from start to finish is noted down. The next score is the number of moves used per problem.

The various scores calculated are namely meantime to solve the problem, mean number of moves, number of problems solved with minimum number of moves and an overall score of total number of problems solved with minimum number of moves (this is obtained by totaling the number of problems solved with minimum number of moves in each category of problems).

**Statistical analysis**
Based on the total score of the PSP the participants were divided into two groups namely each group had 30 patients.

- Poor PSP group – with socio-occupational impairment (poor socio-occupational functioning; PSP total score $\leq 70$)
- Good PSP group – without socio-occupational impairment (good socio-occupational functioning; PSP total score $>70$).

Participants within each group were compared on sociodemographic characteristics and performance on various tests of executive function. Statistically analysis was performed using the Statistical Package for the Social Sciences software version 16.0 (IBM Corp., Armonk, New York, USA). Descriptive statistics were used to assess the socio-demographic characteristics of the patients. Unpaired $t$-test was used for continuous variables and Chi-square test for discrete variables. Results were expressed as mean ± standard deviation. All $P$ values were two-tailed, and the statistical significance was calculated at $P \leq 0.05$.

**RESULTS**

**Comparison of sociodemographic variables of patients with and without socio-occupational impairment**
Both groups were well matched on sociodemographic variables. The poor PSP group has greater number of patients that were unemployed ($P = 0.001$), living in rural areas ($P = 0.001$), higher scores on PANSS ($P = 0.001$), and longer mean duration of illness ($P = 0.036$) [Table 1].

**Comparison of scores on various tests of executive function**
The mean WCST (number of categories completed) in good PSP group (4.73) was greater than the mean WCST (number of categories completed) in the poor PSP group (2.13) ($P = 0.001$) [Figure 1].

The mean WCST (number of perseverative errors) in poor PSP group (34.63) was greater than that in the good PSP group (19.87) ($P = 0.001$) [Figure 2].
The mean WCST (percentage of perseverative errors) in poor PSP group (27.67) was greater than that in the good PSP group (16.33) \( (P = 0.001) \) [Figure 3].

The mean Stroop Effect score (in secs) in poor PSP group (208.13) was greater than that in the good PSP group (173.60) \( (P = 0.094) \).

The mean Color Trails Test 1 time (in secs) in poor PSP group (84.37) was greater than the mean Color Trails Test 1 time (in secs) in the good PSP group (75.77). This difference was not statistically significant \( (P = 0.295) \).

The mean Color Trails Test 2 times (in secs) in poor PSP group (175.80) was greater than mean Color Trails Test 2 times (in secs) in the good PSP group (156.63). This difference was not statistically significant \( (P = 0.263) \).

The mean phonemic fluency (average number of words) in good PSP group (9.07) was greater than the mean phonemic fluency (average number of words) in the poor PSP group (6.73). This difference was statistically significant \( (P = 0.012) \) [Figure 4].

The mean category fluency (number of words) in good PSP group (11.00) was greater than the mean category fluency (number of words) in the poor PSP group (9.07). This difference was statistically significant \( (P = 0.049) \) [Figure 5].

### Table 1: Comparison of sociodemographic profiles in both groups

| Variables                  | Good PSP | Poor PSP | \( P \) |
|----------------------------|----------|----------|--------|
| Gender distribution        |          |          |        |
| Male                       | 23       | 21       | 0.55†  |
| Female                     | 7        | 9        |        |
| Mean age (years)           | 33.57    | 35.87    | 0.231† |
| Education                  |          |          |        |
| School educated             | 0        | 5        | 0.02†  |
| College educated           | 30       | 25       |        |
| Employment                 |          |          |        |
| Never employed             | 0        | 13       | 0.001‡ |
| Unemployed                 | 0        | 17       |        |
| Employed                   | 30       | 0        |        |
| Marital status             |          |          |        |
| Married                    | 16       | 21       | 0.18†  |
| Unmarried                  | 14       | 9        |        |
| Residence                  |          |          |        |
| Urban                      | 30       | 20       | 0.001‡ |
| Rural                      | 0        | 10       |        |
| Socioeconomic status       |          |          |        |
| High                       | 5        | 7        | 0.80†  |
| Middle                     | 22       | 20       |        |
| Lower                      | 3        | 3        |        |
| Family history of          |          |          |        |
| psychiatric illness        |          |          |        |
| Yes                        | 5        | 4        | 0.71†  |
| No                         | 25       | 26       |        |
| Mean PANSS total score     | 50.53±5.64 | 63.63±6.20 | 0.001‡ |
| Mean duration of illness   | 71.80±70.68 | 113.20±78.38 | 0.036‡ |

† \( P<0.05 \) Significant; † Statistical analysis done using Chi-square test; † Statistical analysis done using unpaired \( t \)-test. PSP – Personal and Social Performance; PANSS – Positive and Negative Syndrome Scale.
The mean total number of problems solved with minimum number of moves (transactional net margin method [TNMM]) in good PSP group (8.90) was greater than mean total number of problems solved with minimum number of moves (TNMM) in the poor PSP group (7.67). This difference was statistically significant ($P = 0.021$) [Figure 6].

**DISCUSSION**

In the present study, the percentage of college-educated in those with good socio-occupational functioning (good PSP group) was higher than those with poor socio-occupational functioning (poor PSP group). The difference was statistically significant. Previous studies showed that more years of education positively influenced performance on tasks that tested executive function.\(^{[43]}\) The duration of formal academic training reflected good premorbid functioning, intellectual level and a higher level of information-processing skills in the past. Patients with good education thus did well on cognitive tasks because of this inherent capability. These observations indicate that education may be a protecting factor of cognitive and social functioning in chronic schizophrenia.\(^{[44]}\)

In this study, all of the patients in good socio-occupational functioning (good PSP) group were from the urban locality and were employed as compared to those in poor socio-occupational functioning (poor PSP) group. The study was conducted at a tertiary hospital located at a metropolitan city, so most of the patients in our total study sample that is both groups were from the urban locality and were college educated. Patients living in a large metropolitan city had potentially a better opportunity to enter the workforce than a nonurban population as stated by previous studies.\(^{[45]}\) Employment status before admission to the hospital is a factor that can predict the outcome of psychosocial function, in which patients who do not work, the functional outcome was significantly lower.\(^{[46]}\) In the present study, no statistically significant differences were found between gender, marital status, socioeconomic status, family history of psychiatric illness or age of patients in two groups.

In the present study, the patients with poor socio-occupational functioning (poor PSP) had greater mean negative symptom score on PANSS as compared to patients with good socio-occupational functioning (good PSP). Previous studies have shown a significant correlation between negative symptoms and functional outcome implying that the greater the severity of negative symptoms, the greater the cognitive deficits are; the results also suggest that negative symptoms are related to cognitive function to a greater extent than positive symptoms and cause more disability and thus negative symptoms predict employment outcomes.\(^{[47]}\)

Furthermore, this study showed that the patients with poor socio-occupational functioning (poor PSP) had greater mean PANSS total score as compared to patients with good socio-occupational functioning (good PSP) and the difference was statistically significant.
The results of the present study showed that the mean duration of illness in months was greater in patients with poor socio-occupational functioning (poor PSP) as compared to those with good socio-occupational functioning (good PSP). The association found between longer duration of illness and worsening of performance on the WCST may additionally suggest the progressive character of executive dysfunctions in patients with chronic schizophrenia as indicated in previous studies.\(^{48}\)

The results of the present study show that patients with good socio-occupational functioning (good PSP group) completed more number of categories, made fewer perseverative errors and percentage of perseverative errors as compared to poor socio-occupational functioning (poor PSP group). This is similar to previous studies.\(^{49,50}\) These results show that WCST significantly affects the functional outcome and that better WCST performance is related to higher levels of work function. A study convincingly demonstrates what was suggested in the previous review, that WCST has significant relationships with functional outcome.\(^{51}\) A meta-analytic study convincingly demonstrated what was suggested in the previous review, that WCST has significant relationships with functional outcome and that WCST was the most common way to assess executive functioning in most studies.\(^{52}\) Another study showed that better executive functioning (WCST scores) were associated with more wages earned and more hours worked.\(^{53}\) The negative correlation between WCST and functional outcome has also been reported.\(^{54}\)

In the present study, the mean Stroop Effect score (in secs) in patients with poor socio-occupational functioning (poor PSP) although greater than patients with good socio-occupational functioning (good PSP), the difference was not statistically significant. However, studies have shown that the Stroop Test was significantly negatively correlated with the domains of social functioning which implied that the time taken to complete the task was negatively associated with social functioning.\(^{55,56}\)

In the present study, no statistically significant difference was found in the means of Color Trails Test 1 time (in secs) and means of Colour Trails Test 2 time (in secs) between the two groups. Previous studies have demonstrated no statistically significant difference between trail making test and functional outcome.\(^{57,58}\) However, other researchers have shown that Trail test A and B were significantly negatively correlated with the domains of social functioning; it implied the time taken to complete the task was negatively associated with social functioning.\(^{47}\)

In the present study, the mean phonemic fluency (average number of words) in patients with good socio-occupational functioning (good PSP) was greater than poor socio-occupational functioning (poor PSP) and the difference was statistically significant. The mean category fluency (number of words) in patients with good socio-occupational functioning (good PSP) was greater than poor socio-occupational functioning (poor PSP) and the difference was statistically significant. Previous studies showed that verbal fluency test (semantic and phonemic) had significant positive correlations with the social functioning domains. These results show that schizophrenia patients with good socio-occupational functioning would perform significantly better on verbal fluency tests and thus verbal fluency predicts functional outcome in patients with schizophrenia.\(^{59,60}\) A higher level of education was connected with better results in verbal fluency test, which suggests the educational level has a beneficial influence on verbal abilities (reading and word generation).\(^{61}\)

On analyzing the Tower of London test, the mean total number of problems solved with minimum number of moves (TNMM) in patients with good socio-occupational functioning (good PSP) was greater than poor socio-occupational functioning (poor PSP) and the difference was statistically significant. Other variables measured on Tower of London were not statistically significant. A study done earlier showed that Tower of London was most strongly associated with planning on macro (completeness and complexity of long-term life plans) and micro level (ability to organize the activity during the day). Patients, who did worse on Tower of London often, were unemployed and had other social role or engagement in activities that were below their educational and professional capabilities and they also coped with the labor duties worse.\(^{62,63}\) In another study, the relationship between community functioning and planning was found. Planning is measured by Tower of London test, and thus, it predicts functional outcome in schizophrenia patients.\(^{64}\)

This study emphasizes the need to acknowledge the importance of executive function in the recovery and long-term socio-occupational functioning in patients with schizophrenia. Remission is necessary but not sufficient step for recovery so the aim should be to achieve recovery in schizophrenia for better functional outcome.

A formal neuropsychological assessment for individuals with schizophrenia is recommended with valid and reliable tests. As this assessment will serve as a prognostic marker and will guide further optimal management. Given the importance of neurocognition to the functioning and rehabilitative change, it is important to focus on interventions to improve neurocognition in schizophrenia. The executive functions measured by these tests can be...
Cognitive flexibility, working memory, verbal fluency, psychomotor speed, and planning are useful tools of executive function to assess the ability of patients with schizophrenia and can be a marker of socio-occupational ability. These tests can serve as potential markers in the future to assess the ability of these patients to perform in an occupational domain. Larger studies across different populations are needed further to validate the findings of our studies.

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Conflicts of interest
There are no conflicts of interest.

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Limitations of the study
The intelligence (and hence the cognitive reserve) of the study participants was not tested, although any history suggestive of a developmental delay was excluded from the participants. Some studies have shown executive deficits to be independent of the IQ. The two groups differed in terms of years of education, and this could be a limiting factor that affected performance on executive function tests. All patients in our study were on medications, including antipsychotics, anticholinergics, and benzodiazepines which may have caused minor cognitive deficits. The effect of medication on test performance cannot be ruled out. The sample size was small and circumscribed to one center. Larger studies are needed to validate the results.
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