

# Memory and cognitive training of schizophrenics

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## ABSTRACT

**Objective:** Neurocognitive deficits associated with schizophrenia include difficulties with working memory, executive function, sustained attention spans, abstract thinking and planning ability. This study evaluated the effectiveness of scaffolding technique in improving the neurocognitive deficits of schizophrenics.

**Methods:** Thirty-five schizophrenic male patients were recruited for this study from a tertiary care hospital and a private psychiatric out-patient clinic. However, only 20 patients met the inclusion criteria for this research. All subjects were Diagnostic and Statistical Manual of Mental Disorders (Fourth Edition) diagnosed schizophrenics. Psychopathology was assessed using the Brief Psychiatric Rating Scale. Wisconsin Card Sorting Test was utilized to assess patients' cognitive deficits and as a training tool.

**Results:** The findings in this study demonstrated that memory and cognitive training of schizophrenics using the

scaffolding technique resulted in a significant improvement of these patients' performance on Wisconsin Card Sorting Test, a multi-dimensional task that requires many neurocognitive skills such as spatial memory function, abstraction, visual attention, categorization, cognitive analysis ability, and concept formation. A 6 week retest interval of the memory and cognitive trained schizophrenics showed the durability and stability of cognition, executive function, and memory in schizophrenics who received training.

**Conclusion:** Scaffolding, a memory training technique, is an effective tool in improving memory and neurocognitive deficits of schizophrenics.

**Keywords:** Schizophrenia, neurocognitive deficits, memory impairment, Wisconsin Card Sorting Test, scaffolding, memory and cognitive training.

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**T**he question concerning the presence of memory impairment and neuropsychological deficits in patients with schizophrenia is not new. It goes back to the early part of the 19th century when Morel, a French Psychiatrist used the term "démence précoce" to diagnose patients who suffer from memory problems, thought disorders, social and occupational dysfunction, disorganized speech, and grossly disorganized or catatonic behavior that started at a very early age (adolescence) in the patient's life. This term was later translated to dementia precox by Kraepelin in 1919 to stress the cognitive process (dementia) and early onset (precox) of the disorder.<sup>1</sup>

Schizophrenia, a heterogenous group of severe mental disorders, usually appears first in late adolescence, between the ages of 15 and 24 years in men and 24 and 34 years in women, with a prodromal period of 1-3 years duration.<sup>2</sup> It is a devastating illness with symptoms that progress at a rapid rate during the first 5 years of illness, and as many as 80% of the patients are unable to go back to work or school after the resolution of the first episode.<sup>3</sup> Moreover schizophrenia is a disorder with a very high lifetime suicide risk (10%-13%) compared to that of the general population (1.4%).<sup>4</sup> It is also found that 40%-70% of schizophrenics

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abuse illicit drugs or alcohol.<sup>5,6</sup> Because of the prevalence of schizophrenia (1%) and the disabling chronic nature and the complexity of the disorder, the financial and economic impact of treating schizophrenics is substantial, as more hospital beds are occupied for longer periods of time than those with any other illness.<sup>7</sup>

Recent research in the field of neuropsychology has shown evidence of presence of neurocognitive deficits in schizophrenic patients. Some of the findings point to the presence of these deficits in the frontal and temporal lobe areas of the brain,<sup>8</sup> in the frontal-hippocampal system,<sup>9,10</sup> and in the left hemisphere. Bilateral hemispheres were also implicated in patients with schizophrenia.<sup>11,12</sup> The purpose of this paper is to focus on the memory impairments and neuropsychological deficits in schizophrenics as determined by neuropsychological tests and other modalities of imaging investigations. It will also discuss memory impairments attributed to this disease. Another purpose of this paper is also to highlight a current proven effective cognitive and memory training programs used on these patients. The author will also review the factors that could be underlying schizophrenia.

**Etiology.** The etiology of schizophrenia is unknown. A host of potentially relevant risk factors such as heredity,<sup>13,14</sup> psychosocial stress,<sup>15-17</sup> psychoneuroimmunity,<sup>18</sup> and embryogenetic disruptions are thought to play a role as etiologic factors in this disorder. A number of pre and postnatal influences have been described that might either by themselves or in conjunction with other genetic factors cause schizophrenia. There appears to be an excess of obstetrical complications in the mothers of schizophrenics.<sup>19,20</sup>

Research from different perspectives has focused also on dysfunctional neurotransmitter system activity as the possible neuroanatomical substrate accounting for some symptoms of schizophrenia.<sup>21-24</sup>

**Neurocognitive and memory deficits in schizophrenia.** Cognitive and memory deficits in schizophrenics are significant in tasks that require inferential and abstract thinking and executive functioning.<sup>25</sup> Memory, a process whereby what is experienced or learned is recorded in the central nervous system (registration), where it persists with a variable degree of permanence (retention) and is retrieved from storage (recall), is one of the most important neurocognitive functions affected by schizophrenia. Schizophrenic patients have levels of performance that are consistently 1 to 2 standard deviations below average levels based on age and education.<sup>26,27</sup> The competence of memory function in schizophrenics is the subject of investigations that show deficiencies in schizophrenics on visual-spatial, and verbal recall tasks.<sup>28</sup> A recent functional MRI study presents data which document that schizophrenics and older normal subjects have

impaired visual compensatory efforts while performing Wisconsin Card Sorting Test (WCST).<sup>29</sup>

The development of new neuropsychological test batteries as well as older tests, have furthered the capacities of researchers in the quest of delineating specific neurocognitive deficits in schizophrenics who tend to perform at impaired levels on measures of cognitive function in such tests as WCST, Wechsler Adult Intelligent Scale, Benton Visual Retention test, Halstead Reitan Neuropsychological battery, California Verbal Learning Test (CVLT) as well as other tests.

Many neuropsychological studies have found evidence of a pronounced left hemisphere dysfunction.<sup>30,31</sup> Braff and collaborates also found that schizophrenics manifest memory and executive function deficits. These patients showed neuropsychological impairments in planning, sequencing, concept formation, cognitive set shifting and cognitive set maintenance.<sup>32</sup> Other studies showed vocabulary and spelling deficits in schizophrenics which could be interpreted as a learning disability<sup>33</sup> and fronto-limbic dysfunction.<sup>34</sup> The findings of several brain imaging techniques such as computerized tomography (CT) scans have indicated smaller hippocampal and limbic structures,<sup>35,36</sup> and reduced left temporal gray matter in schizophrenics.<sup>37</sup>

Magnetic resonance imaging (MRI) studies reported enlargement of the lateral ventricles in patients with schizophrenia.<sup>38</sup> Other MRI evaluations of the brain of some schizophrenics using the same imaging tool documented a reduction in the volume of the hippocampal-amygdala and the parahippocampal gyras.<sup>39</sup> Researchers using positron emission tomography (PET) which measured either glucose use or cerebral blood flow have found that schizophrenics have a reduced cerebral glucose metabolic rate in the left temporal region.<sup>40</sup> Single photon emission computed tomography (SPECT) and regional cerebral blood flow (rCBF) studies showed lowered blood flow to the dorsolateral prefrontal cortex while these patients were conducting a complex neuropsychological test.<sup>41</sup> Aside from these neuroimaging findings, delusional symptoms in schizophrenia could be attributed to limbic dysfunction that involves caudate nuclei and temporal lobe structures.<sup>42</sup>

**Methods. I. Subjects.** Thirty five male schizophrenic patients who met the Diagnostic and Statistical Manual of Mental Disorders, Fourth edition (DSM-IV)<sup>43</sup> criteria for schizophrenia were recruited from a tertiary care hospital and from a psychiatric out-patient clinic to participate in this study. Only 20 patients met this study criteria following the exclusion of patients who had a history of head trauma, major neurological disorder (e.g.

**Table 1** - Demographic Data: Means and Standard Deviations.

Variable	Schizophrenics (Experimental N = 10)	Schizophrenics (Control N = 10)	Statistical Significance
Gender	Male: 10 Female: 0	Male: 10 Female: 0	NS <sup>c</sup>
Age	40.0 (12.2)	39.8 (12.0)	NS
Education	10.0 (2.4)	10.4 (2.4)	NS
No of Years of Illness	14.1 (10.8)	14.5 (10.8)	NS
Age of Onset	31.4 (11.2)	31.7 (11.5)	NS
BPRS <sup>a</sup>	16.6 (6.8)	16.4 (6.7)	NS
Medication <sup>b</sup>	635.0 (18.3)	641.3 (18.6)	NS

<sup>a</sup>BPRS = Brief Psychiatric Rating Scale (Overall and Gorham 1962)  
<sup>b</sup>Chlorpromazine units  
<sup>c</sup>Non-significant difference tested by Student's t-test ( $P \geq 0.05$ )

seizures), chronic use of alcohol or illicit drugs, or schizo-affective disorders. Those who underwent electro-convulsive therapy treatment were also excluded from this study as well as those who were attending a day hospital or a psychiatric rehabilitation program. The patients who were included in the study were randomly assigned to one of 2 equal groups: experimental group or control group. Both

groups were assessed on Brief Psychiatric Rating Scale (BPRS).

**II. Measures.** **1. Wisconsin Card Sorting Test.** Wisconsin Card Sorting Test<sup>44</sup> is a complex problem-solving task that probably requires multiple cognitive processes, rather than a simple function.<sup>45,46</sup>

It consists of 4 stimulus cards and 128 response cards which differ in color (red, green, blue and yellow), shape (circle, star, cross and triangle), and numbers (one, two, three and four). The stimulus cards in the standard version of the test are one red triangle, two green stars, three yellow crosses and four blue circles. The administration of test begins by giving the response cards to the patient who is instructed to place each consecutive card under one of the stimulus cards, according to which they consider correct. After each sort, he is informed whether he is correct. The first sorting category is color and after 10 consecutive correct sorts, the category changes to form without forewarning, and then accordingly, to number. Although there are several potential scoring measures, poor performance on the WCST is defined by the number of categories achieved (out of a possible six) and the number of perseverations made.

**2. Brief Psychiatric Rating Scale.** The Brief Psychiatric Rating Scale,<sup>47</sup> is a 17 psychiatric statement questionnaire that assesses the presence and severity of psychiatric disorders with answers given in terms of 7-point Likert Scales.<sup>4</sup>

**3. Scaffolding.** A learning-based technique that takes into consideration the initial level of a subject's

**Table 2** - Pre-training measures of the Wisconsin Card Sorting Test: Means and Standard.

Variable	Schizophrenics (Experimental Group)	Schizophrenics (Control Group)	Significance
Number of Trials Administered	128 (24.86)	128 (24.86)	NS <sup>a</sup>
Total Number Correct	45 (21.50)	43 (20.80)	NS
Total Number of Errors	83 (24.90)	84 (24.90)	NS
Percent Errors	65 (16.72)	63 (16.25)	NS
Perseverative Responses	77 (18.48)	79 (19.00)	NS
Percent Perseverative Responses	60 (15.55)	63 (16.25)	NS
Perseverative Errors	71 (17.90)	73 (18.10)	NS
Percent Perseverative Errors	55 (13.90)	52 (12.40)	NS
Nonperseverative Errors	16 (1.84)	15 (1.65)	NS
Percent Nonperseverative Errors	15 (1.50)	16 (1.75)	NS
Conceptual Level Responses	31 (23.87)	33 (23.98)	NS
Percent Conceptual Level Responses	24 (13.90)	26 (14.10)	NS

NS<sup>a</sup> = Non-significant difference tested by Student's t-test ( $P \geq 0.05$ )

**Table 3** - Post-training (after one week) measures of the Wisconsin Card Sorting Test: Means and Standard Deviations.

Variable	Schizophrenics (Experimental Group)	Schizophrenics (Control Group)	P Value <sup>a</sup>
Number of Trials Administered	116.82 (17.63)	128 (24.84)	p < 0.005
Total Number Correct	66.40 (16.72)	43 (20.80)	p < 0.005
Total Number of Errors	50.70 (25.80)	84 (24.90)	p < 0.005
Percent Errors	41.00 (18.10)	63 (16.45)	p < 0.005
Perseverative Responses	37.75 (29.00)	79 (19.00)	p < 0.005
Percent Perseverative Responses	30.78 (22.40)	63 (16.25)	p < 0.005
Perseverative Errors	35.44 (27.30)	73 (18.10)	p < 0.005
Percent Perseverative Errors	28.63 (20.50)	52 (12.40)	p < 0.005
Nonperseverative Errors	12.00 (7.40)	15 (8.65)	p < 0.005
Percent Nonperseverative Errors	14.10 (8.65)	16 (9.75)	p < 0.005
Conceptual Level Responses	25.35 (7.10)	33 (23.98)	p < 0.005
Percent Conceptual Level Responses	22.85 (6.20)	26 (14.10)	p < 0.005
<sup>a</sup> Significance tested by Student's t-test			

**Table 4** - The measures of the Experimental Group of Comparison of Schizophrenic Patients on Wisconsin Card Sorting Test: Mean and Standard Deviation One Week, Six Weeks Post Initial Training Sessions.

Variable	Schizophrenics (6 weeks post training)	Schizophrenics (1 week post training)	Significance
Number of Trials Administered	118.00 (18.10)	116.82 (17.63)	NS <sup>a</sup>
Total Number Correct	67.77 (14.52)	66.40 (16.72)	NS
Total Number of Errors	51.90 (28.85)	50.70 (25.80)	NS
Percent Errors	42.00 (18.25)	41.00 (18.10)	NS
Perseverative Responses	38.50 (29.20)	37.75 (29.00)	NS
Percent Perseverative Responses	32.90 (24.00)	30.78 (22.40)	NS
Perseverative Errors	36.50 (29.60)	35.44 (27.30)	NS
Percent Perseverative Errors	30.40 (22.75)	28.63 (20.50)	NS
Nonperseverative Errors	14.56 (11.89)	12.00 (7.40)	NS
Percent Nonperseverative Errors	15.75 (8.40)	14.10 (8.65)	NS
Conceptual Level Responses	26.60 (8.00)	25.35 (7.10)	NS
Percent Conceptual Level Responses	24.85 (7.00)	22.85 (6.20)	NS
NS <sup>a</sup> = Non-significance differences t-test (P ≥ 0.05)			

performance on the WCST, and requires the experimenter to provide support to the subject for impaired task aspects.<sup>48</sup> The task components are broken into simpler parts, and the experimenter is continuously adjusting the level of support to the subject's level of achievement.

**III. Statistical Analysis.** Student's t-test was used to compare the performance of the experimental group to that of control group on different WCST tasks with level of significance set  $P < 0.05$ .

**Results.** Twenty (N=20) male schizophrenic patients participated in this study. They were randomly divided to 2 groups (experimental N=10 and control N=10). Statistical analysis of the 2 groups using students' t-test of their demographics in terms of age, education, length of illness, medication dosage; and severity of illness as assessed by BPRS, showed no significant differences between the 2 groups as displayed in Table 1 ( $P = 0.05$ ).

Prior to initiating the memory training program, both groups were assessed on WCST. Comparison of performance scores of the groups using student's t test resulted in no significant group differences on all WCST variables tested (e.g. total number of errors, perseverative responses, perseverative errors, conceptual level responses, etc.) Table 2 illustrates the findings.

One week following memory training program the experimental group, the subjects' performances revealed a statistically significant difference compared to those of control group, using student's t-test. These were assessed on all WCST tasks that involve memory, categorization, tasks, abstraction, concept formation and executive function. Table 3 depicts the results. In order to assess the durability of the gained improvement in the performance of the experimental schizophrenic patients, the group was retested six weeks after the initial memory training sessions. Students' t-test showed no significant differences ( $P > 0.05$ ) between the initial and the re-test results as presented in Table 4.

This finding supports the hypothesis that schizophrenic patients who received memory training were able to learn and maintain appropriate concepts in problem solving, information processing, task analysis, and concentration which enabled them to retain the level of improvement they acquired.

**Discussion.** Several neuropsychological studies have investigated the integrity of memory functioning in schizophrenics and found wide spread deficits in memory functions of these patients with schizophrenic disorders.<sup>49</sup> In other studies it was demonstrated that schizophrenics performed with a disproportionately greater impairment in memory relative to their impairment in general intellectual function, executive function and their generally low

cognitive function.<sup>50-51</sup> This study was intended to investigate the role of a memory and cognitive training program with schizophrenics in improving their level of cognition and enhancing their memory performance. Our findings in this study demonstrated that the memory training of schizophrenic patients resulted in improvement of their performance on WCST, a multi-dimensional task that requires many skills such as memory, abstraction, auditory and visual attention, categorization and executive control with  $P < .005$  or  $P < .001$  on student's t-test. The study also showed that significant improvements were observed following the administration of scaffolding, a learning based technique, utilizing WCST as an assessment and training tool.

By randomly assigning the subjects to two groups (experimental and control) we were able to attribute the changes in the patients' performance to the effect of training. Our sample was homogeneous in terms of sex, age, education, number of years of illness, and medication dosage. None of the patients was involved in a day-hospital or any other rehabilitation programs to avoid the influence of training provided in these programs for schizophrenic patients. This exclusionary criterion was to demonstrate that the memory training of the schizophrenic patients in this study resulted in effects that were not caused simply by some sort of nonspecific cognitive stimulation, hence a relationship between memory training of schizophrenic patients and improved performance in cognitive tasks does suggest that memory training may directly improve aspects of cognition. Here WCST proved to be an excellent task of executive functioning that requires mostly a number of cognitive and non-cognitive abilities to perform<sup>52</sup>, where working memory is an important quality to complete successfully the WCST which was found to be impaired in schizophrenic patients. Finally, six weeks after the initial sessions of memory training, schizophrenic patients clearly retained their improved performance on WCST tasks. Our study did not find significant decline in the gained improvement indicating the durability of the effect of the training on the cognition of the schizophrenic patients.

A few methodological problems in this study need to be addressed in future research. For example the number of participants in this study was relatively small (N=20). The inclusion of a larger number of participants in this study was limited by the lack of trained personnel and resources to conduct such a study in a large scale. Second, the study included only male schizophrenic patients. This was largely due to some cultural and religious restrictions that would not allow an easy access to female patients by a male therapist.

In conclusion, the findings of the present study suggest the efficacy of memory training of schizophrenic patients who are usually found to

suffer from cognitive deficits. Our findings are also consistent with other investigations' reports of improved memory and cognitive levels of patients with schizophrenia utilizing different methods of memory and cognitive training techniques.<sup>53,54</sup> This study results also indicated that memory training of schizophrenics using scaffolding technique established a degree of durable efficacy in their abilities to learn, store, and recall information from memory after six weeks has elapsed following the initial session of training. This study also showed that memory training of schizophrenic patients is durable, a finding supported by other researchers.<sup>55-57</sup> Effectively training the memory of schizophrenics enables them to be able to cope better with the cognitive and memory tasks that are expected from the people who live in the same community to perform regular daily vocational and social activities.

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