

SELECTIVE, SUSTAINED, AND SHIFT IN ATTENTION IN PATIENTS WITH DIAGNOSES OF SCHIZOPHRENIA¹

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Summary.—Attentional deficits are a prominent aspect of cognitive dysfunction in schizophrenia. The present study was designed to investigate attention deficit in a group of patients with diagnosis of schizophrenia. According to the segmental set theory suggested by Hogarty and Flesher, three aspects of attention problems, selective, sustained, and shift in attention, were studied. The 30 patients hospitalized on three psychiatric wards at Shiraz and Isfahan and 30 normal healthy subjects matched for age, sex, and years of education were administered a computerized Continuous Performance Test, Stroop Color-word Test, and Wisconsin Card Sorting test. Analysis showed patients performed more poorly than control subjects on measured aspects of attention. The acute/chronic classification did not predict differences in attention scores between subtypes of schizophrenia, while the positive/negative classification did. Paranoid, undifferentiated, and residual groups by subtypes of schizophrenia showed similar performance on the Continuous Performance Test, but were significantly different on errors on the Wisconsin Card Sorting test and on reaction time to Stroop stimuli in the incongruent color-word condition. Patients with paranoid diagnosis performed better than other subtypes on these tasks. Present results suggest that the Continuous Performance Test is valuable for differentiating of schizophrenia spectrum disorder, while scores on Stroop and Wisconsin card sorting may have better diagnostic value for differentiating subtypes of the disorder.

Cognitive impairments arise from biochemical and structural anomalies in the brain, particularly in schizophrenia. Biological interventions change the chemical state of the condition and may improve cognitive impairments. Cognitive impairments in schizophrenia include a spectrum of disabilities in problem-solving and task performance. Of particular interest are impairments of attention, a major function related to cognition and affect. The deficits in attention have been consistently postulated to be the major underlying deficit which characterizes schizophrenia spectrum disorders. Hogarty and Flesher (1992) classified the various attentional deficits of schizophrenia according to a segmental set theory. To classify a wide range of attention problems of patients, three components were postulated for the theory: failure to establish set or performing with selective attention, failure to maintain set or sustained attention, and failure to shift set or attention. Carter and

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Flesher (1995) showed how robustly these biologically based abnormalities may result in social vulnerability and functional disability in the patients suffering from schizophrenia. Barch, Carter, Hachten, Usher, and Cohen (1999) using the Stroop paradigm showed failure of selective attention in these patients when compared with healthy subjects. Levin, Yurgelun-Todd, and Craft (1989), in their review of the literature, noted that attention deficits were characteristically noted with schizophrenia, and those are consistent with the notion that frontal lobe system involvement is implicated in the disease. They also suggested that there are different attentional abilities in the different clinical subgroups of schizophrenia. Nonparanoid and negative state schizophrenics demonstrate deficits consistent with reduced arousal and distractibility, while paranoid and positive state schizophrenics may show better performance on relevant tasks than normal subjects.

The present study was designed to investigate the set theory components in groups of patients with diagnosis of schizophrenia. The performance of the patients was analyzed for groups of Positive (or Type I), Negative (or Type II), and Chronic/Acute clinical subgroups. Three well known paradigms were selected and adopted for Persian subjects to test the three areas of attention deficit of the patients.

METHOD

Tasks

The Standard Stroop Task relevant for measuring selective attention while the individual is presented the names of colors printed in ink of a color that differs from the color name, e.g., the word 'green' printed in blue ink, and asked to specify the color of the ink. Correct performance requires suppression of the conflicting tendency to respond to the color name (described by Liddle, 1994). The Continuous Performance Test was selected for measuring sustained attention, as it has long been held as a "gold standard" for measuring sustained attention or vigilance (Nuechterlein & Dawson, 1984; Fleming, Goldberg, & Gold, 1994). The original version of the test was developed by Rosvold, Mirsky, Sarason, Branson, and Beck (1956). The test requires tachistoscopic presentation of a random series of letters at a rapid fixed rate (e.g., 1 sec.) over 5 to 15 min. with instructions to respond to a preselected series of letters each time one appears. The Wisconsin Card Sorting measured shifts of attention. Beginning with Fey (1951) patients with diagnosis of schizophrenia have repeatedly typically performed poorly on this task. They have trouble grouping the concepts and improving their performance with feedback; they often show perseveration of incorrect responses.

Subjects

Thirty patients with a diagnosis of schizophrenia hospitalized in three

psychiatric wards at Shiraz and Isfahan were enrolled in the study. The inclusion criteria were agreement on a diagnosis of schizophrenia from two psychiatrists who used DSM-IV criteria (American Psychiatric Association, 1994). Also, on the Mini-Mental State Examination (Folstein & McHugh, 1975), a screening test conducted during a patient's clinical examination, of a possible 30 points, receiving a score of less than 25 suggests cognitive impairment and inability to take the test or a score of less than 20 indicates defined impairment. Accordingly, the patients with scores less than 25 were omitted from the study. Age was between 17 and 45 years. Education was greater than eight years of formal education. Patients with two diagnoses at the Axis I level and those with brain damage (open head injuries) according to history reported by the patients and their families were omitted from the study. Thirty normal healthy subjects matched for age, sex, and years of education were enrolled as a control group.

Materials and Diagnoses

Several measures were used for diagnoses and evaluation of attention processes. The researcher completed a check list of DSM-IV criteria for diagnosis of schizophrenia and categorized the patients as having Positive or Negative (Crow, 1980) and Chronic or Acute schizophrenia. Those patients showing two years duration of the symptoms without remission were regarded as having a diagnosis of chronic schizophrenia (Grebb & Cancro, 1989). The check list information was completed using patients' hospital files, observation, and interview information.

The standard Stroop test (Stroop, 1935) was used as a measure of selective attention including reaction time for a list of 50 color words printed in the same color-word ink for each word, and a similar list of words printed with incongruent ink colors. Reaction time for responses to congruent and incongruent lists for the two tasks were recorded for analysis.

The Continuous Performance Test was a measure of maintenance of attention. It is a computerized program presenting a series of Xs; replacement of an X with the letter A was selected as the target response. Duration of stimulus presentation was 200 msec., and the interstimulus interval was random between 2500 to 4000 msec. The errors missing the target and response to nontarget stimuli were counted as scores for analyses. The Wisconsin Card Sorting Test was used as a measure of ability to shift attention. From the 64 cards, four stimulus cards are placed before the subject, who was instructed to place the next card under one of the four cards if it appeared to belong to the same category. The response card was "categorized" by placement beneath the stimulus card. The subject then was told (feedback) by the experimenter "Correct" or "Incorrect." The test continues until three shifts of category have occurred or until the deck of response cards is exhausted.

An incorrect response based on the previous set after a category had been changed was regarded as a perseverating error and any other error plus the score were recorded as the Total Error score.

Procedure

Patients were assessed individually and in two or three successive sessions if necessary. The above mentioned tests and measurements were carried out successively. The analyses of scores were carried using SPSS-10 processor analyses. A model of multivariate analysis of variance was utilized. Scores on the tests were regarded as dependent variables, including the reaction time on the Stroop test of naming the color word written with the same color, the reaction time for naming of the color word written in an incongruent color, the Continuous Performance Test error scores, the Wisconsin Card Sorting perseveration errors, and Total Error scores. All patients were on antipsychotic medication. The daily dosage of the patients' medication was converted to Chlorpromazine equivalents and entered into the analysis as a covariate when comparing patient groups.

RESULTS

Table 1 represents the mean age of subjects and other relevant demographic variables. The 30 patients included 12 with paranoid, 8 with undifferentiated, and 10 with residual diagnoses (see Table 2). There was no patient with the catatonia subtype of schizophrenia in the sample. The groups were not different in terms of years of age ($t = -.51$, ns) or years of formal education ($t = .28$, ns). There were also no age differences between the sexes ($t = .64$, ns) or for years of education ($t = .33$, ns).

TABLE 1
MEAN AGE OF SUBJECTS AND OTHER RELEVANT DEMOGRAPHIC VARIABLES

Variable	Group	Sex	<i>n</i>	<i>M</i>	<i>SD</i>	<i>SEM</i>
Age	Schizophrenia	Male	18	29.6	7.97	1.88
		Female	12	30.0	8.08	2.33
	Normal	Male	21	29.1	7.19	1.57
		Female	9	31.6	7.60	2.55
Education	Schizophrenia	Male	18	12.1	3.25	.77
		Female	12	11.8	1.70	.49
	Normal	Male	21	12.2	2.04	.44
		Female	9	12.1	.78	.26

For application the multivariate analysis of variance included two between-subjects factors of group (normal and patients) and sex (male, female). The analysis showed groups differed on performance of the tasks ($F_{3,52} = 19.0$, $p < .001$). For all tasks the patients had significantly lower performance than normal subjects. Sex had no effect on task scores ($F = .64$, ns), and the

interaction between the two independent variables was not significant ($F = .61$, ns).

The next step of the analysis was carried out for the effect of the schizophrenia categories for two levels, Positive vs Negative and Acute vs Chronic. The Chlorpromazine equivalent medication for doses used daily by the patients were entered into the analysis as covariate for change. The medication variable had no effect ($F_{5,21} = .35$, ns). The Positive vs Negative diagnosis significantly affected test scores ($F = 3.57$, $p = .02$), but the Acute vs Chronic status was not significant ($F = 1.34$, ns). According to these findings, the chronicity of the illness had no effect on these cognitive performances, while the Positive vs Negative diagnosis was associated with differences in cognitive performances, i.e., the interference effect of the Stroop incongruent test ($F_{4,83}$, $p = .04$) and Wisconsin Total Error scores ($F = 13.6$, $p = .001$). The interaction between the Positive vs Negative and Acute vs Chronic categories had no significant effect on the task scores ($F = .71$, ns).

TABLE 2
MEANS AND STANDARD DEVIATIONS OF TASK SCORES BY TYPE OF SCHIZOPHRENIA

Type	n	Stroop				Continuous Performance Test		Wisconsin Perseveration Errors		Wisconsin Total Errors	
		Congruent		Incongruent		M	SD	M	SD	M	SD
		M	SD	M	SD						
Positive	19	28.4	17.0	79.8	38.9	6.6	4.9	8.2	3.8	17.2	7.8
Negative	11	43.1	37.8	129.2	45.7	8.9	4.0	14.0	5.1	31.0	7.2
Acute	8	27.4	4.8	98.5	43.9	5.6	4.2	8.6	3.9	21.1	9.3
Chronic	22	36.1	31.1	97.7	49.6	8.1	4.7	10.9	5.4	22.7	10.5
Control	30	20.7	1.6	41.7	3.3	1.4	.7	4.2	1.0	5.6	1.5

Table 2 represents the means and standard deviations of the tasks scores according to Positive vs Negative and Acute vs Chronic categorizations. The next analyses were carried out utilizing one-way analysis of variance. The Scheffé *post hoc* analysis with significance level of 0.05 was selected for comparing the scores on the tests among three different diagnostic groups. The analysis indicated no difference between groups for the Stroop congruent condition for three diagnosis groups ($F_{2,27} = 1.24$, ns) and Continuous Performance test error scores ($F = .89$, ns). In further analyses patients with paranoid diagnosis did better on the Wisconsin Perseveration errors in contrast with those having undifferentiated and residual diagnoses, while the latter were not different from each other on this measure. The patients with paranoid diagnosis had scores on Wisconsin Total Errors similar to those with undifferentiated diagnosis, while those with Residual type diagnosis had higher error scores in contrast to patients diagnosed as paranoid. The residual and undifferentiated types did not score differently on total Persevera-

tion Errors. The Stroop interference scores were lower for the paranoid group in contrast to the two other diagnostic groups (Undifferentiated $p = .009$; residual $p < .0001$), while the Undifferentiated and Residual types had similar scores. Table 3 represents the means and standard deviations of the task scores by subtype of schizophrenia.

TABLE 3
MEANS AND STANDARD DEVIATIONS OF TASK SCORES BY DIAGNOSES OF SCHIZOPHRENIA

Diagnosis	n	Stroop				Continuous		Wisconsin		Wisconsin	
		Congruent		Incongruent		Performance		Perseveration		Total	
		M	SD	M	SD	Test		Errors		Errors	
						M	SD	M	SD	M	SD
Paranoid	12	28.2	21.4	59.6	21.1	6.7	6.0	6.5	1.8	14.6	6.7
Undifferentiated	8	28.5	4.6	114.7	36.3	7.8	2.2	11.5	4.4	23.0	8.7
Residual	10	44.6	39.5	130.3	48.0	8.8	4.2	13.9	5.4	30.8	7.5
Control	30	20.7	1.6	41.7	3.3	1.4	.7	4.2	1.0	5.6	1.5

DISCUSSION

The present study was designed to examine the differences in performance on three attention-related tasks by a group of patients with diagnosis of schizophrenia. The analyses showed these subjects with schizophrenia performed more poorly on the tasks in contrast to normal control subjects. The Chronic vs Acute categories did not differ in scores on the tests, while the Positive vs Negative types showed different scores on attention impairments. These are further evidence for attention deficit in schizophrenia; the vague and unnecessary differentiated the patients as acute and chronic cases. Both points have been well recognized in the literature.

The analysis of patients' performance allows several inferences. A close look at Table 3 and its relevant statistical analysis shows that patients with different subtypes of diagnoses had slower mean reaction time for the Stroop congruent condition than the normal subjects, while they were not different from each other on this task. The Stroop congruent color-word task is rather easy, and it may be regarded as a simple word-reading task. The finding suggests that the patients may have generally lower psychomotor activity than normals. The Stroop incongruent condition requires voluntary effort to direct attention to the requested aspect of the stimuli and to ignore or inhibit the automatic process, i.e., reading the word. The normal control subjects had a mean reaction time approximately twice in the incongruent condition than in the congruent condition. The same pattern of response time was observed for patients with paranoid diagnoses, while the delay for undifferentiated and residual types was approximately three times larger than their reaction times in the congruent condition. This finding suggests that patients

with paranoid diagnoses were remarkably better than those with other subtypes of the disorder in controlling their attention.

Liddle (1994) described volitional impairment in schizophrenia. He defined volition as "voluntary insofar as its performance is not dictated by external circumstances. Voluntary acts are self-initiated and follow a path that is planned by an individual." There is evidence in the literature regarding involvement of the left dorsolateral prefrontal cortex (Frith, Friston, Liddle, & Frackowiak, 1991) and right anterior cingulate cortex (Pardo, Pardo, Janer, & Raichle, 1990) using verbal tasks measuring volitional control. The Pardo, *et al.* work measured cerebral blood flow of subjects performing the Stroop incongruent test, the same task used in the present study. They found right anterior cingulate cortex activation of the cortical area suggested as involved in the surveillance of attention.

The data presented here suggest that the paranoid type may have less impairment on the Stroop incongruent test and hence may have better control over attentional processes than the other types. The well organized and systematic delusions observed in paranoid clinical features may be related to this preserved ability, while the other forms of schizophrenia may show delusion or thought disorder and less organization.

The second major inference from Table 3 is based on patients' scores on the Continuous Performance Test, which measures sustained attention. The task designed for the present study was so easy that the control subjects performed it with 1.4 mean errors, i.e., missing target or a "go" response in a "no go" condition. The three patient groups showed similar performance with respect to errors. Performance on this task (Nuechterlein & Dawson, 1984; Fleming, *et al.*, 1994) did not differ among patient groups, but these scored differently from control subjects. This finding confirms the unity of attention deficit in schizophrenia in terms of sustained attention problems. The other tests may be composites of attentional and other processes.

On the Wisconsin Card Sorting test, a test of ability and flexibility in changing attentional set or shifting attention when a signal is presented, the subject may show two classes of errors. Perseveration errors occur when the subject receives feedback calling attention to a change in the set but the incorrect response belonging to the last set continues. When a subject has learned a particular response to a set, he continues emitting that. This kind of error seems related to deficit in working memory (Baddeley, 1992). The total error score is the summation of perseveration errors and other errors. The present results showed that normal subjects produced 4.2 mean perseveration errors and 5.6 mean total errors. This means that normal subjects incorrectly applied the correct response for the category on the average only 1.25 times, while patients with paranoid type did so about eight times, undifferentiated type about 11 times, and the residual type about 17 times. Such errors seem related to problems of working memory.

Fleming, *et al.* (1994) applied Baddeley's (1986, 1992) working memory theory to explain attention deficit in schizophrenia. The "Central Executive" of the working memory system is responsible for co-ordination of the processing of material in the peripheral systems and has access to long-term memory (Baddeley, Della Salla, Logie, & Spinnler, 1991). According to Fleming, *et al.* (1994), Baddeley's view resembles Norman and Shallice's theory of the supervisory role of bilateral prefrontal cortices (1980, 1986). This system is presumed to be utilized only for specific circumstances, which include (1) conscious deliberation given failure of automatic processing, (2) situations that necessitate planning, (3) tasks judged to be difficult, (4) situations involving either novel or inadequately learned chains of actions, and (5) occasions when potent habitual reaction is implicated and must be inhibited. It seems that the Stroop test may tap Items 1 and 5 specifically and other items in a nonspecific manner. The Wisconsin Card Sorting taps numbers 2 and 3, specifically. The Continuous Performance Test to a lesser extent may tap all five aspects. The review of Fleming, *et al.* (1994) supports involvement of the bilateral prefrontal cortex during Wisconsin Card Sorting and Continuous Performance tasks, while processing the Stroop task may involve the right anterior cingulate cortex (Pardo, *et al.*, 1990).

Schizophrenia may be a spectrum of syndromes that affect the same neural circuitry with different magnitudes, i.e., milder for paranoid and more severe for residual types. Clinical observations also emphasize the increased disorganization of thought and behavior in the same direction.

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