

Cognitive Remediation of Working Memory Deficits in Patients with Schizophrenic Disorder

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ABSTRACT:

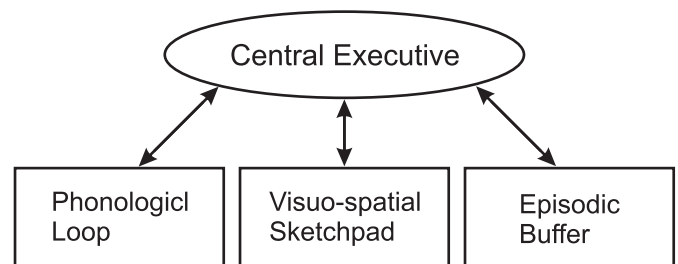
Background: The present study focuses upon the effects of cognitive remediation programme upon the working memory deficits of the patients with schizophrenic disorder. Schizophrenia is a chronic, severe and debilitating psychiatric illness. It is often described in terms of positive and negative symptoms. The working memory deficits are considered a cardinal cognitive feature of schizophrenia. **Methods:** Five patients admitted in Ranchi Institute of Neuro- Psychiatry and Allied Sciences (RINPAS), Ranchi, India in the age range of 20 to 40 years of male sex, meeting the ICD-10 DCR criteria of schizophrenia with minimum education of 12 years were taken for the study, following purposive sampling technique. A self developed socio-demographic and clinical data sheet was used to assess the socio-demographic correlates, the Positive and Negative Symptom Scale developed was used for assessing the psychotic symptoms, The Wisconsin Card Sorting Test and the Stroop test was used for assessing the executive functions and the Letter-Number Sequencing and Spatial Span Subtests taken from the Wechsler Memory Scale-III were used for assessing the working memory of the subjects included in the study. Then a cognitive remediation programme was given to them for a period of three months after which the tests were readministered to see the effects of the intervention programme. **Results:** The patients suffering from schizophrenia show improved working memory ability after the cognitive remediation programme. **Conclusion:** Cognitive remediation programme has a positive effect upon the executive functioning, specially working memory of the patients suffering from schizophrenic disorder.

Keywords: Cognitive remediation, Schizophrenia, Working memory.

INTRODUCTION:

Schizophrenia is a severe, lifelong brain disorder. It is a psychiatric diagnosis that describes a mental disorder characterized by abnormalities in the perception or expression of reality. The word schizophrenia was coined by Eugene Bleuler in 1908 and was intended to describe the separation of function between personality, thinking, memory, and perception. Bleuler described the main symptoms as *4 A's*: Abnormal Affect, Autistic Thinking, Abnormal Association of ideas and Ambivalence. The term "working memory" was introduced by Miller et al (1960) in reference to a postulated quick access brain space where plans can be retained temporarily while they are being formed, manipulated and executed. The wide spread acceptance of the central role played by working memory in cognition has its roots in the highly successful model of working memory introduced originally by Baddeley and Hitch in 1974 and was revised by Baddeley in 1986. They proposed that working memory is a workspace, the capacity of which can be divided between processing and storage. Baddeley and Hitch referred to the storage component as the "Phonemic buffer or "Phonemic loop" and to the flexible general processing system as the "Central executive".

The main component is termed the "Central executive". This component has flexible processing resources that are limited in capacity and can be used both to regulate and coordinate the flow of information within working memory and to perform processing and storage operation. The phonological loop retains verbal material in terms of the sketch based characteristics. The second slave system is the "Visuo-spatial sketch pad" which is specialized for processing material that can be represented in terms of either its visual or spatial characteristics. In a nod to the evidence supporting some involvement of long-term memory in the working memory system, Baddeley (2000) has amended his original three component model by adding an episodic buffer. This storage system communicates bi-directionally with the working memory subsystems and the long-term memory store.



Working memory dysfunction in schizophrenia is characterized by inefficient prefrontal function as most patients exhibit excessive activity when performing a moderately difficult working memory task (Callicott et al., 2003, 2000a; Monoach et al., 1999, 2000, 2003; Jansma et al., 2004; Perlstein et al., 2001). Review of studies show that working memory is a core cognitive deficit in schizophrenia. Spatial working memory deficits associated with dorsolateral prefrontal dysfunction have been found in caucasian samples of schizophrenia patients and their first-degree relatives. (Marina Myles-Worsley, Sohee Park, 2002).

METHOD:

Objectives of the study:

1. Quantitative assessment of working memory deficits in patients with schizophrenic disorder.
2. To rehabilitate the working memory of schizophrenic patients using cognitive rehabilitation techniques.
3. Studying the effects of cognitive rehabilitation upon working memory of the patients.

SAMPLE OF THE STUDY:

A sample of five patients suffering with chronic schizophrenic disorder was drawn from the inpatient department of RINPAS as per ICD-10 DCR criteria. The drawn sample was purposive. Initially, 12 patients were selected but final selection was made of 7 patients who were found suitable for cognitive remediation. During the study, two patients were discharged and thus the study was completed upon all total five patients.

INCLUSION CRITERIA

- Patients diagnosed as suffering from schizophrenic disorder according to the ICD-10 DCR criteria.
- Illness duration of two years or more (not more than three years).
- Age range 20-40years.
- Patients who have acquired significant working memory deficits.
- Patients who gave informed consent to participate in the study.
- Patients, who were cooperative, and who were able to comprehend the instructions properly.
- Patients who were educated up to secondary level.
- Residing in Ranchi and/or nearby places.

Exclusion criteria: Patients were excluded having:

- Significant co-morbid psychiatric or neurological conditions.
- Violent behaviour or having severe positive symptoms.
- History of mental retardation.
- History of alcohol/substance abuse.
- Psychopathology interfering in eliciting reliable information.
- History of severe physical illness in the near past.

TOOLS FORASSESSMENT:

Socio-demographic and clinical data sheet was used to gather information like name, age, sex, education, religion, marital status, age and mode of onset, course and duration of illness etc.

Positive and negative symptoms scale of schizophrenia (PANSS) developed by Kay et al (1980) was used to assess the presence of positive and negative symptoms among the subjects.

Wisconsin Card Sorting Test: The Wisconsin card sorting test was developed by Esta Berg in 1948 who described a procedure for investigating flexibility of thinking in human subjects. Clinically, the test is widely used by Neuropsychologists, Clinical Psychologists, Neurologists and Psychiatrists in patients with acquired brain injury, neurodegenerative disease, or mental illness such as schizophrenia. This test was used for the assessment of the executive functioning of the subjects.

Stroop Neuro-Psychological Screening Test: The Stroop Neuro-Psychological Screening Test was developed by John Ridley Stroop in 1935 which was based on the earlier reports of Cattell (1886) and Brown (1935). It was also used for assessing the executive functioning of the subjects.

Letter-Number Sequencing Test and Spatial-Span Test of Wechsler Memory Scales-III: These tests have been taken from the Wechsler Memory Scales-III which is an individually administered battery of learning, memory, and working memory. The Letter-Number Sequencing subtest is a measure of working memory that uses auditory stimuli to evaluate working memory in individuals with schizophrenia. The Spatial-Span subtest taps an individual's

ability to hold a visual-spatial sequence of locations in working memory and then reproduce the sequence. In the first test, the individual is presented with a string of alternative letters and numbers (e.g. 8-y-2-w) and is asked to repeat the numbers and letters in alphabetically and numerically ascending order. The length of the letter-number strings are gradually increased from two to eight elements.

In the second test, at first, the examinee is asked to replicate an increasingly long series of visually presented spatial locations. The examiner points to a series of blocks at a rate of approximately one block per second and asks the examinee to point to the same blocks in the same order (spatial span forward). In the second part of the subtest, the examiner points to a series of blocks and asks the examinee to point to the same blocks in the reverse order (spatial span backward).

Working Memory Index: The Working Memory Index is formed by summing the scaled scores for Letter-Number Sequencing total score and Spatial-Span total score.

TOOLS FOR MEMORY REMEDIATION:

Card sorting games- In this technique, playing cards were given to the subjects. Initially, they were asked to sort the cards according to their particular groups to which they belonged and they were also said to arrange the cards in the descending order. Subjects were assigned to do this task one by one/individually. This was continued till the subjects were able to do the task without doing any errors. After that, they were said to do this task within a given time limit. Gradually the time limit was decreased and they were instructed to do the task.

When the subjects were able to complete this task successfully, they were assigned a new card sorting technique. In this technique, subjects were asked to sort the cards on their number or face basis, not by their category, as it was in the previous task in order to avoid the carry-over effect. Here, also gradually the time limit was decreased and they were asked to do within that given time limit. After that, the games of interference resistance, rehearsing multiple sets, spatial rehearsal, rehearsing changing sets, rehearsing sequence, and logical rehearsal were used for the rehearsal skill of the subjects. All of the games had three phases.

Interference refers to a situation in which a person is experiencing one event, but a second event occurs and interrupts the person's memory for the first. In this game the subjects were shown a card from the deck and they

were said to say the number or face or suit of the card. Then the card was placed down on the table in front of the client. Then the second card was shown and again they were asked to say the names of the card aloud and again it was placed down on the table. Then the subjects were said to recall the number or face of the previous card shown. This process was continued till the card deck was exhausted. In the rehearsal phase, the game was repeated and the subjects were said to rehearse.

In rehearsing multiple sets requires a person to remember the number of occurrences in several different categories. Here, in the first phase of this game, three cards were shown to the subject, one at a time and they were asked to remember how many cards are there of each suit. Then they were said to read aloud the number of cards they recalled from each suit. In the rehearsal phase, the subjects were shown the cards and they were said to read aloud the face of the card. When they were shown the next card then they were said to say the face of the first card also along with the second one.

Spatial rehearsal refers to memory for people or things in a three dimensional space. The game began with 16 cards, 4 from each suit. The cards were shuffled and arranged into a square grid. The subjects turned over any four cards leaving them in the same position in the grid. If the four cards had the same suit, the cards were removed from the grid otherwise they were left in the same place. Again four cards were turned over and if they were same, then they were removed from the grid. This procedure was continued till all the cards were removed from the grid.

In rehearsing changing sets, the subjects saw three cards, one at a time and named each one aloud as they were placed face down the table. Then, they were showed other cards from the deck, one at a time, until they identified the face or number of the shown cards. When the match was made, then the matched card was replaced by another card from the deck. This process continued until the deck was exhausted.

In rehearsing sequence, the subjects were shown five cards one at a time and then they were placed down on the table in a random order until all the five cards are turned face down. Then the subjects were said to arrange the cards in numerical order from left to right and lowest to highest. The task required them to remember the cards so that they can arrange them in the proper order. In the rehearsal phase, the game was again started but here the subjects had to say the number or face of the cards which were facedown and rehearse the position of the cards before ranging them from lowest to highest.

In logical rehearsal, the subjects were given a deck of cards and a single card was selected from the other deck. They then asked questions about that particular card and whatever information was given, they had to remember them. Then they had to correctly identify that card and produce it from the deck of cards. Thus the game continued with this forced rehearsal procedure.

Solving jumbled sentences- After the subjects had learnt the card sorting games, the second technique of the therapy was started. In this technique, the subjects were given some jumbled sentences and they were asked to arrange it in the correct order. One sentence was given to each subject and this task was carried individually. Gradually when the subjects understood the task and were able to do it correctly, then the time limit was decreased and they were asked to do it within the given time-limit.

Mathematical sums- This was the third technique of the intervention process. Here the subjects were said to do some simple mathematical sums like addition, subtraction, division and multiplication. Initially, the stimulus problems were followed by demonstration and when they understood the task, they were taught to do the calculations orally. Initially, they were given only one sum at a time (like for example; an addition at a time) but gradually, they were given the sums one after the other in a sequence (a multiplication sum following an addition task). This task was also carried out individually by the subjects.

Tapping technique- Another technique which was used for the memory remediation of the subjects was the tapping technique. In this technique, they were instructed that some words will be read out loudly and whenever a particular word will be read out they had to tap on the table by their hand. The subjects were at first made aware about the stimulus word/problem word. This technique was also carried out individually.

PROCEDURE OF THE STUDY:

At first, the Socio-Demographic and Clinical Data Sheet was filled with the help of brief interview with the patients selected for the study and thereafter “The Positive and Negative Symptoms Scale” was administered to screen out the subjects. Subjects with major psychotic symptoms were excluded from the investigation. Informed consent was taken from the patients before starting the study. Then Wisconsin Card Sorting Test, Stroop Neuro- Psychological Screening Test, and the Wechsler Memory Scale-Letter-Number Sequencing and the Spatial-Span subtests were administered upon the subjects selected for the study for assessing the working memory and executive functioning of the subjects. After assessing the subjects on above

mentioned tests, the intervention programme was started. After the intervention programme of three months, the same tests were re-administered upon the patients to see the effects of the intervention programme.

RESULTS AND DISCUSSION:

The obtained data was analyzed using Wilcoxon Sign Rank Test for calculating the significant level and the t+ value was calculated of all the variables

Table 1: Showing socio-demographic variables of the sample

S.No.	Variables	Patients group (total 5)	Percentage	
1.	Age	20-30years	3	60%
		30-40 years	2	40%
2.	Sex	Male	5	100%
		Female	0	-
3.	Education	10-12 years	5	100%
		12 years and above	0	-
4.	Marital status	Married	4	80%
		Unmarried	1	20%
5.	Religion	Hindu	4	80%
		Muslim	1	20%
6.	Residence	Urban	0	-
		Semi-urban	0	-
		Rural	5	100%
7.	Family type	Joint	1	20%
		Nuclear	4	80%
8.	Economicalstatus	Low	2	40%
		Medium	3	60%
		High	0	-
9.	Occupation	Employed	2	40%
		Unemployed	3	60%

The above table shows that three (60%) of the patients belong to the age group of 20-30 years and two of them (40%) belong to the age group of 30-40 years. All the patients were male and maximum were educated up to 12th standard, 80% were married and 80% were Hindu except one (20%) who was a Muslim. All were belonging to rural background and 80% of them were residing in nuclear family, two (40%) of them belonged to low economic status and 60% belonged to middle economic status. Out of five, two of them (40%) were employed and three (60%) were unemployed.

Table 2: Showing the Clinical profile of the sample

S.No.	Variables	Patients group	Percentage
1.	Age of onset	14-24 years	4 80%
		24 years and above	1 20%
2.	Duration of illness	0-1 years	1 20%
		2-3 years	4 80%
3.	Mode of onset	Abrupt	0 -
		Acute	1 20%
		Insidious	4 80%
4.	Course of illness	Continuous	3 60%
		Episodic	2 40%
5.	Progress of illness	Static	1 20%
		Improving	4 80%
		Deteriorating	0 -
		Fluctuating	0 -

The above table shows that most of the patients (80%) are belonging to the age group of 14-24 years. The duration of illness was 2-3 years (80%) and mode of onset of the illness was insidious in most of the patients (80%). The course of illness in 60% cases was continuous and in 2 cases (40%) was episodic. The progress of illness in 80% cases was found to be improving and was static in 20% cases.

Table 3: Analysis of WCST before and after the intervention

Areas of assessment	Conditions	Patients					Wilcoxon sign rank test		
		P1	P2	P3	P4	P5	sign	Mean rank	Critical value of T+ score
Total number of correct responses	Pre-test	78	96	85	60	64	+	2.00	0.00(NS)
	Post-test	79	69	64	74	79	-	4.50	
Total number of errors	Pre-test	50	59	64	68	64	+	3.00	0.0313*
	Post-test	49	32	43	54	49	-	0.00	
Perseverative Responses	Pre-test	33	23	41	74	56	+	3.00	0.0313*
	Post-test	28	12	15	36	21	-	0.00	
Perseverative errors	Pre-test	27	15	25	44	38	+	3.00	0.0313*
	Post-test	20	5	15	29	13	-	0.00	
Non-perseverative errors	Pre-test	29	44	28	39	36	+	3.00	0.0313*
	Post-test	23	27	15	10	26	-	0.00	
Conceptual level responses	Pre-test	46	51	38	43	38	+	3.00	0.0313*
	Post-test	54	83	69	54	61	-	0.00	
Number of categories completed	Pre-test	1	7	3	2	2	+	1.00	0.00
	Post-test	2	2	0	2	3	-	4.00	
Trials to complete first category	Pre-test	58	3	0	27	3	+	3.50	0.4063
	Post-test	53	4	-	8	0	-	1.50	

*Significant at 0.05 level.

The above table shows the performance of the patients on the Wisconsin Card Sorting Test before and after the intervention. It also shows the different areas of assessment (total number of correct answers, total number of errors, perseverative responses, perseverative errors, non perseverative errors, conceptual level responses, total number of categories completed and the trials taken to complete the first category). There was no significant improvement noticed in the total number of correct responses and number of categories completed and in the trials taken to complete the first category. However, a major difference was found in total number of errors, perseverative responses, perseverative errors, non perseverative errors, conceptual level responses. Results show the significant reduction in the errors after remediation. The obtained data indicates that the subject's performance in the area of working memory in different domains was influenced by the rehabilitation procedure which is evident from the reduction in numbers of errors committed before the cognitive intervention in general and perseverative errors as well and significant improvement was found in the area of conceptual level responses also which suggests that the cognitive remediation methods are effectively proving their efficacy and the role of the cognitive behaviour therapy cannot be overlooked in the complete management of the cases suffering from schizophrenia. The difference between the total number of errors on the pre-test and post-test conditions was found to be significant. Similarly the difference in the perseverative responses, perseverative errors, non-perseverative errors, conceptual level responses were found to be significant. But the difference between the total number of correct responses, number of categories completed and trials taken to complete the first category were not significant.

Table 4: Analysis of STROOP Neuro-psychological screening test before and after the intervention

Areas of assessment	Conditions	Patients					Wilcoxon sign rank test		
		P1	P2	P3	P4	P5	Sign	Mean rank	Critical value of T+ score
Colour task	Pre-test	95	98	83	112	67	+	4.00	0.1563*
	Post-test	111	93	97	111	99	-	1.50	
Colour-word task	Pre-test	35	42	32	36	7	+	2.75	0.2188*
	Post-test	41	16	43	38	69	-	4.00	

* Not significant at 0.05 level.

In the above table, the performance of the subjects in the STROOP Neurological Screening Test has been shown. The obtained data indicates that the subjects showed much improvement from their earlier performance on the STROOP test. The scores of the colour task increased substantially in the post-test in comparison to the pre-test conditions. Similarly, the pre-test and post-test performance

also improved on the color-word task. But the difference between the scores was found to be not significant. Jesus De La Higuera Romero (2003) also found a similar result in his study. However, the results of the study are encouraging the improvement occurred in the cases of schizophrenia after cognitive remediation.

Table 5: Analysis of Letter-Number Sequencing Test and Spatial-Span Test of Wechsler Memory Scales-III before and after the intervention

Areas of assessment	Conditions	Patients					Wilcoxon sign rank test		
		P1	P2	P3	P4	P5	Sign	Mean rank	Critical value of T+ score
Letter-number sequencing	Pre-test	6	6	1	3	0	+	2.50	0.3125
	Post-test	10	6	3	6	8	-	0.00	
Spatial-span total score	Pre-test	11	14	0	7	4	+	3.00	0.0313*
	Post-test	17	15	10	13	16	-	0.00	
Working memory index	Pre-test	17	20	1	10	4	+	3.00	0.0313*
	Post-test	27	21	13	19	24	-	0.00	

* Significant at 0.05 level

Above table shows the performance of the subjects on the Wechsler Memory Scale-III Letter-Number Sequencing and Spatial-Span subtests. The performance on the Letter-Number Sequencing test on pre and post assessment show that the cognitive remediation has been found effective which is evident from the number of scores obtained in the pre and post assessments which again confirm the efficacy of the cognitive remediation programme on the schizophrenia patients. However, the obtained difference was not significant. The obtained spatial-span score increased and it was found to be significant. Then, the working memory index was assessed and the difference was also significant. The study conducted by Tamasine C. Greig, Wayne Zito, Bruce E. Wexler, Joanna Fiszdon, and Morris D. Bell (2007) have supported the findings of the present study.

CONCLUSION:

Prior to cognitive remediation, the working memory function of the subjects was found to be impaired. However, after the remediation programme, significant differences were found in the area of working memory. Improvement was also remarkable in the area of total number of correct responses, number of categories completed, and trials taken to complete first category in the Wisconsin Card Sorting Test. Similarly, in the STROOP test, remarkable improvement was found in the areas of colour task and the colour word task. Improvement was also found to be remarkable in the letter-number sequencing test of the Wechsler Memory Scale-III. These results seem to be encouraging and it can be said that the cognitive remediation programme plays a very major role in treating the cognitive deficits especially the working memory deficits of the patients suffering from schizophrenic disorder.

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