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Card Sort Performance and Syndromes of Schizophrenia

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CARD SORT PERFORMANCE AND SYNDROMES OF SCHIZOPHRENIA

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This thesis is submitted in partial fulfillment of the requirements for the degree of

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ABSTRACT

Researchers continue to investigate the possibility of distinguishing subcategories of schizophrenia based on differing symptom patterns. Andreasen and Crow proposed a two syndrome concept based on the differences found in patients exhibiting either positive or negative symptoms. Positive symptoms refer to active processes such as delusions and hallucinations. Symptoms classified as negative are restricted affect, diminished social drive, and diminished emotion. However, the assignment of some symptoms to either the positive or negative groups remains disputed. In a series of studies designed to support the positive-negative segregation, Liddle found evidence for three rather than two schizophrenic syndromes. Liddle refers to these syndromes as psychomotor poverty, disorganization, and reality distortion. Psychomotor poverty is characterized by symptoms traditionally considered negative. Reality distortion is identified with positive symptoms. The disorganization syndrome consists of symptoms like inappropriate affect, tangentiality, and distractibility, which various investigators have assigned to either the positive or negative symptom groups. The current study sought to corroborate Liddle's finding of three syndromes of schizophrenia. One of the cognitive measures with which Liddle sought to establish the validity of the disorganization syndrome was the Wisconsin Card Sorting Test (WCST). As Liddle predicted, only the disorganization syndrome was associated with poor performance on the WCST. In the past decade researchers interested in schizophrenia have focused considerable attention on the WCST. One line of study has investigated the ability of patients with schizophrenia to learn the WCST. The findings appear to imply that some patients with schizophrenia suffer from an impairment which severely limits their ability to benefit from incentives and explicit coaching on the WCST. The current study examined the relationships among the syndromes of schizophrenia and performance on the WCST both before and after coaching. Fifty inpatients at Eastern State Hospital with a diagnosis of schizophrenia volunteered. As predicted, the symptoms segregated into three syndrome groups similar to those of Liddle's research. Furthermore, only the disorganization syndrome was associated with impaired performance on the WCST. The disorganization syndrome correlated with poor performance both before and after instructions. IQ emerged as a significant variable in the correlations between disorganization and standard, pre-coaching WCST performance. However, in the relationship after coaching, IQ was not a significant factor. These findings support the validity of the disorganization syndrome and provide possible insights into characteristics which distinguish patients who do not benefit from coaching on the WCST.

CARD SORT PERFORMANCE AND SYNDROMES OF SCHIZOPHRENIA

Introduction

Due to the heterogenous nature of patients diagnosed with schizophrenia, clinicians and researchers continue to search for reliable and valid methods of subdividing this diagnosis into more homogenous sub-classifications. Most researchers agree that schizophrenia is quite possibly a group of related disorders that share common features and a relatively poor outcome (Andreasen, 1985). It is possible that these related disorders vary in their manifestations depending on the neurochemical or functional brain system that is affected (Andreasen & Olsen, 1982). Although sometimes said to represent a "unitary position," in Dementia Praecox and Paraphrenia, Kraepelin indicated his belief that the disorder should be divided into subtypes and that the subtypes could reflect different cerebral localizations in areas such as the frontal or temporal lobes (cited in Andreasen, 1982).

Such speculation has strong implications for research and treatment. Andreasen (1985) notes that if schizophrenia is a heterogenous group of disorders and research investigations fail to recognize this fact by pooling together unlike patients, positive results will be lost because they are averaged out in a diverse sample.

With these concerns in mind, several lines of study

have focused on distinguishing subcategories of schizophrenia based on different patterns of long term and phasic symptoms (Andreasen, 1982; Crow, 1980; Lewine, 1985; Liddle, 1987a). Both Andreasen (1985) and Crow (1985) argued that in order to accommodate a body of neurological and biological evidence, a two syndrome concept of schizophrenia should be adopted. Andreasen (1985) and Crow (1985) advocated a two syndrome concept based on the differences found in patients exhibiting either positive or negative symptoms. A positive/negative symptom distinction was first used by Hughlings-Jackson (cited in Green & Walker, 1985), but much of the empirical work in this area is attributed to Andreasen and Crow (Lewine, 1985).

Positive symptoms refer to active processes, characterized by delusions, hallucinations, and a range of bizarre behaviors (Andreasen & Olsen, 1982; Carpenter, Heinrichs, & Wagman, 1988; Crow, 1985). Negative symptoms generally are identified as restricted affect, diminished social drive, anhedonia, and diminished emotion (Crow, 1985; Carpenter et al., 1988; Andreasen & Olsen, 1982). The distinction suggests different clinical and biological correlates.

Andreasen (1985) found significant differences between patients exhibiting positive symptom patterns and those with negative symptom patterns using external validators such as premorbid adjustment, ventricular brain ratios, course in

the hospital, and indices of cognitive dysfunction. Her findings revealed that negative symptoms are correlated with poor premorbid adjustment, increased ventricular to brain ratio, poor response to neuroleptic therapy, a chronic course, and cognitive impairment. Positive symptoms, on the other hand, were correlated with acute onset and a good response antipsychotic medication (Andreasen & Olsen, 1982; Crow, 1985).

Although Andreasen and Crow agreed on the need to delineate subcategories of schizophrenia based on positive and negative symptoms, the assignment of certain symptoms to either the negative or positive groups remains an issue of debate (Liddle, 1987b). For example, Andreasen (1982) included inappropriate affect in the negative group, while Crow (1980) considered it a positive symptom (Liddle, 1987b). Andreasen and Crow both regarded disorders of the form of thought such as derailment and incoherence as positive symptoms, but Lewine, Fogg, and Meltzer (1983) designated these symptoms as negative ones. The frequent occurrence of patients with mixtures of symptom types further confounded attempts to classify schizophrenic patients (Liddle, 1987a).

While the concept of positive and negative symptom patterns has proven useful for research and descriptive purposes, researchers agree on the necessity of further studies which confirm the internal reliability of various

symptom measurements (Andreasen, 1985). Furthermore, the relationship between these symptom patterns and various external validators remains to be unequivocally established.

Liddle (1987b) initially designed a series of studies to support the validity of the positive-negative segregation of symptoms. His findings, however, suggested the possibility of three rather than two schizophrenic syndromes. The conceptualization for Liddle's three syndrome model schizophrenic symptoms resulted from the factor analysis of symptom ratings on forty schizophrenic patients.

Liddle (1987b) began by assessing schizophrenic symptoms using Andreasen's (1984a, 1984b) Scale of the Assessment of Negative Symptoms (SANS) and Scale for the Assessment of Positive Symptoms (SAPS). Factor analysis and subsequent analysis of correlations between symptoms provided only partial support for the positive-negative dichotomy. As stated above, the symptoms segregated into three syndromes instead of two. Liddle designated these: the psychomotor poverty syndrome; the disorganization syndrome; and the reality distortion syndrome.

The major difference between Liddle's (1987b) findings and those of other investigations using positive and negative symptom ratings was the identification of the disorganization syndrome. The disorganization syndrome described by Liddle consists of symptoms which other

investigators have variously assigned to either the positive or negative symptom groups. Symptoms of the disorganization syndrome are inappropriate affect, poverty of content of speech, tangentiality, derailment, pressured speech and distractibility.

The psychomotor poverty syndrome is characterized by symptoms traditionally considered negative symptoms. These symptoms are poverty of speech, decreased spontaneous movement, unchanging facial expression, paucity of expressive gesture, affective non-responsivity, and a lack of vocal inflections (Liddle, 1987b). The reality distortion syndrome is marked by the traditionally "positive" symptoms of hallucinations and delusions.

The component symptoms of these syndromes resemble the features of three classical types of psychotic illness, hebephrenia, catatonia, and deteriorating paranoid disorders (Liddle, 1993). Interestingly, it was these three types of illness that early in the century Kraepelin combined into a single entity which we now call schizophrenia (cited in Liddle, 1993).

Liddle and Barnes (1990) later replicated the finding of three syndromes of schizophrenia in a second sample of subjects. In the replication study, symptoms were assessed using the SANS and the Manchester scale. The Manchester scale was used in place of the SAPS for rating delusions, hallucinations and incoherence of speech because it is more

suitable for use with patient who cannot tolerate a long interview.

Liddle and Barnes (1990) asserted that these syndromes do not reflect separate illnesses. They hypothesized that the syndromes represent three distinguishable components of the schizophrenic process. Liddle (1987a) suggested that the heterogeneity of schizophrenia arises not from the existence of several discrete illnesses but instead from the occurrence of these distinct but overlapping pathological processes, or syndromes. The syndromes, he continues, are linked by a fundamental abnormality essential to schizophrenia. The relative contributions to the overall illness from the various syndromes will differ between patients, depending upon factors such as constitution or environmental influences. While each syndrome produces a characteristic group of symptoms, the overall symptom profile of each individual patient reflects the relative contribution of the three syndromes (Liddle, 1987a; Liddle & Barnes, 1990).

Liddle and his associates speculated that the psychomotor poverty, disorganization and reality distortion syndromes reflect cerebral dysfunction at different sites (Liddle, Barnes, Morris, & Hague, 1989). They noted the similarity of these syndromes to the syndromes resulting from brain injury. The symptoms of psychomotor poverty (flat affect, apathy, and decreased conversation) parallel

the symptoms experienced with dorsal prefrontal brain damage. Likewise, the disorganization syndrome shares common symptoms (shallow, silly affect, and garrulous speech) with the effects of damage to the orbital prefrontal area. Finally, the symptoms of reality distortion (hallucinations and delusions) mimic the symptoms of temporal lobe epilepsy.

After identifying the three syndromes, Liddle and his colleagues proceeded to establish their validity with measures of cognitive performance, cortical neurological signs, and patterns of cerebral blood flow. (Liddle, 1987a; Liddle et al., 1989; Liddle & Morris, 1991; Liddle et al., 1992). Liddle (1987a) began by examining the relationship between the syndromes, cognitive functioning and cortical neurological signs. The findings revealed that the syndromes were associated with distinctive patterns of cognitive performance as measured by neuropsychological tests. Psychomotor poverty syndrome was correlated with poor performance on tests of long-term memory, object naming, and conceptual thinking. The disorganization syndrome was associated with poor performance in tests of concentration, orientation, immediate recall and word learning. Both of these syndromes were correlated with cortical neurological signs. Specific impairments were evident in the processing of sensory information and poor motor coordination. The reality distortion syndrome showed

little evidence of correlation with cognitive or neurological dysfunction. This study strengthened Liddle's supposition that the syndromes are distinct syndromes and that they reflect pathological processes involving dysfunction at different cerebral cites.

In a 1992 study, Liddle et al. examined the relationship between the three symptom profiles and patterns of cerebral blood flow using positron emission tomography. The authors predicted that patient's symptoms would segregate into three syndromes and that the syndromes would be associated with differing patterns of cerebral blood flow. As predicted, the psychomotor poverty and disorganization syndromes were associated with altered perfusions at different loci in the pre-frontal cortex, and reality distortion was associated with altered perfusions in the medial temporal lobe. This evidence supports the authors primary hypothesis that the three syndromes are generated by distinguishable pathological processes. They note however, that the extensive patterns of abnormal blood flow in the limbic and association cortex as well as the related subcortical nuclei in each of the syndromes indicates that the abnormalities underlying schizophrenic symptoms are not confined to a single loci. Instead, the authors contend, they involve distributed neuronal networks for which an anatomical basis is discernible.

In order to test the hypothesis that both psychomotor

poverty and disorganization would be associated with impaired performance on neuropsychological tests which are sensitive to frontal lobe function, Liddle and Morris (1991) designed a study using tests sensitive to frontal lobe impairment. As predicted, poor performance was correlated with severity of psychomotor poverty and disorganization but not with reality distortion. Although both the psychomotor poverty and disorganization syndromes were associated with impaired performance on the neuropsychological tests, the patterns of impairment performance were different. Psychomotor poverty was associated with slowness of mental activity, including slowness in generating words. The disorganization syndrome showed impairment in tests in which one is required to inhibit an established but inappropriate response. The findings are further evidence that psychomotor poverty and disorganization are linked with different, distinguishable patterns of impaired performance in functions considered characteristic of the pre-frontal cortex.

Due to the strong reciprocal connections of the pre-frontal cortex with other areas of the association cortex, Liddle and Morris (1991) note that these findings do not indicate that the primary abnormality of schizophrenia lies in the pre-frontal cortex. Instead the results indicate that some of the symptoms of schizophrenia are associated with neuropsychological impairments of the type seen in

patients with frontal lobe damage. Other symptoms appear to be unrelated to these impairments.

However, caution is warranted in interpreting these results. Liddle and Morris (1991) acknowledge that the localizing value of neuropsychological tests is limited by the complexity of inter-relations between different parts of the brain. A possible alternative explanation for the above results is that the relationships between syndromes and impairment in frontal lobe tests is due to the relationship between the syndromes and a generalized cognitive deficit (Liddle & Morris, 1991). Liddle and Morris discount this explanation, however, due the significance of partial correlations that allowed for the influence of variation in performance on the graded naming test (an approximate measure of overall intelligence).

Another viable explanation for the findings is that chronicity is a major determinant of neuropsychological impairment in schizophrenia. In this case a tendency for either psychomotor poverty or disorganization to be associated with a longer duration of illness might account for the findings. Duration of illness was associated with impaired performance on some of the neuropsychological tests, but partial correlations between the syndrome scores and neuropsychological tests revealed that all of statistically significant correlations remained significant after partialling out the effect of duration of illness.

Liddle and Morris (1991) conclude that increased chronicity is associated with neuropsychological impairment, but this accounts for only a minor component of the relationship between syndromes and patterns of neuropsychological impairment.

A recent work by Van der Does, Dingemans, Linszen, Nugter and Scholte (1993) replicated Liddle's (1987b) findings of a three-dimensional structure of symptoms. Van der Does et al. (1993) point out that the value of their work lies in the fact that their patient population was young with recent-onset schizophrenia. The previous work by Liddle and his colleagues had been with chronic samples. An additional finding by Van der Does et al. (1993) was that only disorganization and not negative symptoms was associated with the neuropsychological test administered in the study. This research provides further evidence of the validity of disorganization as a distinct symptom dimension.

A modified version of the Wisconsin Card Sorting Test (WCST) was among the tests administered by Liddle and his colleagues (Liddle et al., 1989; Liddle & Morris, 1991). Van der Does et al. (1993) used the same modified version of the WCST. In both sets of work only the disorganization syndrome was associated with impaired performance on the WCST. Liddle and his colleagues reported that the disorganization syndrome was significantly correlated with percent of perseverative errors on the WCST (Liddle et al.,

1989; Liddle & Morris, 1991). Among the patients in their younger, less chronic sample Van der Does et al. (1993) found that disorganization was associated with total errors, percent of perseverative errors, and non-perseverative errors.

The WCST was originally designed to evaluate abstract thinking ability in normals, but has gained increasing acceptance as a clinical neuropsychological measure (Heaton, 1981). The test has shown specific sensitivity to impairment in the frontal lobe region of the brain. Because of the numerous hypotheses surrounding the role of the frontal lobe dysfunction in schizophrenia, the WCST has attracted considerable attention from schizophrenia researchers. Early research indicated that schizophrenic patients tend to perform poorly on the WCST (Fey, 1952). A later study found that metabolic activity in the dorsolateral prefrontal region increased in normal subjects but not in schizophrenic patients while performing the WCST (Weinberger, Berman, & Zec, 1986). Furthermore, better performance correlated with increased blood flow in the frontal cortex in the patient sample. These findings support the hypothesis that prefrontal malfunction impaired the performance of schizophrenic patients on the WCST.

In the past decade researchers have focused on several issues concerning schizophrenic patients' poor performance on the WCST. One question centers on whether or not

schizophrenic patients can learn the WCST and remediate possible cognitive deficits through the use of intensive teaching. A second concern focuses on the role of motivational factors in schizophrenic's abilities on the WCST. Researchers question whether or not the deficits in performance can be attributed simply to motivational factors.

Goldberg, Weinberger, Berman, Pliskin, and Podd (1987) were the first to investigate the possibility that schizophrenics might "learn" the WCST through the use of detailed information and card-by-card instructions. Goldberg et al. found that even after trials which included card-by card instructions, patients returned to pre-instruction levels of functioning on subsequent trials. Goldberg and his colleagues observed that "the hallmark of patients' behavior was a failure to use feedback to alter response."

These results appeared to suggest that schizophrenic subjects have a deficit on the WCST which is not remediable (Green, Satz, Ganzell, & Vaclav, 1992). Goldberg et al. (1987) noted, however, that motivational factors could not be ruled out as a possible explanation for their results. The second interpretation is especially compelling as frontal lobe syndromes are also characterized by motivational deficits (Summerfelt, Alphs, Funderburk, Strauss, & Wagman, 1991).

Bellack, Mueser, Morrison, Tierney, and Podell (1990) initially hypothesized that schizophrenic patients' poor performance was the result of inattention or lack of effort, rather than inability to master the task. They predicted that performance would be enhanced by providing incentives. The researchers gave positive reinforcement (a nickel) contingent on correct responses to one group and noncontingent reinforcement (also a nickel) to a second group. Neither procedure had an effect on performance. These results suggest that poor performance was not a simple result of lack of interest or motivation.

In a second cohort, Bellack et al. (1990) provided a training phase in addition to the monetary incentives. The results for this cohort were significantly different than those of the first cohort. The instructions resulted in performance similar to that of normals. More surprising, the improvements were sustained in subsequent trials.

Bellack and his associates (1990) offer several explanations for the discrepancy between their results and those of Goldberg et al (1987). They note that the subjects in the Goldberg et al. study were selected with the expectation that they would perform poorly on the WCST. In other words, the sample in the Goldberg et al. study were more impaired. A second explanation is that while some subgroups may have frontal lobe dysfunction, this is not a universal occurrence or that some patients can compensate

for such an impairment (Bellack et al., 1990). If the second explanation is supported, then further research is needed to identify which subtypes of patients have impairments that cannot be remediated and which patients can benefit from incentives and training.

One study did find improvement utilizing only incentives without instructions in a sample of 14 subjects (Summerfelt et al., 1991). In this study subjects were offered an initial sum of $7.50. With each correct response the subjects were given a dime. Each incorrect response cost a nickel. This design allowed subjects to earn substantially more than in other studies, and performance did improve.

In reply to the study by Summerfelt et al. (1991), Goldberg and Weinberger (1991) point out that although performance improved, scores remained in the impaired range. In addition, only the number of perseverative errors improved, not the number of completed categories. These two scores are usually strongly negatively correlated. Goldberg and Weinberger (1991) propose that perhaps subjects did not learn the essence of the test (to abstract concepts and switch sets). Instead, they may have learned not to make the same wrong response consecutively.

Green, Ganzell, Satz, and Vaclav (1990) conducted a preliminary study in which they replicated the Goldberg et al. (1987) design with the addition of 2-cent incentives for

correct responses. Results indicated two levels of post-instruction performance among schizophrenic patients: learners and non-learners. Green and his associates later confirmed an overall improved performance with a larger sample (Green et al., 1992). Green et al. (1992) point out that although comparison is difficult, their sample is probably closer to the chronically ill group studied by Goldberg et al. (1987) than to the acute patients of Bellack et al. (1990).

Together these findings imply that some schizophrenic patients may suffer from an underlying neuropsychological impairment which severely limits their ability to benefit from incentives and explicit coaching on the WCST. Other patients, however, evidenced a performance deficit on the WCST that appears remediable through the use of incentives and coaching. Several groups of researchers have raised questions about possible observable and categorical differences which can distinguish and predict those who benefit from incentives and coaching and those who do not (Bellack et al., 1990; Green et al., 1990; Green et al., 1992; Van der Does & Van den Bosch, 1992).

One important observation is that not all schizophrenic patients have difficulty with the test (Van der Does & Van den Bosch, 1992). Braff et al. (1991) reported results of relatively intact WCST functioning in a majority of forty neuroleptic-treated outpatients with chronic schizophrenia.

They compared the performance of schizophrenic subjects to a control group of non-patients on an extensive battery of neuropsychological tests which included a full WAIS-R, an expanded Halstead-Reitan, and the WCST (Braff et al., 1991). The pattern of deficits in this patient population was generalized and included poor performance on conceptual skills, psychomotor problem solving, and incidental memory. Interestingly, the WCST score of the patients was within the average range. In fact, the WAIS-R verbal IQ was slightly better at discriminating control from schizophrenic subjects in this study. Nonetheless, the authors emphasize that 14 of the 40 of the subjects with schizophrenia did have abnormal scores on the WCST. Braff et al. (1991) plan further studies to examine the characteristics of this subgroup.

Almost 18% of the sample used by Bellack et al. (1990) performed within a normal range without instruction. In an article reviewing the research on the WCST and schizophrenia, Van der Does and Van den Bosch (1992) suggest that future research should address the issue of which measures of symptomatology and chronicity could be used to differentiate normal from poor performing patients and learners from nonlearners.

Of course, the interest is not the WCST in and of itself (Bellack, Mueser, Tierney, & Podell, 1991). The significant question is the nature and plasticity of any

underlying structural or functional impairment. When extended to rehabilitation efforts, the above results suggest the importance of combining motivational with specific instructions for training and problem solving. It is assumed, though not proven, that successful learning on the WCST would be associated with success in skills training procedures (Green et al., 1992). If this is determined to be the case, initial screening of problem-solving capacity may provide empirical support in targeting the patients most likely to benefit form social and behavioral rehabilitation programs.

The present study continues to examine the relationship between performance on the WCST and the three syndromes of schizophrenia proposed by Liddle (1987b). The author predicts that symptom ratings as assessed by Andreasen's SANS and SAPS will yield three factors similar to those found by Liddle and his colleagues (Liddle, 1987b; Liddle & Barnes, 1990). Previously, Liddle and his associates and Van der Does et al. (1993) found a significant correlation between the disorganization syndrome and poor performance on the WCST (Liddle et al., 1989; Liddle & Morris, 1991). The current author will explore the hypothesis that the disorganization syndrome will be the only syndrome associated with poor performance on an abbreviated version of the WCST administered in standard format. Furthermore, the disorganization syndrome will continue to be correlated

with poor performance on a "post-instruction trial," in spite of monetary incentives and a previous trial with detailed instructions. This would strengthen the supposition that the disorganization syndrome is a separate construct. Also confirmation of this hypothesis will add to the body of evidence that the disorganization syndrome reflects an underlying neurological impairment similar to that observed in patients with frontal lobe damage. Neither the psychomotor poverty nor the reality distortion syndromes are predicted to be associated with poor performance on the Wisconsin Card Sorting Test.

METHOD

Subjects

Fifty inpatients patients from Eastern State Hospital in Williamsburg, Virginia participated as subjects. Subjects were selected, according to the following criteria, from the Continuing Rehabilitation, Intermediate Intensive Care and Community Preparation programs. To participate, (1) patients had to be currently diagnosed with schizophrenia according to the DSM-III-R criteria, and (2) patients with a dual diagnosis of mental retardation or substance abuse were excluded. Care was taken to avoid patients who had experienced medication changes or an acute psychotic episode in the past two weeks. No patients with a history of traumatic brain injury or diagnosed neurological conditions were included in the study.

The subjects included 34 males and 16 females who ranged in age form 25 to 64 years (M = 39.92); had a mean education level of 11.46 years; and a mean estimated intelligence quotient (IQ) of 77.46. IQ estimates were obtained from the Vocabulary and Picture Completion subtests of the Wechsler Adult Intelligence Scale-Revised (WAIS-R). Demographic information on the 50 subjects is presented in Table 1. All psychotropic medication was converted to Thorazine equivalents using the conversion tables of Mason

and Granacher (1980).

Table 1

Demographic Information (N = 50)

	Min	Max	Mean
Age	25.0	64.0	39.9
Education (yrs)	6.0	16.0	11.5
Hospitalization (current/yrs)	0.5	17.0	5.5
IQ	45.0	120.0	77.5
Meds (mg/day Thorazine)	0.0	3167.0	847.8

Materials

Following Liddle's (1987b) original procedure, symptom ratings for the Reality Distortion, Psychomotor Poverty, and Disorganization syndromes were obtained from Andreasen's (1984a, 1984b) SANS and SAPS (see Appendix A). These scales have proven to be reliable in assessing symptoms. Andreasen recorded inter-rater reliability scores from individual items of the SANS in the range of .696 to .926 (Andreasen, 1982). The reported mean reliability was .76 ($p<.001$). An informal interview provided most of the information necessary for the SANS and the SAPS. Although Andreasen (1982, 1984a, 1984b) provides guidelines for the interview,

she also recommends using patients' charts and the opinions of nurses and clinicians familiar with the patients. These additional sources of information were used to complete ratings, in accordance with Andreasen's recommendations.

Subjects performed three abbreviated administrations of the WCST (see Appendix B). The WCST consists of four stimulus cards and two decks of sixty-four response cards. Both the stimulus and response cards are numbered to a certain order so that in order, no two successive response cards have the same color, form or number. In a standard administration, subjects are given one deck of cards and told to match the cards, starting at the top, to one of the four stimulus cards before them. The test continues until the subject completes six categories or until both decks are used.

Instead of six sets of matches or two decks of cards, an abbreviated trial consisted of three sets of matches or one deck of cards. Most of the research with schizophrenic patients and the WCST has employed a modified version of the WCST. A common modification is the Stuss and Benson modification (Goldman, Axelrod & Tompkins, 1992). The current study used a modification similar to that of Stuss and Benson (1983). The findings of Goldman, Axelrod, Tandon and Berent (1991) demonstrated compatibility between the standard (128-card) and abbreviated (64-card) versions of the WCST.

Although several different scores can be derived from the WCST, the measure of traditional focus in schizophrenia research has been the percentage of perseverative errors (Summerfelt et al., 1991). These errors are also found at high levels in patients with structural frontal lobe damage. Van der Does and Van den Bosch (1992), however, warn that studies in the past may have focused too much on perseverative error scores. The current study will report the percent of perseverative errors, the percent of correct responses and the number of categories completed. The number of categories, perseverative errors and correct response rates were derived according to the scoring instructions outlined by Heaton (1981).

Correct responses are simply any response that is correct for the rule in place at that time (Heaton, 1981). A perseverative response is defined as one that would have been correct on the previous stage. For example, if a subject has responded correctly to color 10 consecutive times, and goes on responding to color, the color responses beyond the criterion of 10 would be perseverative responses. The first exception to this definition of perseveration is that a subject can make a perseverative response before completing the first category. Once a subject has made the first incorrect unambiguous response (a response that matches the stimulus card on only one dimension), that sorting principle will be the perseverative principle in the

first stage. It is also possible for the "perseverated-to" principle to change within a single stage of the test if the patient makes three unambiguous incorrect matches in succession according to another principle.

Heaton (1981) points out that not all perseverative responses are errors. For example, an ambiguous response can match both the correct rule and the "perseverated-to" principle. In this case, the response is scored as a correct response, as well as a perseverative response. Perseverative errors are responses that match only the "perseverated-to" principle.

The Picture Completion and Vocabulary sections of the Wechsler Adult Intelligence Scale-Revised (WAIS-R)(Wechsler, 1981) were administered to each subject to provide an estimated IQ. It was anticipated that some subjects would experience frustration from their inability to perform the WCST. These subtests of the WAIS-R were selected because they are easy to administer and can be completed in a few minutes. In this way the author attempted to keep subjects' frustration at a minimum. Procedure and scoring followed the directions of Wechsler (1981). Scores were prorated to arrive at an overall IQ estimate. Vocabulary is the subtest most strongly correlated with a Full Scale IQ score. Wechsler reports a correlation coefficient of .85 between the Vocabulary and Full Scale IQ. The correlation coefficient for Picture Completion and Full Scale IQ is .73.

Five patients had a Full-Scale IQ score in their chart. In these cases the estimates were all within 10 points of the actual IQ.

Procedure

Patients who met the designated criteria were asked to participate. The experimenter outlined the procedure and the expected time allowance of a maximum two hours. The interview and IQ testing took place in one hour-long session. The WCST was administered in a second, approximately hour-long session. The two sessions were conducted within a week of one another. To control for sequence effects, half of the subjects started with an interview session, the other half with the WCST. All subjects began by reading and signing a consent form.

In an attempt to control for experimenter bias, a Masters level student, who was blind to the purpose of the study, conducted half of the testing sessions. The author was neither present during these sessions, nor was she aware of subjects performance until after the symptom ratings were made.

Each interview session followed the general outline provided by Andreasen (1984a, 1984b). Ratings were made immediately after the interview based on the interview data and additional information obtained from the subject's chart or care-givers. Rater reliability for the SANS, and the SAPS were determined by the independent ratings of another

graduate student who was present at 26 initial interviews. Both raters reviewed the subjects' social history and recent clinical notes. A second interview was scheduled at least three months following the initial interview to determine the temporal reliability of the scales. This interview followed the same general format as the initial interview.

The Vocabulary and Picture Completion subtests of the WAIS-R were administered during the interview session. These subtests were included in the interview session in an attempt to avoid tiring or frustrating subjects excessively during the card sorting session.

Demographic and historical data were collected from each patient's records. The information included possible confounding variables such as: age, sex, education, IQ score, length of current hospitalization, and current medication.

Participants performed three abbreviated trials of the Wisconsin Card Sorting Test. During all three trials, 2 cent incentives were given immediately following correct responses. Additionally, all patients were paid a noncontingent 50 cents, or the option of the equivalent in cigarettes, at the end of their participation.

The first trial was conducted in the standard format outlined in Appendix B. The second trial was considered the "learning" or "training" condition. At the beginning of this trial, subjects were told about the nature of the three

categories and the occurrence of shifts in the matching procedure. "There are three possible rules to match the cards. You can sort them by color, shape, or number. Only one rule is correct at any given time, and it will stay the same for a while. After you get several correct in a row, the correct rule to match will change without warning. You have to determine which is the new correct rule." Additionally, subjects received card by card instructions. They were be told which category was correct for each card and why. "Right, you should be matching to color now, and they are both the same color. You must ignore the number of things and shape of things." With an incorrect response subjects will be told, "Wrong, remember you have to match by color (demonstrate) and ignore shape and number." The third, "post instruction" trial was in the standard format of the first trial.

Results

Symptom Measures

Information from the interview and chart was applied to scoring the SAPS and SANS. The inter-rater reliability of the SANS and the SAPS were determined using Pearson Correlations. The more conservative kappa scores were calculated for comparison purposes (Cohen, 1960). The correlation coefficients are based on the independent ratings of 26 subjects. The correlation values for items ranged from a minimum of .37 on poor eye contact to a .97 on clanging (see appendix C). The mean inter-rater reliability for the two sets of concurrent ratings was .73.

The temporal reliability of ratings was assessed by another rater at least 3 months after the initial interview. The correlations of these ratings with the author's ratings ranged from -.32 to .80. The mean was .43.

The symptom items were subjected to factor analysis using the program FACTOR from SPSS. In order to avoid making assumptions about the relationships between symptoms, both single item scores and global scores were employed as the units of analysis. Because the occurrence of several of the rated items were quite rare in this sample, only the items rated as definitely present in more than 10% of the sample were included in the factor analysis. The items

excluded were: voices conversing; somatic or tactile hallucinations; olfactory hallucinations; delusions of jealousy; delusions of sin or guilt; delusions of mind reading; thought broadcasting; thought insertion; thought withdrawal; repetitive behavior; and incoherence. Liddle (1987b) also excluded the items not found in at least 10% of his sample.

In addition, Liddle (1987b) argued that several of the SANS items are measures of performance in daily life rather than symptoms. He did not include the items assessing self-care, occupation, and social functioning in his factor analysis. The current study included these items in the analysis as most researchers agree that these items can be regarded as symptoms.

In all 47 symptom items were included in the factor analysis. The factor analysis of SAPS and SANS items yielded three factors which accounted for 44.7% of the overall variance. Of the 47 symptom items, 39 had a high loading on only one of the three factors. The factor loadings and variance accounted for by each factor are presented in Tables 2, 3, and 4. The composition of each factor is similar to those identified by Liddle and his associates (Liddle, 1987a; Liddle & Barnes, 1990).

Because of the small sample size relative to the number of items included in the factor analysis, this analysis must be considered exploratory in nature. However, the fact that

the three resulting factors are extremely similar to those found by Liddle (1987b) supports the assumption that these are valid dimensions of symptoms measured on the SANS and SAPS.

Table 2

Factor Loadings on Factor 1 (N = 50)

Symptom	Psychomotor Poverty factor 1
Unchanging Facial Expression	.76
Decreased Spontaneous Movement	.73
Paucity of Expressive Gestures	.81
Poor Eye Contact	.56
Affective Nonresponsivity	.75
Lack of Vocal Inflections	.73
Poverty of Speech	.77
Latency of Response	.62
Affective Flattening	.78
Alogia	.71
Relations with Friends/Peers	.70
Anhedonia	.68
Recreational Activities	.66
Thought Blocking	.61
Avolition/Apathy	.49
Intimacy and Closeness	.46
% of variance	19.60

Table 3

Factor Loadings on Factor 2 (N = 50)

Symptom	Disorganization Syndrome factor 2
Thought Disorder	.83
Attention	.78
Social and Sexual Behavior	.53
Loose Associations	.80
Social Inattentiveness	.72
Inattentiveness in Mental Status	.66
Impersistance at Work/School	.53
Tangentiality	.77
Illogicality	.61
Pressured Speech	.53
Distractible Speech	.76
Inappropriate Affect	.45
Poverty of Content of Speech	.45
Clanging	.41
% of variance 15.90	

Table 4

Factor Loadings on Factor 3 (N = 50)

Symptom	Reality Distortion factor 3
Delusions	.81
Hallucinations	.61
Auditory Hallucinations	.62
Visual Hallucinations	.44
Voices Commenting	.48
Delusions of Control	.57
Persecutory Delusions	.60
Grandiose Delusions	.70
Somatic Delusions	.64
% of variance 9.20	

As anticipated the syndromes were not significantly correlated. The correlation between Psychomotor Poverty syndrome and Reality Distortion was r = .04, p = .76, and psychomotor poverty with Disorganization was r = .10, p = .50. The correlation between Reality Distortion and Disorganization was r = .17, p = .14. The syndrome scores for this and all future correlations in the study were created from the sum of all variables loading on that factor.

Disorganization was the only syndrome significantly correlated with any of the demographic variables measured: age; education; length of current hospitalization; IQ; and medication level. Scores for the Disorganization Syndrome were positively correlated with length of current hospitalization (r = .37, p = .01) and negatively correlated with IQ (r = -.45, p = .001). None of the syndromes were significantly associated with age, education, or medication level.

Several of the demographic variables were intercorrelated in this sample. Age was significantly correlated with length of current hospitalization (r = .37, p = .01). Education was negatively correlated (r = -.40, p = .01) with length of current hospitalization and was positively correlated with IQ (r = .38, p = .01).

Wisconsin Card Sorting Test Performance

The pre-instruction and post-instruction trials, trials

one and three, of the WCST were scored. Each subject received the following scores for both the pre- and post-instruction trials: percentage correct; percentage of perseverative errors; and number of completed categories score. Error rates from the "learning trial" (trial two) are not included as subjects were given step by step instructions throughout the trial. Errors were corrected and explained during the instructional trial. T-tests revealed no differences in the scores of tests administered by the author and those administered by an assistant blind to the purpose of the study.

Scores from the second, " post-learning," trial were compared with the scores from the first trial using paired samples T-tests to determine the degree to which patients improved their WCST performance. All three sets of scores, percent correct, percent of perseverative errors, and number of complete categories, showed a significant difference between pre- and post-instruction trials ($p < .001$). T values for the percentage correct, perseverative errors and categories completed are as follows: percentage correct - 5.26; percent of perseverative errors 4.58; and categories achieved -4.19. The means are presented in Table 5. Overall, the three measures of performance indicated significant improvement between the pre- and post-instruction trials.

Table 5

Mean Scores on the Wisconsin Card Sorting Test (N = 50)

	Pre-Instruction	Post-Instruction
Percent Correct	41.90	58.24
Percent Perseverative Errors	42.94	26.74
Completed Categories	.78	1.48

The means indicate significant improvement as a result of prompting and instruction. However, when compared to normals, the overall WCST performance by all subjects was impaired on both pre- and post-instruction trials. However, the pre-instruction means are similar to those found by Green et al. (1992). In their baseline condition Green and his associates reported an average of 27.2 correct (43%), a mean of 25.1 perseverative errors (39%), and a mean of .80 categories completed. Green et al. note that 54% of their sample could not attain a single category in the first trial. Green et al. report significant improvement after instructions and incentives. They do not give the exact means after instructions, but their graph indicates a level of performance similar to that in the present study on

In the present study only 4 individuals (8% of the sample) completed all three categories on the first trial. This number increased to 17 (34% of the sample) after coaching. In a standard administration, a completed categories score of six was achieved by 76% of normals and 27.8% of patients with known focal frontal damage (Heaton, 1981). Twenty-six individuals (52% of the sample) did not attain a single category on the first trial; sixteen subjects (32% of the sample) did not attain a category after incentives and explicit instructions.

The percentage correct on the first trial ranged from 23% to 90%. Although 22% of the sample obtained 25% or fewer correct, the remaining 78% of the sample were fairly evenly distributed in the range of percentage correct. After the instruction trial, the percentage correct ranged from 21% to 94%. In this trial, 12% of the sample had 25% or fewer correct.

The percentage of perseverative errors ranged from 5% to 73% on the first trial and from 3% to 72% on the second trial. In a sample of normals with less than 12 years of education, the mean percentage of perseverative errors in the standard format was 15.1%. As noted in Table 3, the mean percent of perseverative errors in the current study was 42.94% in the pre-instruction trial. The mean percentage of perseverative errors remained at 26.74% even after explicit instructions. On the first trial the

frequencies were fairly evenly distributed across the range, but 22% achieved 70% or more in their perseverative error score. Before the instructions, 20% of the sample achieved fewer than 16% perseverative errors. Some individuals, however, had high error score with low perseverative error scores. These individuals matched the cards in a random pattern which was neither correct nor perseverative. For example, a subject might match a few cards to number, a few to shape, one to color and then to number again.

Heaton (1981) adopted a criterion score of above 16 perseverative errors on a standard administration as indicative of focal frontal involvement. On an abbreviated trial, this number could be prorated to 8. In this sample, more than 84% of this sample had an excess of 8 perseverative errors on the pre-instruction trial. Sixty percent maintained a perseverative error score above 8 on the post-instruction trial.

Pearson correlation coefficients revealed a significant relationship between all of the WCST scores and IQ. None of the other demographic variables were significantly correlated with performance on any dimensions of the WCST. Table 6 gives the correlation coefficients between IQ and the WCST scores.

Table 6

Pearson Correlations of IQ and WCST Scores (N = 50)

WCST Score	IQ
% Correct, Trial 1	.48**
% Correct, Trial 2	.53**
% Perseverative Errors, Trial 1	-.33*
% Perseverative Errors, Trial 2	-.36*
Categories Achieved, Trial 1	.46**
Categories Achieved, Trial 2	.55**

* P<.01 ** p<.001

In a normative study with both normal and brain damaged subjects, Heaton (1981) found moderate to strong correlations between IQ and various WCST scores. Interestingly, the correlations were stronger for the brain injured subjects than for the normal subjects. Heaton did not report percentage correct scores, but Table 7 gives the correlations found by Heaton for IQ, the categories achieved and the percentage of perseverative errors.

Table 7

Correlations Between Key WCST Measures and IQ for Normal and Brain Damaged Patients (Heaton, 1981)

(Brain Damaged N = 208, Normal N = 150)

	Full Scale IQ	
WCST Measure	Brain Damaged	Normal
% Perseverative Errors	-.44	-.30
Categories Achieved	.41	.22

Symptom Patterns and WCST Performance

Since many subjects exhibited evidence of more than one of the three syndromes, correlations were obtained between syndrome rating and WCST scores. The author used Pearson correlations to examine these relationships. Correlations between syndrome scores and WCST measures are presented in Table 8.

The correlations revealed significant relationships between the Disorganization Syndrome and several of the WCST measures. The Disorganization Syndrome was the only syndrome associated with the WCST measures, and it was associated with all WCST values except the perseverative error score on the second trial.

Table 8

Pearson Correlations Between Syndrome Scores and WCST Measures (N = 50)

	Syndromes		
WCST Measures	Psychomotor Poverty	Disorganisation	Reality Distortion
% Correct (1)	-.24	-.36**	.08
% Correct (2)	-.22	-.35*	.12
% Persev. Errors (1)	.21	.29*	.04
% Persev. Errors (2)	.13	.19	-.11
Categories (1)	-.26	-.33*	.11
Categories (2)	-.23	-.38**	.22

*p<.05 **p<.01

Partial correlations, which partialled out the effects of IQ, revealed that IQ was an important moderating variable in several of these relationships. When the effect of IQ was taken into account, the relationship between the Disorganization Syndrome and percent correct on the first trial approached significance (r = -.21, p = .08). The relationship with perseverative errors on the first trial also approached significance (r = .22, p = .07).

Interestingly, the relationships which remained significant were between disorganization and the post-instruction measures of percentage correct (r = -.29, p = .03) and categories completed (r = -.32, p = .02).

Discussion

The factor analysis of schizophrenic positive and negative symptom ratings in this study confirmed the three syndrome model proposed by Liddle and his associates (Liddle, 1987b; Liddle & Barnes, 1990). As described by Liddle, the psychomotor poverty syndrome is composed of six symptoms: poverty of speech; decreased spontaneous movement; unchanging facial expression; paucity of expressive gestures; affective non-response; and lack of vocal inflections. All of the above items had high loadings on this first factor. Additional negative symptoms loading on the first fact in this study were poor eye contact, affective flattening, alogia, thought blocking and latency of response. Several of the SANS items measuring self-care and social function also loaded on the first factor. Lack of relationships with friends and peers, anhedonia, lack of recreational interests and activities, lack of ability to feel intimacy and closeness, and avolition also loaded on this factor. In Liddle's (1987b) work recreational interests and relationships with friends and peers correlated with psychomotor poverty.

The second factor, the Disorganization Syndrome, included the six items reported by Liddle and three items not included in Liddle's model (Liddle, 1987b; Liddle &

Barnes, 1990). These three item are: bizarre social and sexual behavior; illogicality; and clanging. Illogicality and clanging are symptoms included in the Formal thought Disorder section of Andreasen's (1984b) scale. Stuss and Benson (1983) list sexual disinhibition and inappropriate social behavior as symptoms typical of patients with brain injury exhibiting pseudopsychopathy. Though not included in his factor analysis, impersistance at work and school and social inattentiveness also correlated with Liddle's (1987b) disorganization. These two items plus inattentiveness during Mental Status Exam and an overall measure of attention loaded on the second factor in the current study.

The third factor consisted of the following symptoms: auditory hallucinations; voices commenting; persecutory delusions; grandiose delusions; somatic delusions; visual hallucinations; and delusions of control. These results differ only slightly from the Reality Distortion Syndrome proposed by Liddle (Liddle, 1987b; Liddle & Barnes, 1990). Liddle's Reality Distortion Syndrome included delusions of reference but not grandiose delusions, delusions of control or visual hallucinations.

These factors accounted for 44.7% of the variance in the current sample. This compares with 64.2% in Liddle's sample. It appears, then, that Liddle's (1987b) model of three syndromes of schizophrenia is a useful, descriptive system for delineating relatively homogenous groups of

symptoms found in schizophrenia.

Furthermore, results indicate that rating scale items can be reliably assessed by two experienced raters. The mean reliability correlation for concurrent ratings was .73. Andreasen (1982) reports a mean reliability of .76 from correlations on the SANS. Due to low temporal reliability ratings, few conclusions can be made at this time about the stability of these syndromes over time. There are several explanations, however, for the low temporal reliability in this study. During the intervening months between the first and second interviews, five of the patients included in the second set of interviews began Clozaril therapy. Another patient had been refusing all medication for the two weeks prior to re-rating. Finally, the follow-up rater was not familiar with the patients in this study. Both of the first two raters had previous or constant contact on the unit with a majority of the subjects in the study. In all probability, the more familiar the rater is with the subject, the broader the context used, and the more accurately the symptoms are assessed. In support of this explanation, the follow-up rater had 13 symptom items on which she rated 15 or more patients with a zero. The author had only two items on which on which she rated more than 15 of the same patients with zeros.

The standard kappa coefficients were lower than the correlation coefficients. Cohen (1960) states that the

kappa is intended for use with nominal scales. The weighted kappa is probably a more accurate computation for reliability ratings of symptoms on a numeric scale. Future research using scaled items should consider the weighted kappa.

The disorganization syndrome was associated with length of hospitalization and negatively correlated with IQ. Liddle and Barnes (1990) report a positive correlation between length of illness and psychomotor poverty (r = .39, p = .004) and a negative correlation between length of illness and Reality Distortion (r = -.36, p = .006). Liddle and Barnes also noted a trend (r = -.26, p = .06) for scores for Psychomotor Poverty to be associated with lower doses of antipsychotic medication. None of the syndromes correlated with levels of prescribed psychotropic medication in the current study.

Lifetime length of hospitalization could not be obtained accurately from the current subjects' charts and was not included in the analysis. Instead, the author used length of hospitalizations at Eastern State as a measure of hospitalization. In most cases, the length of hospitalization at Eastern State was close to or equivalent to lifetime hospitalization. In some cases this measure did not include hospitalizations at previous clinics or private hospitalizations.

The present study examined the effect of instructions

and coaching on WCST performance. Post-instruction performance improved significantly, but the overall average of post-instruction performance remained at an impaired level. These findings reaffirm the well documented results that individuals with schizophrenia have difficulty performing the WCST (Bellack et al., 1990; Goldberg et al., 1987; Goldman et al., 1991; Green et al., 1990; Green et al., 1992; Summerfelt et al., 1991; Thompkins, Goldman, & Axelrod, 1991; Weinberger et al., 1986). The fact that 52% of the current sample could not complete a single category on the first trial is in line with the Green et al. (1992) finding that 54% of schizophrenic subjects could not attain a category on the first trial.

On the other hand, 34% of this largely chronic sample did complete all three categories on the third trial. Therefore, the conclusion of Goldberg et al. (1987) that "teaching chronically ill patients with schizophrenia how to perform on the Wisconsin Card Sorting Test through conventional instructional techniques does not result in learning," is not an accurate generalization. Some individuals with chronic schizophrenia do appear able to remediate poor performance on the WCST with coaching. The inaccuracy of the conclusion by Goldberg et al. was noted by Green and his colleagues in their initial study (Green et al., 1990). These findings corroborate the conclusions of other studies which emphasize the necessity of combining

motivational with specific instructional factors to improve WCST performance among some schizophrenic patients (Goldberg & Weinberger, 1994; Green et al., 1992). These instructional effects however, appear to interact with symptom characteristics of schizophrenic patients.

In their first study, Green et al. (1990) predicted that future research could identify groups of learners and nonlearners based on post-instruction scores. Green's follow up study revealed a negatively skewed distribution without a point of rarity (Green et al., 1992). In other words, the data did not support the concept of discrete learner and non-learner groups. The distribution on all three post-instruction measures in the current study also failed to support the notion of discrete learner and non-learner groups.

In an attempt to support further the validity of Liddle's model, the present study explored the relationship between the three factors/syndromes of schizophrenia, performance on the WCST, and various demographic variables. If one accepts Liddle's hypothesis that the reality distortion syndrome is not associated with malfunction of the frontal lobes, it is not surprising that this syndrome showed very little relation to any of the WCST measures.

As hypothesized, only the disorganization syndrome was related to any of the WCST measures. The disorganization syndrome was negatively associated with the percentage

correct on the first trial and remained significant on the second trial. The relationship of the disorganization syndrome to perseverative errors was significant on the first trial but not on the second trial. The negative correlation between the disorganization syndrome and completed categories was significant on both trials. In all, these relationships indicate that the disorganization syndrome is unique in its association with various measures on the WCST. The disorganization syndrome tends to be less associated with perseverative errors after training than before training. However, it appears that disorganization is not associated with actual "learning" of the WCST principles. If the concepts of switching and maintaining categories were understood after the instructions, the negative correlation with number of categories completed and percentage correct should decrease substantially. This did not happen. The negative correlation with percentage correct remained significant as did the correlations with categories completed. In fact, the negative relationship between disorganization and categories completed increased after training. In summary, the higher a patient's rating on disorganization, the less correct responses, more perseverative errors, and fewer categories a patient is likely to make. As predicted, even after detailed instructions, a higher rating on disorganization is associated with fewer correct responses and fewer categories

achieved.

Several hypotheses can explain the relationship between the disorganization syndrome and performance on the WCST. One explanation is that the mechanisms underlying the disorganization syndrome are associated with a difficulty in voluntary attention and inhibiting inappropriate responses. This is the explanation favored by Liddle and Morris (1991). They note that an impairment in the inability to inhibit inappropriate responses is characteristic of the impairments seen in patients with frontal lobe damage. Liddle and Morris use this explanation to support their theory that the disorganization syndrome is associated with frontal lobe dysfunction. They conclude:

> These findings do not indicate that the primary abnormality in schizophrenia necessarily lies in the pre-frontal cortex. The findings merely indicate that some of the phenomena of schizophrenia are associated with neuropsychological impairments of the type seen in patients with frontal lobe damage, while other schizophrenic symptoms appear to be unrelated to such impairments. (p.344)

Another explanation is that chronicity is a determinant of cognitive impairment in schizophrenia. A tendency for greater chronicity to be associated with disorganization might account for the results. Although length of hospitalization was correlated with disorganization, length of hospitalization was not correlated with any WCST variables. Furthermore, partial correlations controlling for length of hospitalization revealed that all correlations between disorganization and WCST measures remained

significant. Therefore, this explanation appears to be less plausible.

A possible explanation is that disorganization is linked to problems with memory. Patients simply cannot remember the instructions in order to use them. Goldberg and Weinberger (1994) note that problems with memory could explain the overall findings that some patients with schizophrenia have difficulty learning the WCST. They discount this hypothesis, however, based on research indicating that patients with schizophrenia do not have increased rates of forgetting. In addition, most studies employed a format in which instructions were repeated frequently. In the present study instructions were repeated frequently, but memory was not assessed and cannot be ruled out as a possibility.

It is also possible that the relationships between the Disorganization Syndrome and impairment on the WCST represents a more generalized cognitive deficit. Liddle and Morris (1991) acknowledge this possibility but discount it based on their finding of a trend toward a negative association between disorganization and graded naming (r = -.28, p < .10). They note that "performance in the graded naming test provides an approximate measure of overall intelligence" (p.343). In the current study, however, disorganization was negatively correlated with estimated IQ scores (r= -.46, p=.001). The relationships between IQ and

psychomotor poverty and IQ and reality distortion were not significant.

Furthermore, IQ was correlated significantly with all performance measures on the WCST. Although Heaton (1981) did not consider IQ a confounding factor in WCST analyses, the IQ of brain injured subjects appeared highly correlated (r = .41) with categories achieved and negatively correlated with percentage of perseverative errors (r = -.44). Heaton did not indicate if these relationships were significant. In considering the performance of psychiatric patients, Heaton referred to a 1951 study by Fey (cited in Heaton, 1981). For that population of schizophrenic subjects, Wechsler-Bellevue IQ was not significantly correlated with categories achieved (Fey, 1951). The mean IQ for that group of subjects was 92.3. This average IQ is significantly higher than the average in the current study.

One study in the recent body of research on schizophrenic patients' performance on the WCST examined the relationship between performance, IQ, and various other measures of cognitive functioning (Goldman et al., 1991). The mean Full Scale IQ was in the average range (91.2) for the 14 subjects (Goldman et al, 1991). The mean education was 14.2 years, and the mean age was 32.1. Information on the length and number of hospitalizations was not given, but this appears to be a less chronic sample than in the present study. Among the less chronic subjects, the number of

categories achieved was correlated with measures of memory, and nonverbal intellectual functioning. Verbal IQ was not significantly correlated with the number of categories achieved (r = .51).

In the present study the correlations between Disorganization and WCST performance, which partialled out the effect of IQ, revealed that IQ was an important mediating factor on all measures in the first, no instruction trial. In the second, post-instruction trial, disorganization, with effects of IQ partialled out, remained significantly negatively correlated with the percentage correct and the number of categories achieved.

These results do support previous findings of an association between disorganization and more impaired WCST performance. However, IQ emerged as a critical mediating variable on the standard, no-training trial. Of importance is the fact that the estimated mean IQ in the present study was below average. Most of the studies on the WCST report a mean IQ in the average range. In Heaton's normative samples, all groups, both normal and brain injury, had a mean IQ in the average range (Heaton, 1981).

With IQ as a mediating variable, the explanation of a generalized cognitive deficit cannot be ruled out. Several articles have emphasized the fact that although the WCST is reported to be sensitive to frontal lobe function, more generalized cognitive deficits also can produce impaired

WCST performance (Braff et al., 1991; Goldberg & Weinberger, 1994; Van der Does & Van den Bosch, 1992).

Van der Does and Van den Bosch (1992) point out that the selectivity of the WCST to frontal lobe malfunction was proven with patients known to have focal brain damage due to tumor, trauma, epilepsy, or surgery. They note that the pattern of brain-behavior functioning which was established by this research does not necessarily apply to cases in which the brain damage is not focal. Van der Does and Van den Bosch (1992) cited a 1980 study by Robinson et al. which indicated that the WCST did not discriminate between focal frontal and diffuse brain damage.

At the same time, if IQ or a generalized cognitive deficit were the sole factor in the association between the disorganization syndrome and impaired WCST performance, then the partial correlations between disorganization and post-instruction performance should not have been significant. The conclusion of Liddle and Morris (1991) that disorganization is associated with impaired attention and the ability to inhibit inappropriate responses seems to fit the pattern of findings on the post-instruction trial. Because the perseverative error score is the only score generally considered sensitive to frontal lobe malfunction, the pattern of impairment in this study does not permit one to make conclusions about possible associations between the disorganization syndrome and malfunction in the frontal

cortex. However, Stuss and Benson (1983) found that even after instructions, leucotomized orbitofrontal patients evidenced an inability to maintain extended sequences of correct responses. In their study this pattern was more prominent than perseverative responses. Similarly, in the current study disorganization was associated with fewer correct and fewer categories but not perseverative responses after instructions. Liddle and his associates have pointed out the similarities between the symptoms of disorganization and those in patients with localized orbitofrontal lesions.

Perhaps two of the above interpretations could work together. Low estimated IQs could explain subjects' overall impaired performance on the first, no instruction, trial of the WCST. This is a particularly compelling explanation with the current sample of patients who's mean estimated IQ was 77.5. In particular, IQ appears to be the important element in the association between disorganization and WCST performance before instructions. At the same time, inattentiveness and inability to inhibit incorrect responses could explain the association between disorganization and poorer performance after detailed instructions and a learning trial.

In summary, this study replicated Liddle's (1987b) findings of a three syndrome model of symptoms in schizophrenia. The results confirm the finding of Liddle and Morris (1991) that disorganization is associated with

impaired performance on the WCST. This study also sheds light on possible difference between those patients with schizophrenia who profit from detailed instructions on the Card Sort and those who do not. Disorganization is linked with poorer performance on the WCST even after explicit instructions. IQ is not a mediating factor in this association. It seems that a logical explanation for this association could be an impairment in attention and an impairment in the ability to inhibit inappropriate responses. The pattern of responses appears similar to that found after instructions in patients with localized orbitofrontal lesions (Stuss & Benson, 1983). Nonetheless, higher ratings on the disorganization syndrome were associated with lower IQ and longer hospitalization.

Because IQ was associated with disorganization and was a mediating variable in pre-instruction WCST performance, future research on schizophrenic subjects' abilities on the WCST should consider IQ as a possible factor in performance. In addition, future research should explore the possibility of generalized cognitive deficits and memory deficits among patients with high ratings on the disorganization syndrome.

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APPENDIX A

Sample Items from SAPS and SANS

HALLUCINATIONS

Hallucinations represent an abnormality in perception. They are false perceptions occurring in the absence of some identifiable external stimulus. They may be experienced in any of the sensory modalities, including hearing, touch, taste, smell, and vision. True hallucinations should be distinguished from illusions (which involve a misperception of an external stimulus), hypnogogic and hypnopompic experiences (which occur when the patient is falling asleep or waking up), or normal thought processes that are exceptionally vivid. If the hallucinations have a religious quality, then they should be judged within the context of what is normal for the patient's social and cultural background. Hallucinations occurring under the immediate influence of alcohol, drugs, or serious physical illness should not be rated as present. The patient should always be requested to describe the hallucination in detail.

Auditory Hallucinations

The patient has reported voices, noises, or sounds. The commonest auditory hallucinations involve hearing voices speaking to the patient or calling him names. The voices may be male or female, familiar or unfamiliar, and critical or complimentary. Typically, patients suffering from schizophrenia experience the voices as unpleasant and negative. Hallucinations involving sounds rather than voices, such as noises or music, should be considered less characteristic and less severe.

Have you ever heard voices or other sounds when no one is around?

What did they say?

None	0
Questionable	1
Mild: Patient hears noises or single words; they occur only occasionally	2
Moderate: Clear evidence of voices; they have occurred at least weekly	3
Marked: Clear evidence of voices which occur frequently	4
Severe: Voices occur almost every day	5

Voices Commenting

Voices commenting are a particular type of auditory hallucination which phenomenologists as Kurt Schneider consider to be pathognomonic of schizophrenia, although some recent evidence contradicts this. These hallucinations involve hearing a voice that makes a running commentary on the patient's behavior or thought as it occurs. If this is the only type of auditory hallucination that the patient hears, it should be scored instead of auditory hallucinations (No. 1 above). Usually, however, voices commenting will occur in addition to other types of auditory hallucinations.

Have you ever heard voices commenting on what you are thinking or doing?

What do they say?

None	0
Questionable	1
Mild: Has occurred once or twice	2
Moderate: Occurs at least weekly	3
Marked: Occurs frequently	4
Severe: Occurs almost daily	5

APPENDIX A (continued)

Global Rating of Severity of Bizarre Behavior

In making this rating, the interviewer should consider the type of behavior, the extent to which it deviates from social norms, the patient's awareness of the degree to which the behavior is deviant, and the extent to which it is obviously bizarre.

None	0
Questionable	1
Mild: Occasional instances of unusual or apparently idiosyncratic behavior; patient usually has some insight	2
Moderate: Behavior which is clearly deviant from social norms and seems somewhat bizarre; patient may have some insight	3
Marked: Behavior which is markedly deviant from social norms and clearly bizarre; patient may have some insight	4
Severe: Behavior which is extremely bizarre or fantastic; may include a single extreme act, e.g., attempting murder; patient usually lacks insight.	

POSITIVE FORMAL THOUGHT DISORDER

Positive formal thought disorder is fluent speech that tends to communicate poorly for a variety of reasons. The patient tends to skip from topic to topic without warning, to be distracted by events in the nearby enviornment, to join words together because they are semantically or phonologically alike even though they make no sense, or to ignore the question asked and ask another. This type of speech may be rapid, and it frequently seems quite disjointed. It has sometimes been referred to as "loose associations." Unlike alogia (negative formal thought disorder), a wealth of detail is provided, and the flow of speech tends to have an energetic, rather than an apathetic, quality to it.

In order to evaluate thought disorder, the patient should be permitted to talk at length on some topic, particularly a topic unrelated to his psychopathology, for as long as five to ten minutes. The interviewer should observe closely the extent to which his sequencing of ideas is well connected. In addition, the interviewer should insist that he clarify or elaborate further if the ideas seem vague or incomprehensible. He should also pay close attention to how well the patient can reply to a variety of different types of questions, ranging from simple (Where were you born?) to more complicated (How do you think the present government is doing?)

The anchor points for these ratings assume that the patient has been interviewed for a total of approximately forty-five minutes. If the interview is shorter, the ratings should be adjusted accordingly.

APPENDIX A (continued)

Derailment (Loose Associations)

A pattern of spontaneous speech in which the ideas slip off one track onto another which is clearly but obliquely related, or onto one which is completely unrelated. Things may be said in juxaposition which lack a meaningful relationship, or the patient may shift idiosyncratically from one frame of reference to another. At times there may be a vague connection between the ideas, and at others none will be apparent. This pattern of speech is often characterized as sounding "disjointed." Perhaps the commonest manifestation of this disorder is a slow, steady slippage, with no single derailment being particularly severe, so that the speaker gets farther and farther off the track with each derailment without showing any awareness that his reply no longer has any connection with the question which was asked. This abnormality is often characterized by lack of cohension between clauses and sentences and by unclear pronoun references.

Example: Interviewier: "Did you enjoy college?" Patient: "Um-hum. Oh hey well, I oh, I really enjoyed some communities I tried it, and the, and the next day when I'd be going out, you know, um, I took control like uh, I put, um, bleach on my hair in, in California. My roommate was from Chicago, and she was going to the junior college. And we lived in the Y.M.C.A., so she wanted to put it, um, peroxide on my hair, and she did, and I got up and looked at the mirror and tears came to my eyes. Now do you understand it, I was fully aware of what was going on but why couldn't I, I . . . why, why the tears? I can't understand that, can you?"

None	0
Questionable	1
Mild: Occasional instances of derailment, with only slight topic shifts	2
Moderate: Several instances of derailment; patient is sometimes difficult to follow	3
Marked: Frequent instances of derailment; patient is often difficult to follow	4
Severe: Derailment so frequent and/or extreme that the patient's speech is almost incomprehensible	5

APPENDIX A (continued)

AFFECTIVE FLATTENING OR BLUNTING

Affective flattening or blunting manifests itself as a characteristic impoverishment of emotional expression, reactivity, and feeling. Affective flattening can be evaluated by observation of the patient's behavior and responsiveness during a routine interview. The rating of some items may be affected by drugs, since the Parkinsonian side-effect of phenothiazines may lead to mask-like facies and diminished associated movements. Other aspects of affect, such as responsivity or appropriateness, will not be affected, however.

Unchanging Facial Expression

The patient's face appears wooden, mechanical, frozen. It does not change expression, or changes less than normally expected, as the emotional content of discourse changes. Since phenothiazines may partially mimic this effect, the interviewer should be careful to note whether or not the patient is on medication, but should not try to "correct" the rating accordingly.

Not at all: Patient is normal or labile	0
Questionable decrease	1
Mild: Some decrease in facial responsiveness	2
Moderate: Facial expressiveness is significantly decreased	3
Marked: Facial expressiveness markedly decreased	4
Severe: Facial expression is essentially unchanging	5

Decreased Spontaneous Movements

The patient sits quietly throughout the interview and shows few or no spontaneous movements. He does not shift position, move his legs, move his hands, etc., or does so less than normally expected.

Not at all: Patient moves normally or is overactive	0
Questionable decrease	1
Mild: Some decrease in spontaneous movements	2
Moderate: Significant decrease in spontaneous movements	3
Marked: Movements are markedly decreased	4
Severe: Patient sits immobile throughout the interview	5

APPENDIX A (continued)

AVOLITION-APATHY

Avolition manifests itself as a characteristic lack of energy, drive, and interest. Patients are unable to mobilize themselves to initiate or persist in completing many different kinds of tasks. Unlike the diminished energy or interest of depression, the avolitional symptom complex in schizophrenia is usually not accompanied by saddened or depressed affect. The avolitional symptom complex often leads to severe social and economic impairment.

Grooming and Hygiene

The patient displays less attention to grooming and hygiene than normal. Clothing may appear sloppy, outdated, or soiled. The patient may bathe infrequently and not care for hair, nails, or teeth--leading to such manifestations as greasy or uncombed hair, dirty hands, body odor, or unclean teeth and bad breath. Overall, the appearance is dilapidated and disheveled. In extreme cases, the patient may even have poor toilet habits.

No evidence of poor grooming and hygiene	0
Questionable	1
Mild: Some slight but definite indication of inattention to appearance	2
Moderate: Appearance is somewhat disheveled	3
Marked: Appearance is significantly disheveled	4
Severe: Appearance is extremely disheveled	5

Impersistence at Work or School

The patient has had difficulty in seeking or maintaining employment (or schoolwork) as appropriate for his or her age and sex. If a student, he/she does not do homework and may even fail to attend class. Grades will tend to reflect this. If a college student, there may be a pattern of registering for courses, but having to drop several or all of them before the semester is completed. If of working age, the patient may have found it difficult to work at a job because of inability to persist in completing tasks and apparent irresponsibility. He may go to work irregularly, wander away early, complete them in a disorganized manner. He may simply sit around the house and not seek any employment or seek it only in an infrequent and desultory manner. If a housewife or retired person, the patient may fail to complete chores, such as shopping or cleaning, or complete them in an apparently careless and half-hearted way.

No evidence of impersistence at work or school	0
Questionable	1
Mild: Slight indications of impersistence	2
Moderate: Definite indications of impersistence	3
Marked: Significant indications of impersistence	4
Severe: Patient consistently fails to maintain a record at work or school	5

APPENDIX B

Instructions for Administration and Scoring

Wisconsin Card Sorting Test

Chapter 3
TEST ADMINISTRATION

MATERIALS

WCST materials can be obtained from Psychological Assessment Resources, Inc., P.O. Box 98, Odessa, Florida 33556. They include four stimulus cards, two identical decks of 64 response cards, and recording forms. All stimulus and response cards have systematic figure configurations, and are numbered to indicate the standard order. In this order, no two response cards in succession have the same color, form, or number.

INSTRUCTIONS TO PATIENT (with associated examiner activities footnoted below)

"This test is a little unusual, because I am not allowed to tell you very much about how to do it. You will be asked to match each of the cards in these decks to one of the four key cards.[a] You must always take the top card from the deck,[b] and place it below the key card you think it matches.[c] I can't tell you *how* to match the cards, but I will tell you each time whether you are right or wrong. If you are wrong, leave the card where you've placed it, and try to get the next card correct. Use this deck first,[d] and then continue with the second deck. There is no time limit on this test."

a. Lay out the stimulus cards across the table from the patient, in the standard order, with the first card at the patient's left side.
b. Throughout the test, the stimulus cards and the cards in the decks should be kept in order. Never shuffle the cards or allow the patient to do so. As they face the patient, the figures on the cards should have the following configurations (triangles have the bases facing down, and stars have two points facing down): cards with only one figure have it in the center; cards with two figures have one in the upper left and one in the lower right; when there are three figures they are in the configuration of an equilateral triangle, with two figures on either side of the top and the third centered at the bottom of the card; when there are four figures they are in the configuration of a square, with one figure at each corner of the card.
c. Point to the four stimulus cards.
d. Examiner hands the first deck to the patient, and places the second deck to the side.

PROCEDURE

The examiner begins by responding "right" each time the patient matches to color, and "wrong" each time he or she does not match to

color. This continues until the patient has completed 10 *consecutive* color responses. The examiner then, without comment, changes to form as the correct response.

Form remains the correct sorting principle until the patient has again completed 10 consecutive correct responses. Then the examiner (again giving the patient no warning or clue as to what is happening) changes the correct sorting principle to number. After 10 consecutive number responses the examiner will switch back to color, and then to form and number in the manner just described. The test continues either until the patient has completed the six categories, or until both decks have been used. At no time should the examiner indicate to the patient that he or she is changing the sorting rule, or give the patient any information that is not contained in the initial instructions.

The test is not timed, and the patient is informed of this. If the patient begins to sort the cards *very* quickly, the examiner may ask the patient to slow down so that the examiner can keep up on the record sheet. The examiner should practice the administration and recording until he/she can at least keep up with a patient who sorts one card per second. We have found that slowing some patients down too much can interfere with their performances, because they may become distracted and lose track of what they are doing.

Patients will sometimes become confused about how to form the response card piles below the stimulus cards. The examiner may help by moving the response cards if the patient should place them in columns beneath the stimulus cards or on top of the stimulus cards.

If the examiner thinks a patient may be matching new response cards to the top cards of the response piles rather than to the stimulus cards, he/she should remind the patient of the correct procedure. (If the patient makes "other" responses, defined below, this may be the problem.)

If a patient should become frustrated and begins randomly "dealing" the cards rather than matching to stimulus cards, the examiner should stop the patient and insist that he/she look at the stimulus cards and try to match them.

RECORDING PATIENT RESPONSES

At the top of the recording form, the examiner may mark off each category as the patient completes it ("CFNCFN"; C=color, F=form, N=number).

The recording form has 128 response items, each one "CFNO" with O=other. The examiner records the patient's response by making a slash through those dimensions which are the same on the

APPENDIX B (continued)

response and stimulus cards. If the response and stimulus cards are exactly the same, the item would be recorded CFNO. If the response card has both the same color and number of figures as the stimulus card, record as CFNO. If the response card does not match the stimulus card on any dimension, record as CFNØ. The response is recorded in the same manner each time, irrespective of whether it is correct or incorrect. The patient should not see the recording form.

We have found it helpful to draw a line under the last item when the criterion of 10 consecutive correct responses has been reached, and to record the new correct sorting category below that line.

APPENDIX B (continued)

Chapter 4
SCORING

We suggest that WCST scoring be begun by circling all incorrect responses. Then count and record the *total number of errors*, the *total number of correct responses* (including each "criterion run" of 10 consecutive correct responses), and the *number of categories completed* (0 to 6).

The next step in scoring the WCST is to record the *perseverative responses*. Our experience suggests that the perseverative reponse score is the most useful diagnostic measure that is derived from the test. We have broadened the definition of this score in an effort to encompass all instances of perseveration that we have encountered. For example, there are occasional patients who begin the WCST by sorting to form or number and continue with this preference throughout the test, never completing a single category. Also, patients will sometimes perseverate for many trials to an incorrect sorting category that is not the one that was correct in the immediately preceding stage of the test. These obvious examples of perseveration are not counted as such by most scoring systems that have been used with the WCST. In comparing our broadened definition of perseveration with the more traditional perseveration scores, we have found that the new score gives somewhat better diagnostic accuracy (for predicting the presence or absence of brain damage and presence or absence of frontal lobe involvement in focal cases).

With two exceptions to be described below, a perseverative response is defined as one that would have been correct in the *previous* stage. For example, if a patient has responded correctly to color 10 consecutive times, and goes on from there responding to color, those color responses beyond the criterion run would be perseverative responses. The first exception to this definition of perseveration is that it is also possible for the patient to make perseverative responses before he/she has completed one category. Once the patient has made the first incorrect unambiguous response in stage one (that is, a response that matches the stimulus card only with respect to form or number), that sorting principle will be the one to which he/she can perseverate in the first stage.

Our second exception to the traditional scoring of perseveration is rather complicated. (Case examples that illustrate these scoring procedures are provided at the end of this section of the manual.) It is possible for the "perseverated-to" principle to change within a single stage of the test if the patient makes three unambiguous incorrect matches in succession[4] according to another principle (i.e., the principle that is neither the correct one in the current stage, nor the one that was defined as the "perseverated-to" principle according to the rules given above). Although there can be only one "perseverated-to" principle at a time, theoretically this principle can change more than once in a single stage; that is, provided that the

APPENDIX B (continued)

criterion of three consecutive unambiguous sorts are made to another incorrect principle.

Not all perseverative responses are errors. This is because of the rules in Footnote 4 regarding the scoring of ambiguous responses. That is, if ambiguous responses are correct but (a) match the "perseverated-to" principle and (b) occur within a series of unambiguous perseverative errors, then they are perseverative responses. *Perseverative errors* are those perseverative responses that are also errors; i.e., those items on the recording sheet that have been recorded as perseverative responses and also circled as errors. The *nonperseverative errors* score can be computed by subtracting the total number of perseverative errors from the total error score on the test.

The major WCST scores (those that are included on the recording form) have now been defined. Our normative study will also present results on five special WCST measures that may be of interest in future work with the test.

The *percent perseverative errors* score is the total number of perseverative errors divided by the total number of trials in the test.

There are two measures of conceptual ability. The first is the number of *trials to complete the first category.* This gives an indication of initial conceptualization before shift of set also is required. To compute the second measure, first count all correct responses in the test that occur consecutively in runs of three or more. These are called "conceptual level responses," and probably reflect some insight into the correct sorting principle (i.e., three correct responses in a row usually would not occur by chance alone). The total number of conceptual level responses divided by the total number of trials in the test is the *percent conceptual level responses* score.

The *failure to maintain set* score is the number of times in the test that the patient makes five correct responses in a row but fails to get

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[4]An ambiguous response is one that matches the stimulus card according to more than one dimension (for example, both color and form). Ambiguous responses can occur between the three consecutive unambiguous ones, provided that these ambiguous responses all match the stimulus card according to the new "perseverated-to" principle (i.e., in addition to the other principle or principles). When the "perseverated-to" principle is changing in this manner, perseverative responses to the new principle are counted in the scoring starting with the second unambiguous response.

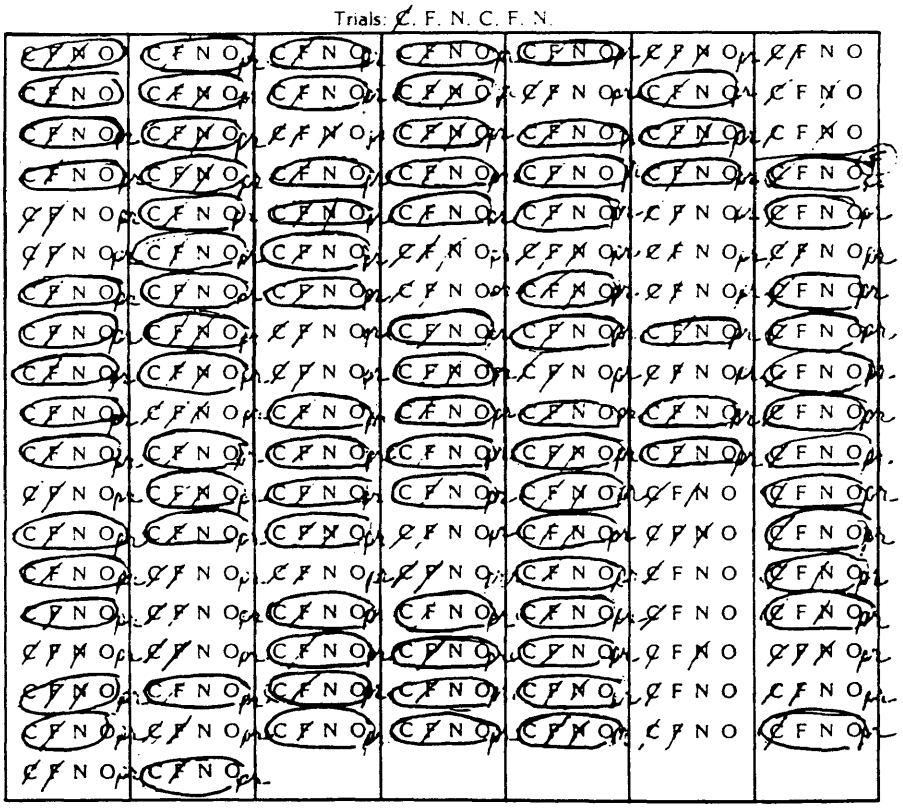
As a general rule throughout the WCST, an ambiguous response is classified as perseverative if it matches the perseverated-to principle and also meets two rather complex criteria. These criteria ensure that the ambiguous response in question is a part of a consistent pattern of perseverative responding. Thus, an ambiguous reponse is scored as perseverative only if (a) it matches the "perseverated-to" principle in force at the time, (b) the closest *unambiguous* responses both preceding and following the ambiguous one are perseverative responses, and (c) all other ambiguous responses between the response in question and the nearest unambiguous responses on either side also match the perseverated-to principle (i.e., the series cannot be broken by any responses that do not match the perseverated-to principle).

APPENDIX B (continued)

the 10 that are required to complete the category (i.e., runs of five to nine consecutive correct responses). When the patient does this, he/she has shown definite insight into the correct sorting principle, has almost certainly had unambiguous correct responses reinforced, and nevertheless has not been able to consistently use the strategy that has been successful.

TABLE 1

Scoring Example 1: WCST Results of a 29 Year Old Man with Bilateral Frontal Lobe Infarcts



CORRECT 39 ERRORS 89 PERSEVERATIVE RESPONSES 116

NONPERSEVERATIVE ERRORS 2 PERSEVERATIVE ERRORS 87 CATEGORIES 1

FORM #307-SF

The final score is called *"learning to learn"* (after Tarter, 1973), and reflects the patient's average change in efficiency across the successive stages of the WCST. This score can be calculated only for patients who complete three or more categories/stages of the test.

APPENDIX B (continued)

The first step is to compute a percent error score (total errors divided by total number of trials) for each category attempted that has at least 10 trials in it. Categories do not have to be successfully completed in order to be considered. Next, compute the change score for each successive pair of categories; i.e., category one minus category two, category two minus category three, category three minus category four, etc. The average of these change scores is the "learning to learn" score for the test. A positive score would suggest improved efficiency across successive categories, presumably due to learning.[5]

To illustrate these scoring rules, three patients' WCST recording forms will be reviewed. The first is that of a 29 year old man who suffered bilateral frontal lobe infarcts secondary to a ruptured anterior communicating artery aneurysm (Table 1). He completed only one WCST category, and made 89 errors and 39 correct responses in the test. In scoring the perseverative responses in stage one, note that the first unambiguous incorrect response occurs on the second sort. This establishes "form" as the initial perseverated-to response principle. The next 101 responses all are either ambiguous or unambiguous matches to form, and all are classified as perseverative responses. However, the next (103rd) response does not match to form, and this interrupts the perseverative series. Although the 104th response does match to form, it is ambiguous; because neither the preceding nor the following responses match to form, this response cannot be classified as perseverative. The patient makes 10 correct color responses in a row, so the perseverated-to principle shifts to color. The first response after the shift matches to color and is unambiguous, so this is classified as perseverative; although the distinction is somewhat arbitrary, an *ambiguous* response after the shift would not be scored as perseverative because of the rule that the closest preceding unambiguous response would have to be perseverative. The next response also is an unambiguous color match and therefore is perseverative. The patient went on matching to color for the rest of the test, obtaining 13 more perseverative responses. Of the total 116 perseverative responses, 87 are also perseverative errors. Subtracting this score from the total error score, the nonperseverative error score of two is obtained. The percent perseverative error score in 87 divided by 128, or 68%. The number of trials in the first category is 113. There were only 16 correct responses that occurred in runs of three or more; thus, 16 divided by 128 gives 12.5% as the percent conceptual level response score. There were no instances of failure to maintain set. Finally, because the patient failed to complete three categories; a learning-to-learn score cannot be computed.

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[5]It is recognized that the inclusion of the first (category one minus category two) change score makes it more difficult to obtain a positive overall learning to learn score, because of the novel difficulty of making the first shift of set. Nevertheless, we found that excluding the first change score actually reduced the differences obtained between brain damaged and normal groups.

APPENDIX C

INTERRATER RELIABILITY ON FACTOR ITEMS
CONCURRENT RATINGS
PEARSON CORRELATIONS AND KAPPA COEFFICIENTS

	Pearson	Kappa
Unchanging Facial Expression	.75	.56
Decreased Spontaneous Movement	.60	.25
Paucity of Expressive Gestures	.68	.48
Poor Eye Contact	.37	.30
Affective Nonresponsivity	.54	.20
Lack of Vocal Inflections	.73	.36
Poverty of Speech	.78	.36
Latency of Response	.59	.23
Affective Flattening	.73	.45
Alogia	.70	.29
Relations with Friends/Peers (impaired)	.71	.25
Anhedonia	.82	.50
Recreational Activities (lack of)	.73	.40
Thought Blocking	.79	.46
Avolition/Apathy	.47	.43
Intimacy and Closeness (lack of)	.80	.55
Thought Disorder	.80	.56
Attention	.86	.62
Social and Sexual Behavior (bizarre)	.89	.48
Loose Associations	.68	.21
Social Inattentiveness	.81	.55
Inattentiveness in Mental Status	.72	.31
Impersistance in Work/School	.72	.49
Tangentiality	.78	.29
Illogicality	.53	.38
Pressured Speech	.42	.31
Distractible Speech	.67	.19
Inappropriate Affect	.48	.14
Poverty of Content of Speech	.46	.42
Clanging	.97	.69
Delusions	.89	.44
Hallucinations	.92	.70
Auditory Hallucinations	.90	.66
Visual Hallucinations	.86	.62
Voices Commenting	.92	.65
Delusions of Control	.86	.37
Persecutory Delusions	.82	.31
Grandiose Delusions	.85	.47
Somatic Delusions	.83	.34

APPENDIX C (continued)

TEMPORAL RELIABILITY ON FACTOR ITEMS
DELAYED RATINGS
PEARSON CORRELATIONS AND KAPPA COEFFICIENTS

	Pearson	Kappa
Unchanging Facial Expression	.59	.25
Decreased Spontaneous Movement	.74	.27
Paucity of Expressive Gestures	.74	.20
Poor Eye Contact	.19	-.03
Affective Nonresponsivity	.47	.04
Lack of Vocal Inflections	.52	.42
Poverty of Speech	.68	.21
Latency of Response	.69	.18
Affective Flattening	.55	.14
Alogia	.68	.19
Relations with Friends/Peers (impaired)	.47	.09
Anhedonia	.52	.27
Recreational Activities (lack of)	.58	.20
Thought Blocking	.51	.04
Avolition/Apathy	.36	.10
Intimacy and Closeness (lack of)	.20	.08
Thought Disorder	.50	.02
Attention	.54	.15
Social and Sexual Behavior (bizarre)	.13	.04
Loose Associations	.27	.18
Social Inattentiveness	.64	.42
Inattentiveness in Mental Status	.41	.09
Impersistance in Work/School	-.32	-.32
Tangentiality	.66	.22
Illogicality	.32	.09
Pressured Speech	.24	.08
Distractible Speech	.53	.11
Inappropriate Affect	.41	.10
Poverty of Content of Speech	.33	.03
Clanging	-.11	-.04
Delusions	.75	.33
Hallucinations	.29	.09
Auditory Hallucinations	.36	.22
Visual Hallucinations	.07	.37
Voices Commenting	-.21	-.02
Delusions of Control	.80	.21
Persecutory Delusions	.32	.09
Grandiose Delusions	.71	.35
Somatic Delusions	.53	.35

VITA

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