

# Working Memory in Schizophrenia

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## Abstract

**Background:** Working memory has been reported to be impaired in schizophrenia, but there are inconsistencies in the literature. Therefore, we undertook the current study with the objective of assessing both auditory and visuospatial working memory tasks in a sample of schizophrenia patients in comparison to normal controls, and its correlation with psychopathology.

**Method:** The sample comprised of 78 drug naive or drug free patients of either sex, aged between 18–45 years, fulfilling diagnosis of schizophrenia according to ICD-10 Diagnostic Criteria for Research, and 35 age, sex and education matched normal controls. SAPS and SANS were used to assess positive and negative symptoms in patients, respectively. To assess working memory, Letter-Number Sequencing and Spatial Span subtests of Wechsler Memory Scale, Third edition (WMS-III) were used.

**Results:** There were significantly lower scores in schizophrenia patients compared to normal controls in spatial span forward ( $p < .001$ , Cohen's  $d = 2.51$ ), backward ( $p < .001$ , Cohen's  $d = 2.62$ ) and total scores ( $p < .001$ , Cohen's  $d = 2.78$ ) as well as letter-number sequencing scores ( $p < .001$ , Cohen's  $d = 1.87$ ). In the patient group, there was significant negative correlation between SANS total score with spatial span forward ( $r = -.227$ ,  $p < .01$ ) and total scores ( $r = -.164$ ,  $p < .05$ ).

**Conclusion:** Our study suggests impairment of both visuospatial as well as auditory memory in patients of schizophrenia as compared to controls. Furthermore, visuospatial working memory correlated inversely with negative symptoms (German J Psychiatry 2010; 13 (3) 116–120).

**Keywords:** schizophrenia, working memory, negative symptoms

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## Introduction

Attention and memory are the most frequently researched areas of cognitive impairment in patients with schizophrenia. Working memory, in particular, has emerged as an important domain of dysfunction (Lee & Park, 2005). Though neuropsychological studies have demonstrated deficits in several areas, working memory seems to be most severely affected (Saykin et al., 1991, 1994). Deficits in working memory are associated with the severity of negative symptoms as well as impairments in social and occupational functioning (Bowen et al., 1994; Corrigan et al., 1994). Broadly, two types of working memory paradigms have been investigated in schizophrenia (Perry et al., 2001). One involves transient, short-term memory that does not require manipulation of the stored information, whereas the other involves both maintenance and manipulation, a part of ex-

ecutive functioning. Schizophrenia patients often show more severe impairment on the second type (Barch, 2005). Working memory has two components, verbal and spatial, impairments of both having been reported in schizophrenia (Pantelis et al., 1997; Perry et al., 2001; Brown et al., 2007).

Although working memory deficits have been found in patients with schizophrenia in several studies, some researchers have also found no significant difference compared to normal controls. For example, Park and Holzman (1992) found that schizophrenia patients exhibited impaired visuospatial working memory performance but not impaired auditory working memory. To increase the complexity of simple digit span tasks, Gold et al. (1997) studied letter-number sequence task in schizophrenia patients to assess the capability to hold and manipulate information. They found deficits on the letter-number sequence task which suggest an impaired auditory working memory and also this impaired

letter-number sequence performance correlated significantly with Wisconsin Card Sorting Test perseverative responses, a measure of executive function. Hence, we undertook the current study with the objective of assessing both auditory and visuospatial working memory tasks in a sample of schizophrenia patients in comparison to normal controls, and its correlation with psychopathology.

## Method

### Participants

This was a cross-sectional, hospital-based study conducted in the Central Institute of Psychiatry, Ranchi, India. The study was approved by the ethical committee of our Institute. Sample consisted of 78 drug naive or drug free (at least 3 months) patients of either sex, aged between 18-45 years, fulfilling diagnosis of schizophrenia according to ICD-10 Diagnostic Criteria for Research (WHO, 1993) with illness duration less than two years and at least six years of formal education. Those with comorbid psychiatric disorder, substance abuse or dependence (except nicotine or caffeine), history of major medical or neurological disorders or history of electroconvulsive therapy in the past 6 months were excluded from the study. Normal control group consisted of 35 subjects who were age, sex and education matched with respect to schizophrenia group having General Health Questionnaire (GHQ-12; Goldberg & William, 1988) score of less than three and without any history of major medical or psychiatric disorder. Written informed consent was obtained from all the participants.

### Tools

A semi-structured pro-forma specially designed for the study was used for recording socio-demographic and clinical details. A 34-item clinician administered Scale for the Assessment of Positive Symptoms (SAPS; Andreasen, 1984) and 25-item clinician administered Scale for the Assessment of Negative Symptoms (SANS; Andreasen, 1983) were used to assess positive and negative symptoms of schizophrenia, respectively. In both the scales, items are scored on a scale of 0 to 5 (0 = no abnormality and 5 = severe). To assess depression, a 9-items scale Calgary Depression Scale for Schizophrenia (Addington et al., 1990), specifically developed for the assessment of depression in schizophrenia was used. The 12-item version of General Health Questionnaire (GHQ-12; Goldberg & William, 1988) was used to screen normal controls. To assess working memory, Letter-Number Sequencing and Spatial Span subtests of Wechsler Memory Scale, Third edition (WMS-III; Wechsler, 1997) were used. Letter-Number Sequencing is a measure of auditory working memory in which a series of numbers and letters are presented in a random order and the examinee must reorganize the numbers into ascending order and the letters into alphabetical order. Total score ranges from 0-21 points. Spatial Span is the visual analogue of the digit span subtest which measures

**Table 1. Sample Characteristics**

	<b>Patients N=78 Mean (SD)</b>	<b>Normal N=35 Mean (SD)</b>	<b>Mann- Whitney U</b>
Age	30.33 (6.78)	32.20 (7.53)	p = .243
Duration of illness in months	16.95 (6.34)	-	-
Age of onset	28.77 (6.84)	-	-
Age of first hospitalization	2.96 (9.15)	-	-
Number of hospitalization	0.13 (0.41)	-	-
SAPS total score	23.08 (9.48)	-	-
SANS total score	30.24 (13.36)	-	-
CDRS total score	2.69 (3.56)	-	-
	<b>N (%)</b>	<b>N (%)</b>	<b>Fisher's exact test (p)</b>
Sex			
Male	76 (97.4)	33 (94.3)	.586
Female	2 (2.6)	2 (5.7)	
Education			
Up to matric	43 (55.1)	19 (54.3)	1
Intermediate	20 (25.6)	9 (25.7)	
Graduate	15 (19.2)	7 (20.0)	
Domicile			
Urban	25 (32.1)	24 (68.6)	<.001
Rural	53 (67.9)	11 (31.4)	
Occupation			
Employed	34 (43.6)	30 (85.7)	<.001
Unemployed	44 (56.4)	5 (14.3)	
Marital status			
Single	28 (35.9)	9 (25.7)	.199
Married	50 (64.1)	26 (74.3)	

Note: \*\*\* p < .001 (2-tailed)

spatial working memory and consists of two parts, Spatial Span Forward and Spatial Span Backward. The score ranges from 0-32 points.

### Procedure

Socio-demographic and clinical details were obtained from the subjects followed by rating on SANS, SAPS and CDRS to evaluate current psychopathology. Thereafter, tests of working memory were administered on all the subjects.

### Statistical analysis

Statistical analysis was carried out using SPSS version 10.0 (SPSS Inc., Chicago, IL, USA). Normality of data was examined using histograms and Shapiro-Wilk test statistic. Mann-Whitney U test and Fisher's exact test were used to study the group differences in socio-demographic and clinical variables. Kendall's tau ( $\tau$ ), a non-parametric correlation, was used to assess bivariate relationship between working memory scores and clinical characteristics. Scatter plots were used to study the relationship between working memory and

**Table 2: Comparison of working memory between schizophrenia patients and normal controls**

	<b>Patients N=78 Mean (SD)</b>	<b>Normal N=35 Mean (SD)</b>	<b>Mann- Whitney U</b>
Spatial span forward	5.09 (1.57)	9.14 (1.65)	153.5***
Spatial span backward	3.09 (1.29)	7.06 (1.71)	148.5***
Spatial span total	8.21 (2.48)	16.20 (3.22)	134.5***
Letter-number sequencing	2.77 (1.14)	5.97 (2.13)	294.5***

Note: \*\*\* p < .001 (2-tailed)

clinical characteristics. The level of significance was kept at p<.05.

## Results

### Sample characteristics

The sample characteristics have been summarized in table 1. The mean age in patient group was 30.33 (SD 6.78) years and in controls was 32.20 (SD 7.53) years; there was no significant difference between them. Similarly, there was no significant difference between the two groups in terms of sex, education and marital status. However, there was significant difference in terms of domicile and occupation (p<.001). Mean age of onset of illness in the patient group was 28.77 (SD 6.84) years, whereas mean duration of illness was 16.95 (SD 6.34) months.

### Working memory

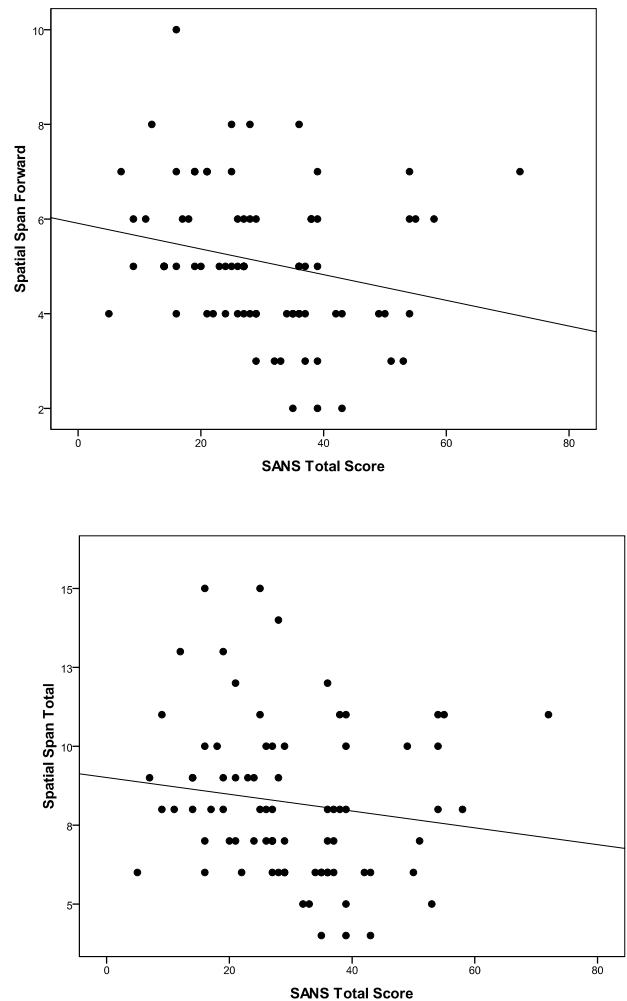
Group comparison in working memory scores have been summarized in table 2. There were significantly lower scores in schizophrenia patients compared to normal controls in

**Table 3: Kendall's tau correlation between working memory with clinical variables**

	<b>Spatial span forward</b>	<b>Spatial span backward</b>	<b>Spatial span total</b>	<b>Letter-number sequencing</b>
Age	-.054	-.073	-.106	.014
Duration of illness in months	.008	-.022	-.036	-.068
Age of onset	-.053	-.077	-.102	.008
Age of first hospitalization	.010	-.033	-.013	.209*
Number of hospitalization	.015	-.042	-.011	.208*
SAPS total score	-.063	-.053	-.066	-.010
SANS total score	-.227**	-.096	-.164*	-.072
CDRS total score	.032	.077	.060	.047

Note: \* p < .05, \*\* p < .01 (2-tailed)

spatial span forward (p<.001, Cohen's d = 2.51), backward (p<.001, Cohen's d = 2.62) and total scores (p<.001, Cohen's d = 2.78) as well as letter-number sequencing scores (p<.001, Cohen's d = 1.87). Table 3 shows correlation between working memory and clinical variables. In the patient group, there was significant negative correlation between SANS total score with spatial span forward ( $\tau = -.227, p<.01$ ) and total scores ( $\tau = -.164, p<.05$ ) (figure 1). There was significant positive correlation between letter-number sequencing and age at first hospitalization ( $\tau = .209, p<.05$ ) as well as number of hospitalizations ( $\tau = .208, p<.05$ ). There were no correlations of working memory scores with SAPS or CDRS scores.



**Fig 1: Scatterplot showing correlation of SANS total score with (a) spatial span forward and (b) spatial span total in patients with schizophrenia (N=78)**

## Discussion

The main findings from our study were impairment of both visuospatial as well as auditory memory. The effect sizes for the findings were large (Cohen, 1988). The re-

sults of this study support the hypothesis that schizophrenia patients have impaired performance on working memory measures when compared to a normal sample. In contrast to Park and Holzman (1992) who found impairment in visuospatial working memory with sparing of auditory working memory performance, our findings revealed impairment in both domains, thus refuting the *modality specific hypothesis* for working memory impairment in schizophrenia patients.

We found a significant negative correlation between negative symptoms as measured by SANS and spatial working memory in schizophrenia patients, though the effect size for the finding was small. The patients with greater severity of negative symptoms fared worse in spatial working memory tasks. The relationship of negative symptoms of schizophrenia with executive functioning deficits including working memory has been reported in several studies (Carter et al., 1996; Cameron et al., 2000; Palmer et al., 2000; Moritz et al., 2001). Furthermore, Carter et al. (1998) have reported association of functional hypofrontality with deficits in working memory. Also, there are evidences to suggest prominent role of frontal lobes in working memory tasks (D'Esposito, 2007) and frontal lobe abnormalities, specifically in dorsolateral prefrontal cortex, have been correlated with working memory task performance in schizophrenia patients (Honey and Fletcher, 2006; Kawada et al., 2009).

We found no correlation between positive symptoms and working memory tasks. This is in consonance with majority of studies which have found poor correlation between severity of positive symptoms of schizophrenia with executive dysfunction (Addington et al., 1997; Collins et al., 1997; Voruganti et al., 1997; Basso et al., 1998; Nieuwenstein et al., 2001). Verbal working memory did not correlate with either positive or negative symptoms. However, significant positive correlation with age at first hospitalization as well as number of hospitalizations appears paradoxical as both of these are indicators of greater illness severity.

Our study had adequate sample size to detect the difference between the groups. Limitations of our study include cross-sectional design and under-representation of females which limit generalizability of our findings across gender. Future studies should include neuroimaging modalities to take neuropsychological probes one step further in identifying neuroanatomical correlates of cognitive dysfunction in schizophrenia.

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