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COGNITIVE ABILITY AND CHANGE IN LONG-TERM CHRONIC SCHIZOPHRENIA

Michael Ashton

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ABSTRACT

COGNITIVE ABILITY AND CHANGE IN LONG-TERM, CHRONIC SCHIZOPHRENIA

Michael Ashton, Ph.D.
Concordia University, 1997

This study examined the change in cognitive functioning over a more than 45 year period in a group of elderly male schizophrenic patients, controlling for effects of aging, early adult intellectual ability and psychiatric diagnostic status.

Subjects were veterans of World War Two. Twenty-two chronic schizophrenic patients were matched with two community-dwelling control groups on age and education level and also compared in terms of intellectual change patterns to a group (Psychiatric) of patients with psychiatric diagnoses of primarily depressive disorder and to a group (Alcoholic) of community-dwelling veterans with a history of heavy drinking. One of the normal control groups (ConTot) was further matched on total wartime score on the Revised Examination "M" Test of intelligence, while the other (ConVoc) was matched on the Vocabulary subtest score.

The patterns of change in intellectual abilities were examined within and between groups. Current performance on a battery of neuropsychological tests was also assessed comparatively in relation to the Schizophrenic, Psychiatric and ConVoc groups. Further, the relation of early adult

demographic and treatment-related variables to cognitive performance and change was examined.

The Schizophrenic group declined in all intellectual abilities, except vocabulary, and showed loss in general intelligence significantly greater than that observed in the ConVoc and ConTot groups. Certain abilities--perceptual-social judgement, mechanical aptitude and arithmetic reasoning--showed greater decline than that associated with normal aging effects. Schizophrenic group stability and the control groups' tendency for increased vocabulary ability argues against its use as a matching criterion in studies lacking premorbid data.

While declining more in intellectual ability than the Alcoholic group, the Schizophrenic group did not differ from the Psychiatric group in terms of patterns of cognitive change. The influence of general rather than specific psychopathology effects is thus suggested. Generally, neuropsychological performance did not differentiate the Schizophrenic group from the Psychiatric and ConVoc groups. Premorbid and treatment-related variables were not predictive of long-term cognitive outcomes in the psychopathology groups. Results were examined in the context of the concept of heterogeneity of course and outcome in schizophrenia.

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Introduction

Some influential formulations of schizophrenia in this century, starting with that of Kraepelin (1919), have considered its course in essentially pessimistic terms. Kraepelin characterized schizophrenia as dementia praecox because it emerged in young adulthood and was characterized by an acute loss of cognitive function although memory was assumed to be spared. Given this perspective on the cognitive impairment, termed a "static encephalopathy" by some (e.g., Hyde et al., 1994), it was predicted that individuals with the disorder would demonstrate significant and enduring deficits in functioning over the life span. Cognitive deficit was considered a defining element of the configuration of significant biological, psychological and affective impairments associated with schizophrenia. Contrasting with this view of the disorder is one, originating as early as 1911 with some of the writings of Eugen Bleuler (1951), proposing a diversity of outcomes, including amelioration, in schizophrenia.

More recent studies of the long-term course of schizophrenia have supported the perspective of diversity and complexity of outcome in schizophrenia (e.g., M. Bleuler, 1978, Ciompi, 1980; Harding, Brooks, Ashikaga, Strauss, & Breier, 1987a, 1987b; Huber, Gross, Schuttler, & Linz, 1980; McGlashan, 1988; Tsuang, Woolson & Fleming, 1979). Emerging from these studies is a view of

schizophrenia as more polymorphic and fluctuating in its course than had been previously postulated by the Kraepelinian view. Significant improvement or recovery is reported--as indicated by hospitalization rates, psychotic symptomatology and psycho-social adjustment--in approximately one half the subjects followed into old age over decades of time. Such longitudinal evidence of a diversity of outcome characteristics suggests that schizophrenia is more fruitfully conceptualized as a clinical syndrome rather than as a unitary disease entity. None of these large-scale, long term follow-up investigations, however, provided specific and quantitative assessments of the course of cognitive functioning of schizophrenic subjects.

Conceptual Models

Predominant current heuristic conceptual models are subsumed within a neurodevelopmental hypothesis regarding the etiology of schizophrenia. The principal formulations propose disturbed neural development as determinant in the emergence of dysfunctional brain systems specifically linked to schizophrenic pathology (e.g., Dalen & Hays, 1990; Gottesman & Shields, 1982; Meehl, 1962; 1990; Lewis, 1989; Lyon, Barr, Cannon, Mednick, & Shore, 1989; Mednick, Huttunen, & Machon, 1994; Mednick, Machon, Huttunen & Bonnet, 1988; Mirsky & Duncan, 1986; Walker,

Davis, Gottlieb & Weinstein, 1991; Weinberger, 1987; Zubin & Spring, 1977). Genetic predisposition influences, pathological environmental events, and/or combinations of these factors have been hypothesized to interfere with normal fetal neural development processes.

The most frequently ascribed early environmental events linked to the development of central nervous system abnormalities have been obstetrical complications and in-utero viral infections (e.g., Goodman, 1989; Mednick et al., 1988; 1994; Mirsky & Duncan, 1986). For example, second trimester prenatal influenza infections have been proposed as critical in increasing the risk for schizophrenia. The neural and behavioural consequences emerging from fetal viral infection alone may be significantly different from those associated exclusively with abnormal genetic predisposition and from those consequences resulting from an interaction of compromised genetic processes and environmental insults such as infections and obstetrical complications. In addition, it is assumed that variation in the severity and type of underlying neural dysfunction interacts with personality characteristics and life experiences of the individual to determine risk for schizophrenia (Mednick et al., 1994) and to influence the long-term course and outcome of the disorder (Harding, Zubin, & Strauss, 1992). Such neurodevelopmental conceptual frameworks provide a heuristic framework which can

accommodate longitudinal evidence of differing clinical syndromes and subtypes within the general definition of schizophrenia.

Important differences exist among models in terms of the age at which putative brain abnormalities are assumed to develop and in relation to the role of hypothesized triggering events. The latter are assumed to act, usually by late adolescence, to evoke the overt signs of the schizophrenic disorder. Some diathesis-stress models of schizophrenia (Cannon, Barr, & Mednick, 1991; Meehl, 1962, 1990; Rosenthal, 1963; Zubin & Spring, 1977) posit the development of brain abnormalities in the perinatal period. These models that suggest an early appearance of neurodevelopmental anomalies also ascribe a critical etiological role to stressful experiences occurring during childhood and adolescence. Such stressors affect the degree of risk for schizophrenia and influence the time of onset of clinical symptoms. For example, Meehl (1962, 1990) advances a model in which the hypothesized gene for schizophrenia is seen to give rise at birth to a biological continuum of brain abnormalities (schizotaxia) that is ineluctably expressed as behaviour traits (schizotypy). In turn, the degree of exposure, during childhood and adolescence to significant noxious psychosocial experiences will determine the subset of these schizotypes which ultimately manifest themselves as overt full-fledged schizophrenic symptoms

during young adulthood.

Other recently proposed early neurodevelopmental models propose a different time frame for the establishment of risk for the disorder. These formulations also advance the idea of a graded continuum of central nervous system liability (Benes, 1989; Murray & Lewis, 1987; Weinberger, 1987). In contrast, however, they suggest that the risk for schizophrenia is conclusively established during the perinatal period with the development of schizophrenia-specific neuropathology. These early-occurring neurostructural abnormalities then interact in adolescence with processes of normal brain maturation, particularly in the dorsolateral prefrontal cortex, and give rise to the psychopathology (Weinberger, 1987). Thus the degree of risk, itself, is not affected by later developmental events in adolescence. The neuromaturational processes of adolescence govern only the timing, not the degree of liability for the psychopathology.

Despite the differences regarding the role of later environmental and neurodevelopmental events in determining the liability or basic risk for schizophrenia, both groups of theorists share certain emphases. They propose a perinatal-phase occurrence of schizophrenia-specific neuropathologies and the non diagnostic-specific nature of later occurring triggering events that may be neuromaturational or environmental.

Contrasting late neurodevelopmental models suggest that schizophrenic neuropathology emerges only over a longer time frame and not conclusively during the perinatal period (Feinberg, 1990; Gottesman & Shields, 1982; Pogue-Geile, 1991). The propositions of these late neurodevelopmental models are rooted in the central premise of developmental genetics which posits a process of genetic expression varying significantly among different cells and over time. Accordingly, the models describe the neurobiological substrate for the schizophrenia diathesis as emerging post-pubertally, a product of defects in genes that control normal brain development.

The role of environmental influences during childhood or adolescence in this model of post-pubertal, genetically-determined brain abnormalities in schizophrenia is seen to be one of increasing the impact of these anomalies rather than one of directly determining the disorder itself (Feinberg, 1990; Gottesman & Shields, 1982; Pogue-Geile, 1991). For example, the neurodevelopmental effect of fetal viral infections and perinatal complications, involving potentially significant central nervous system insults, would not be sufficient in themselves to produce symptoms associated specifically with schizophrenia. In particular, perinatal occurring cerebral insults, it is suggested, are present in only a minority of eventual schizophrenic patients and are also associated with a number of other

psychopathologies (Pogue-Geile, 1991). Thus environmental events, such as perinatal and fetal complications, might serve to enhance the penetrance of later-occurring, genetically-controlled brain development irregularities which are particular to schizophrenia. In so doing, such environmental events influence the eventual biological and behavioural course of the disorder but not the inherent predisposition for schizophrenia.

Summary. Within the framework of the predominant models of schizophrenia lies an apparent consensus regarding the significantly biological nature of the substrate of vulnerability for the disorder. Moreover, there is a shared emphasis on the essentially complex relationship between biological vulnerability, environmental processes, including life events and personality, and the biopsychosocial manifestation of the disorder over the life course. Research protocols and explanatory formulations which attempt to understand the course of schizophrenia must contend with interacting influences of compromised neurodevelopment, attributes of environment, life experience, aging processes, and individual psychological and cognitive characteristics.

Long-Term Outcome of Schizophrenia

The complexity of interaction of vulnerability and moderating factors in the expression of schizophrenia is consistent with the diversity of its clinical phenomena and

course reported in recent long-term studies. In the past 20 years, several major European studies with large samples of schizophrenic subjects followed over periods ranging from two to six decades have reported findings of significant heterogeneity of outcome (e.g., M. Bleuler, 1978; Ciompi, 1980; Huber et al., 1980). They describe favourable outcome ratings, indicating recovery or significant improvement in occupational, social, and behavioural functioning in slightly more than half of their subjects. Methodological weaknesses, however, such as inattention to representivity of samples, the lack of standardized diagnostic procedures and criteria, lack of control group comparisons, as well as single and unblind clinical and social outcome assessments, limit the unambiguous generalizations that can be made from these findings. Nonetheless, the studies, by identifying eight to twelve distinct patterns of temporal course in the disorder, do effectively challenge the view of schizophrenia as unremitting and progressively deteriorative in nature (Shepherd, Watt, Falloon, & Smeeton, 1989).

Recent North American long-term follow-up studies with more exacting research design standards do not report the same uniformly high levels of favourable outcome in schizophrenia described in the European investigations (McGlashan, 1988). Nonetheless, the clear indications of heterogeneity in the course of the disorder found in the European studies are replicated in the North American

reports (Harding et al., 1987a, 1987b; McGlashan, 1988). North American study findings suggest that while functioning does deteriorate over the early course of the disorder, the decline ends at a point roughly five to ten years after onset and is succeeded by a levelling off, or, in some samples, by varied trajectories of improvement in social, occupational and behavioural indicators.

The results of two of these North American long-term follow-up investigations serve to illustrate the heterogeneity of illness outcome observed in several others. A follow-up investigation of 186 schizophrenic subjects, an average of 35 years after their first admission, reported that 46 percent of the sample was rated improved or recovered on indices of global functioning (Tsuang et al., 1979). Average age at follow-up was 58 years. McGlashan (1984), reporting on a retrospective follow-up study of a severely and chronically ill, drug resistant sample of 163 schizophrenic patients, assessed outcome an average of 15 years postdischarge with an average age at follow-up of 47 years. Global outcome ratings indicated that 6 percent of the sample had recovered, 8 percent had good outcomes, and 23 percent had moderately improved outcomes. The majority of the subjects, however, stayed the same or showed worsening conditions.

The considerable variance in outcome over long periods may be linked to the essentially multi-dimensional nature of

schizophrenic chronicity (McGlashan, 1988). Rather than comprising only the dimension of time, or the length of manifest presence of schizophrenia, chronicity may additionally involve dimensions of institutionalization, biological treatment resistance and age of onset. Study samples of chronic schizophrenics differing significantly on these dimensions will show different long-term outcomes. For example, a recent finding underlined the potential contribution of comprehensive rehabilitation to a more positive outcome in even severely-ill, long-institutionalized schizophrenic patients (Harding et al., 1992). In a comparison investigation, a large sample of elderly, long-institutionalized patients was matched carefully on variables of age, gender, diagnosis and length of hospitalization with a cohort from an earlier investigation that had shown remarkable recovery and improvement in many aspects of functioning (Harding et al., 1987a,b). The earlier sample differed in having had access to a comprehensive rehabilitation program at the onset of the deinstitutionalization movement in the 1950's. Results revealed that the comparison sample did significantly less well in terms of a variety of outcome indicators.

Further supporting the concept of a complex outcome process in schizophrenia is the reported presence within samples of subsets of subjects displaying combinations of productive and dysfunctional domains rather than global

uniformity in level of functioning (Harding, 1991; McGlashan, 1988). Such intra-subject heterogeneity in outcome is understandable in terms of the concept of semi-independent domains of functioning proposed by Carpenter, Strauss, Pulver, & Wolyniec (1987). This perspective indicates that several moderately related, yet significantly independent, spheres of outcome may be described, for example: employment, social functioning, severity of symptoms and duration of hospitalization (Strauss & Carpenter, 1974). Considerable intra-individual variation may occur across these domains of outcome.

The evidence for a diversity and possible plasticity of clinical courses and outcomes in patients with schizophrenia lends support and interest to the view that it is not a unitary clinical or biological phenomenon; rather it is seen to subsume divergent and significantly independent sub-types which merit specific efforts at research and conceptualization. The significant diversity observed in the phenomenology and long term course of schizophrenia may relate to differences in the particular origins of vulnerability to the disorder, to the diversity of moderating influences that confront vulnerable individuals, as well as to the developmental level of subjects under study (Walker et al., 1991). The substantial evidence for multiple etiologies, trajectories and outcomes, and for variation across domains of functioning in schizophrenia,

suggests the appropriateness of longitudinal tracking of important dimensions of individual functioning in schizophrenia. The study of change in cognitive functioning from premorbid to longer-term phases in chronic schizophrenic patients and the relation of such changes to other aspects of long-term outcome is congruent with such a research orientation.

Premorbid Development and Schizophrenic Outcomes

The identification of precursors of schizophrenia assumes evidence for consistent relations between antecedents and outcome characteristics of the disorder. A central element in this line of inquiry has concerned the elucidation of aspects of premorbid psychosocial functioning that might be associated specifically with the emergence of schizophrenia, with its sub-types and its varied outcomes in multiple domains. The complexity of this type of investigation is accentuated by the challenge of disentangling premorbid influences from those factors related to the schizophrenic disease process, such as the emerging psychopathology itself, institutionalization, treatment and age effects. For example, the differentiation of premorbid indices from subtle early morbid processes, present before the emergence of overt psychotic symptomatology is inevitably fraught with a certain arbitrariness (Strauss & Carpenter, 1974, 1977; Harrow & Westermeyer, 1987).

Further affecting prediction initiatives is the likelihood that the course of outcome may comprise several semi-independent domains which show continuity over time. Specific outcome criteria may therefore be best predicted by their corresponding premorbid variables rather than by global premorbid indices (Strauss, Klorman, & Kokes, 1977; McGlashan, 1986a; Strauss & Carpenter, 1974). Thus, cognitive functioning at outcome may be optimally anticipated by premorbid cognitive functioning.

Premorbid social competence has emerged as one of the most extensively studied prognostic constructs in psychopathology (Herron, 1987). In a study employing the Zigler-Phillips Social Competence Scale (Zigler & Phillips, 1960; 1981), schizophrenics were found to have less premorbid social competence and poorer psychiatric outcome than three other psychiatric diagnostic groups (Westermeyer & Harrow, 1986). Schizophrenics with superior premorbid social competence were seen to have good general outcome, good work adjustment and fewer psychotic symptoms at a two year post-discharge follow-up. Rehospitalization and social adjustment were not predicted by premorbid competence. Cognitive outcomes were not examined specifically in this investigation which also did not explore long-term predictor-outcome relationships.

The presence of a substantial central premorbid social competence factor, predictive across domains, was also

indicated in a study by Stoffelmayr, Dillavou, and Hunter (1983). The investigation was a cumulative-data analysis, including a wide variety of schizophrenic populations and follow-up periods and incorporating a procedure in which the meta-analysis is corrected for sampling error. One-third of the variance in global outcome was seen to be accounted for by premorbid social competence. Results provided only partial support, however, for the position proposing the existence of several semi-independent predictor-outcome relationships (Strauss, Klorman, & Kokes, 1977).

Most studies of premorbid prognostic indicators have been restricted to schizophrenics with acute conditions and to short- term time frames. With recent evidence of significant heterogeneity of outcome from lifetime follow-up studies, the possibility emerges that premorbid predictor-outcome relationships may be significantly attenuated when examined in relation to longer term outcomes in chronic schizophrenics (Heaton & Drexler, 1987; McGlashan, 1986a, 1986b; 1988). In other words, the salience of predictors may change with the length of follow-up. The predictive ability of premorbid variables may change both in terms of power and specificity over longer terms (McGlashan, 1986a).

One investigation reported that, in terms of the first follow-up decade, premorbid functioning variables of social, sexual and instrumental functioning were strong predictive factors in relation to a global outcome measure comprising

38 specific outcome variables (McGlashan, 1988). In the second decade, specific family functioning variables (i.e., overinvolvement between patient and family) and dimensions of the psychopathology (i.e., presence of paranoid ideation, presence of ideas of reference and/or depressed mood) were seen to be the best predictors. Finally, in the follow-up interval including the third decade and beyond, genetic predisposition (i.e., family history of schizophrenia), premorbid instrumental functioning (i.e., acquisition of skills) and, again, characteristics of the psychopathology, were identified as important predictors.

The predictive power of premorbid variables in relation specifically to the long-term course of intellectual ability in schizophrenia remains relatively unexplored. The concept of sustained semi-independent domains of predictor-outcome relationship implies that the long term course of cognitive ability might be more effectively predicted by premorbid intellectual performance rather than by a composite measure of premorbid functioning.

Childhood intelligence and outcomes in schizophrenia. In longitudinal studies concerned specifically with childhood intellectual precursors of schizophrenia, some consistency is seen in results from retrospective research showing schizophrenics to have lower childhood intelligence than their school-age peers and siblings (e.g., Albee, Lane, & Reuter, 1964; Lane & Albee, 1965; Offord, 1974; Schafner,

Albee, & Lane, 1967). The evidence, however, is not unequivocal. Earlier findings of premorbid differences between schizophrenics and their school-age peers were called into question by results indicating that such differences dissipate when the groups of children are matched on socio-economic status (Lane & Albee, 1970). In another study the significant pre-schizophrenic deficits in childhood IQ were found only in relation to matched classmates but not to siblings (Watt & Lubensky, 1976). Although, elsewhere, lower childhood intelligence has been reported in schizophrenics compared with their siblings, analogous deficit patterns have been revealed for patients with personality disorders (Pollack, Woerner, & Klein, 1970). The specificity of the association of lower childhood intelligence to schizophrenia was therefore called into question.

A retrospective study of childhood behavioural precursors of schizophrenia found schizophrenia outcome and marital status (i.e., either ever married or never married) in middle age to be predicted significantly by the combination of low IQ and lack of aggressivity in childhood, but not by either variable in isolation (Roff & Knight, 1980). Another report concluded that childhood intelligence was not significantly related to length of hospitalization up to four years after the initial hospital admission (Watt & Lubensky, 1976). A meta-analysis of the retrospective

research in the area concluded that pre-schizophrenic children, adolescents and young adults perform below randomly selected or peer controls on a variety of standardized measures of intelligence and academic performance (Aylward, Walker, & Bettes, 1984). As was indicated in relation to earlier studies, however, such relationships are not specific to schizophrenia but are also negative prognostic markers for other psychiatric conditions (Goldstein, 1987; Pogue-Geile, 1991; Summers & Hersh, 1983) and for well-being in old age (Gold, Andres, Schwartzman, & Arbuckle, 1985).

Childhood intelligence appears to be only a weak and inconsistent prognostic indicator for schizophrenia. Its influence may be restricted to a limited sub-type of the disorder characterized by a severely deteriorating course (Watt & Saiz, 1991). Only the most malignant courses of schizophrenia may show a limited relationship with childhood intellectual deficit. However, even such a limited relationship between premorbid childhood intelligence and specifically cognitive outcome in schizophrenia may be questioned. An investigation of childhood precursors of severe cognitive impairment in schizophrenia revealed that schizophrenic subjects who eventually developed severe cognitive dysfunction (i.e, age disorientation) did not differ in level of childhood school performance from schizophrenics who remained cognitively intact (Buhrich,

Crow, Johnstone & Owens, 1988).

Such findings of a relatively weak sensitivity and specificity in the relation of indices of childhood intelligence to outcome in schizophrenia suggest that low intelligence may be an independently determined and heritable characteristic that affects the risk for all types of psychopathology in a non-specific fashion (Jones & Offord, 1975; Meehl, 1990). As such, intellectual deficits may be viewed, not as an element of a putative schizophrenic phenotype, but rather as independently transmitted heritable traits that interact with the diathesis (Pogue-Geile, 1991).

Premorbid intellectual ability and cognitive outcome in schizophrenia. Investigations of intellectual characteristics in adolescence and early adulthood that might predict later cognitive outcome in schizophrenia have offered equivocal findings. Greater cognitive deficits in the course of the disorder were predicted by poorer premorbid school and IQ performance (Jones & Offord 1975) and lower education levels (Harrow, Marengo, Pogue-Geile & Pawelski, 1987). Education level, but not measured premorbid intelligence (measured at army enlistment), was predictive of change in intelligence test performance of schizophrenic patients over a nine year period (Schwartzman & Douglas, 1962). Lower education levels were associated with greater deficits over the period. A later follow-up, however, 17 years after the initial premorbid assessment,

revealed no relationship between change in intelligence scores and either education level or premorbid intelligence (Schwartzman, Douglas & Muir, 1962). Other reports have suggested that premorbid declines in cognitive ability are relatively mild and focal with a resultant preservation of general intellectual ability (Goldberg, Hyde, Kleinman & Weinberger, 1993; Hyde et al., 1994; Pogue-Geile, 1991; Walker & Levine, 1990).

A study of older (mean age = 56 years) schizophrenic patients, covering a 35-year period after initial premorbid testing, reported that higher levels of measured premorbid intelligence were generally associated with greater intellectual loss in both a control and a schizophrenic group (Schwartzman & Rudolph, 1977). However, this relationship was less pronounced and not significant in terms of overall measured intelligence for the schizophrenic subjects.

A review of cross-sectional and longitudinal studies of neuropsychological functioning in schizophrenia concluded that premorbid intellectual functioning, as indexed by educational background, is not a significant contributor to group differences in neuropsychological performance among the schizophrenic patients studied (Heaton & Drexler, 1987). The lack of direct measures of premorbid intelligence in the reviewed studies limits their salience to the question of premorbid intellectual determinants for cognitive function

in schizophrenia. Also the survey included only a small number of studies of older groups of chronic schizophrenics and thus does not permit conclusions regarding the role of premorbid intellectual ability in the course of long term chronic schizophrenia.

The Nature and Course of Cognitive Function in Schizophrenia

Cognitive impairment has been consistently reported in investigations of schizophrenia. Schizophrenic subjects have been observed to perform at impaired levels both in terms of IQ (Aylward et al., 1984; Goldberg et al., 1993; Hyde et al., 1994), global cognitive screening indices (Arnold et al., 1995; Davidson et al., 1995; Harvey et al., 1995), and on neuropsychological test batteries (Heaton & Drexler, 1987; Levin, Yurgelun-Todd, & Craft, 1989; Taylor & Abrams, 1984). Contrasting with descriptions, generally, of severe cognitive impairment are reports of attenuated (Chaikelson & Schwartzman, 1983; Mulsant et al., 1993) or essentially age-related (Goldstein, Zubin, & Pogue-Geile, 1991) deficits.

The differing levels of impairment reported across investigations may reflect subtype differences in their samples. Chronically hospitalized and clinically unimproving schizophrenics appear to be at heightened risk for greater cognitive deficits and for enduring impairment (Davidson et al., 1995; Golden et al., 1980; Harvey et al., 1995; Klonoff, Fibiger, & Hutton, 1970; Schwartzman & Douglas,

1962; Heaton & Drexler, 1987). The oldest age cohorts of this type of chronically- hospitalized patient group may exhibit cognitive ability consistent with dementia (Davidson et al., 1995; Harvey et al., 1995). In contrast, elderly schizophrenics residing in the community and treated in acute care facilities have revealed significantly less cognitive impairment than patients with Alzheimer's disease (Mulsant et al., 1993).

Findings of impaired cognitive ability associated with schizophrenia have elicited interest in the diagnostic specificity of such deficits. A spectrum of cognitive disability across psychiatric disorders has been proposed, with schizophrenia associated with the most severe pole of the gradation (Harrow, Grossman & Silverstein, Meltzer, & Kettering, 1986). The limited number of controlled comparisons of schizophrenics' cognitive performance with that of individuals with other psychiatric diagnoses present a mixed perspective regarding the issue of diagnostic-specific cognitive deficits. A review of the few comparisons of cognitive function across diagnoses reported that schizophrenics show deficits in relation to patients diagnosed with neuroses and alcoholism (Aylward et al., 1984). In a later study employing an inventory of cognitive functioning from which scores on the Mini Mental State Exam (MMSE; Folstein, Folstein, & McHugh, 1975) were derived, schizophrenia was also associated with greater cognitive

impairment than depression, adjustment and chronic bipolar disorders, both in terms of differences in scores on the cognitive inventory and of differences in the percentage of subjects below a stipulated cutoff point on the MMSE (Fabrega, Mezzich, Cornelius, & Ahn, 1989). Contrastingly, in relation to comparisons involving depressed patients, Mulsant et al. (1993) found no differences between elderly schizophrenic subjects and those with diagnoses of recurrent major depression, both with and without psychotic features. Others have reported greater abstraction deficits associated with higher levels of general psychopathology in both depressed and schizophrenic subjects (Braff, Glick, Johnson, & Zisook, 1988). Both clinical groups were significantly more impaired in abstraction ability than a normal control group over the short (mean = 55 days for patients; 44 days for normals) test-retest interval.

Comparisons of schizophrenic subjects with those with substance abuse and psychotic and personality disorders have also produced inconsistent results. Diverging somewhat from the Aylward et al. (1984) review, Fabrega et al. (1989) reported that while a greater percentage of schizophrenic subjects than those with substance abuse fell below the MMSE "deficit" cutoff, no significant differences between the two groups were evident on the cognitive inventory scores. In relation to the differentiation of schizophrenia from psychotic and personality disorders, the review of Aylward

et al. (1984) reported findings that Full Scale IQ scores of schizophrenics were similar to those of psychotic and personality disordered patients. In comparison, the studies employing the MMSE have reported more impairment in schizophrenic subjects when contrasted with individuals with bipolar disorder (Fabrega et al., 1989; Mathai & Gopinath, 1985) although the Fabrega et al. report did not indicate whether its bipolar subjects had psychotic symptomatology. Similarly, chronic schizophrenic subjects were seen to perform more poorly on the WAIS (full scale and all subtests) and on the Halstead-Reitan Battery, than nine chronic non-schizophrenic patients--including seven with psychotic and personality disorders--of comparable age and education (Lawson, Waldman, & Weinberger, 1988).

The one third of the schizophrenic subjects in the Lawson et al. (1988) study with enlarged cerebral ventricles consistently scored most poorly among all subjects on all tests. The pattern of results in the comparisons across diagnoses and within the schizophrenic group, suggested that cognitive impairment in schizophrenia was not the product of psychopathology. Rather, a disease process, related to specific areas of neurodysfunction, was advanced as the source of deficit. The conclusions in the Lawson et al. (1988) report regarding the association in schizophrenia between neuroanomalies and cognitive impairment are echoed in numerous other investigations. A convergence of findings

over several years from neuropsychological (Levin et al., 1989; Kolb & Whishaw, 1983; Taylor & Abrams, 1984) and neurophysiological (Berman, Zec, & Weinberger, 1986; Golden et al., 1980; Johnstone, Crowe, Frith, Husband, & Kreel, 1976; Paulman et al., 1990) studies, often employing neuroimaging technologies, provides support for neurodevelopmental models. These studies suggest that a significant proportion of schizophrenic patients have neurostructural and neurophysiological abnormalities which contribute to their observed cognitive impairments. It is suggested that the degree of neuroanomalies may define subtypes of schizophrenia with more predominant neuropathology and a corresponding accentuation of cognitive deficit (Braff et al., 1991; Lawson et al., 1988; Levin et al., 1989; Paulman et al., 1990).

Evidence has not been unequivocal, however, as to the critical role of cerebral anomalies, in particular cerebral ventricular enlargement, in defining a specific cognitively deteriorative, chronic sub-type of schizophrenia. Nonsignificant associations of observed neuroanomalies and neurodysfunction with cognitive impairment were described in a group of chronic schizophrenics with poor outcomes and with, in a large proportion of cases, evidence ("soft signs") of neurodysfunction (Kolakowska, Williams, Jambor & Ardern, 1985; Kolakowska, Williams, Ardern et al., 1985). These findings challenged the ascription of causal status

solely to organic factors in attempts to explain cognitive impairment in long term schizophrenia.

A continuation of the Kolakowska, Williams, Jambor and Ardern (1985) and Kolakowska, Williams, Ardern et al.(1985) investigations further called into question the proposition that a distinct organic subtype of chronic schizophrenia may be associated with significant cognitive impairment (Williams, Reveley, Kolakowska, Ardern, & Mandelbrote, 1985). This investigation was of particular interest because it examined ventricular enlargement in schizophrenia in relation to a range of long term outcomes and deficit features of schizophrenia. Schizophrenics did show significant cerebral ventricle enlargement in group comparisons with normals. Further, cerebral ventricle enlargement was observed to be present almost exclusively in those schizophrenics with chronic courses, an observation in line with findings showing a higher proportion of individuals with enlarged ventricles in chronically hospitalized, as opposed to ambulatory and acute schizophrenic patients (Weinberger, Torrey, Neophytides, & Wyatt, 1979; Johnstone et al., 1976). However, lateral brain ventricle size was unrelated to level of cognitive impairment, a negative finding also reported in Weinberger et al.(1979).

The combined results from the Kolakowska, Williams, Jambor and Ardern, 1985, Kolakowska, Williams, Ardern, et

al.(1985) and Williams et al.(1985) studies can be seen as challenging the proposed existence of a clinically distinct, cognitively disruptive, organic subtype of chronic schizophrenia, indexed by combining measures of neurological dysfunction, cognitive impairment and cerebral ventricular enlargement. A further alternative to an exclusively neuropathological interpretation of cognitive deficits over time in chronic schizophrenia was suggested by Goldstein et al. (1991). This cross-sectional study that employed the Halstead-Reitan Neuropsychological Test Battery (HRB; Reitan & Wolfson, 1985) reported that cognitive deficits in schizophrenics were essentially equivalent to those seen in normal aging rather than related to indices of neurophysiological abnormality or long-term institutionalization. The divergent findings with regard to this question of the association of neuroanomalies with cognitive impairment in schizophrenia may reflect, in part, differences in sample characteristics and in the diagnostic, assessment, and neuroimaging methods of the studies under consideration.

Cross-sectional research designs have attempted to discern the temporal course of cognitive ability in schizophrenia. A review of studies of cognitive functioning in schizophrenia, concerned with drawing out indications of changes in intellectual functioning over time and over the course of the disorder, found no significant difference in

mean age between schizophrenic groups classified as impaired or unimpaired in comparisons with reference groups or norms (Heaton & Drexler, 1987). There was a tendency for groups with diagnoses of chronic schizophrenia and with histories of long term hospitalization to be assigned to the impaired classification. In those studies employing the Wechsler Adult Intelligence Scale (WAIS; Wechsler, 1955), the mean Full Scale IQs of the schizophrenic group did not decrease with age. An important limitation, recognized in this review, is the very small number of studies involving older subjects.

Null effects of age on general intellectual deficit in either acute or chronic schizophrenics were reported in a study that examined these groups at different ages (Harrow, Marengo, Pogue-Geile, & Palewski, 1987). In relation to abstraction ability, the same study found that both young and old chronic groups showed high levels of concrete thinking. Effects of aging, however, were seen within the chronic schizophrenic subgroup itself on a specific measure of abstraction ability. Older chronic schizophrenics (i.e., those over 45 years of age) performed more poorly than their younger (under 35 years) chronic counterparts on tests of abstract reasoning. The lack of normal and non-schizophrenic, psychiatric control groups, as well as the absence of a premorbid measure of abstract functioning, preclude definite interpretations of this finding in terms

of specific effects on abstraction ability of schizophrenic psychopathology over time. Attribution of the loss to effects intrinsic to the nature of schizophrenia could not be concluded.

Relatively few studies have examined schizophrenics over the age of 60. A recent cross-sectional study examined successive chronic, institutionalized schizophrenic cohorts in their third through seventh decades of life who were similar in terms of performance on a reading test index of premorbid intellect (Hyde et al., 1994). Using norm-referenced tests sensitive to progressive dementia, the study reported significantly impaired performance on all tests but no indication of further decline, after initial loss, over five decades of illness, above and beyond that occurring in normal aging as indexed by age norms for the tests. The lack of a control group precluded the assessment of more subtle differences in relation to normative aging.

Other recent cross-sectional investigations of the long term course of cognitive function in chronic, heavily institutionalized schizophrenic patients intimate a different portrait of the long term temporal course of intellectual decline (Davidson et al., 1995; Harvey et al., 1995). The core study (Davidson et al., 1995) stratified its population of institutionalized schizophrenic subjects into seven age groups, designated by ten year age intervals from 25 years to over 85 years. Performance on the Mini-

Mental State Examination (MMSE; Folstein et al., 1975) was seen to be significantly impaired at all age levels, confirming observations of previous investigations. However, unlike most earlier reports, comparison of the results across the age range revealed a very gradual but nonetheless continuous decline in cognitive performance over the seven age periods examined. The decline in performance culminated in levels of cognitive function in the oldest patients consistent with severe dementia. Retesting of a subgroup of the geriatric patients one and two years later showed no significant further deterioration (Harvey et al., 1995). The results underlined the gradual nature of the decline; significant differences in performance would have been overlooked had the age range examined not exceeded 20 years and had the comparisons not included subjects older than 65 years. Such a pattern, and the more stable pattern of enduring significant impairment observed in the Hyde et al. (1994) findings were suggested as consistent with a neurodevelopmental (Weinberger, 1987) rather than a neurodegenerative disorder such as Alzheimer's disease in which rapid cognitive deterioration is observed.

An earlier cross-sectional investigation, which did include normal controls, reported more nuanced findings (Chaikelson & Schwartzman, 1983). Two cohorts of chronic, hospitalized schizophrenic patients and normal subjects, in their early forties and late sixties, were assessed on

carefully selected neuropsychological tests sensitive to aging and/or schizophrenia. As in the other long-term cross-sectional studies that included geriatric schizophrenic subjects (Davidson et al., 1995; Harvey et al., 1995; Hyde et al., 1994), results revealed some impairment relative to normals in both younger and older schizophrenic subjects. Additionally, consistent with the findings of Hyde et al., older schizophrenic subjects showed no accentuation of the impairment seen in the younger schizophrenic cohort after considering the effects of normal aging. However, the Chaikelson and Schwartzman (1983) results further revealed that the normal sample showed more pronounced negative age effects than did the schizophrenic group. Only four of the ten neuropsychological test indices which had differentiated schizophrenics from normals in the younger sample continued to do so with the older subjects. Interestingly, the younger schizophrenic group in this study had a mean age in the early forties. At this age, within the neurodevelopmental conceptual framework of a static encephalopathy (Goldberg et al., 1994; Hyde et al., 1994), the younger cohort in this study would be assumed to have already passed through the period of abrupt decline in cognitive ability associated with the first decade or two of the disorder. A pivotal facet of this study is the finding that in this sample of chronic schizophrenic patients, the stabilization of cognitive ability is accompanied by some

areas of recuperation of function to near normal levels.

Taken together, the cross-sectional findings regarding temporal change in cognitive ability in chronic schizophrenia underscore the conceptualization of the disorder as essentially heterogeneous. Aside from possible problems of diagnostic reliability, divergent findings, such as those observed here, may reflect the presence in the investigations of different subtypes of schizophrenia (Arnold & Trojanowski, 1996). Support for the neurodevelopmental hypothesis is evident in descriptions portraying a relatively early stabilization of intellectual deficit following an initial abrupt decline in early adulthood. To the extent that other observations reveal a very slow rate of intellectual deterioration over many decades, pursuant to a precipitous decline in early adult life, they are nonetheless consistent with a neurodevelopmental formulation of schizophrenia. This pattern of temporal change may be characteristic of a severe subtype of schizophrenia generally associated with long periods of institutionalization. In comparison, mild cognitive impairment, recuperation and even amelioration of cognitive functioning may characterize the evolution of more benign forms of the disorder.

In addition to the dearth of controlled studies of changes in intellectual performance over time in elderly schizophrenics, there have been few investigations employing

a longitudinal, test-retest paradigm with pre-morbid measures. Major declines with age in most cognitive abilities are reported in studies of normal populations employing cross-sectional methods. Longitudinal investigations have suggested, in contrast, a more complex perspective on cognitive changes in aging, with indications of augmentation, stability, and decline in performance associated with different cognitive abilities (Gold, Andres, Etezadi, Arbuckle, Schwartzman, & Chaikelson, 1995; Horn, 1978; Schaie, 1983; 1989; Schwartzman, Gold, Andres, Arbuckle, & Chaikelson, 1987). Nonverbal intellectual skills such as spatial problem-solving ability that are more dependent on physiological factors may be most vulnerable to decline with age (Gold et al., 1995; Horn, 1978; Schaie, 1983; Schwartzman et al., 1987). Other skills such as vocabulary and mechanical knowledge appear to be more subject to early ability levels and life style influences (Gold et al., 1995; Hultsch, Hammer, & Small, 1993). Given such evidence of a complex and not readily predictable course of normal change in intelligence, longitudinal, as opposed to cross-sectional research paradigms, optimize the interpretation of results comparing intellectual abilities in schizophrenics with those of control samples.

Several early longitudinal investigations reported findings supportive of an early-stage occurrence of cognitive decline in schizophrenia. Changes in intelligence

test performance in normal and schizophrenic subjects, with an average age at re-test of 26 years, were examined in a study including premorbid measures with a two year, test-retest interval (Lubin, Gieseking, & Williams, 1962). Schizophrenic subjects were tested one to three months after being hospitalized. While normals demonstrated gains on all the subtests employed, the schizophrenic subjects declined on four of the five subtests.

Two reports covering nine and seventeen years, were oriented to the question of the course of intellectual ability in the first two decades of schizophrenia (Schwartzman & Douglas, 1962; Schwartzman et al., 1962). In an investigation covering nine years, with normal controls matched on age, total intelligence score at time of enlistment, occupation and time interval between testing, male schizophrenic war veterans in their early thirties exhibited significant intellectual loss, compared to pre-morbid baseline performance, on the Revised Army "M" measure of intelligence. Subjects with a history of acute onset of the disorder and those who showed clinical improvement tended to exhibit less cognitive decrement.

At the 17 year follow-up point, it was observed that schizophrenic subjects who had remained in hospital since the first testing showed further decline in scores on the M measure while ex-patients who had been discharged prior to testing showed an increase in scores to almost premorbid

levels (Schwartzman et al., 1962). The different course of intellectual ability revealed in ex-patients and in-patients over almost two decades may, it was proposed, reflect the presence of discrete subtypes of schizophrenia in the two groups. This hypothesis is consistent with reviews and other investigations suggesting that cognitive impairment and neurological dysfunction are more severe in chronic or process schizophrenia than in its acute forms (Golden et al., 1980; Heaton & Drexler, 1987; Heaton et al., 1978; Klonoff et al., 1970).

Even further differentiation of subtypes within the chronic schizophrenia form itself may be indicated given cross-sectional findings of different levels of impairment in very long-term chronic schizophrenics (Owens & Johnstone, 1980). Significant differences in levels of assessed impairments in neurological, cognitive and behavioural functioning were associated with different diagnostic classifications based on the syndrome checklist of the Present State Examination (Wing, Cooper, & Sartorius, 1974). The question remains as to whether specific subtypes of long term chronic schizophrenia are defined by reliable and distinctive configurations of neuropathology, premorbid characteristics as well as cognitive and behavioural outcome features (Carpenter & Fitzpatrick, 1988).

Investigations, without premorbid measures, of the later intellectual course of chronic schizophrenia have

tended to support suggestions of a pattern of relative stabilization or a very gradual decline in intelligence. These reports have added support to proposals of an early-phase occurrence of decline associated with the emergence of the schizophrenic process. For example, schizophrenics entering their second decade with the disorder, were reported to show negligible changes in IQ over an 8.4 test-retest interval during which they were hospitalized (Smith, 1964). Declines, during the same period, in the ability to shift mental set were reported, however, suggesting more insidious long term effects of chronic schizophrenia to which IQ tests may be relatively insensitive. Similar findings (i.e., relative stability of measured IQ with impairment in neuropsychological function) were described in a study of older schizophrenics with histories of 20 years with the disorder (Klonoff et al., 1970). More recently, unchanged cognitive ability in chronic schizophrenic patients over a five year, test-retest interval in a later (i.e., after 30 year) phase of the disorder has been described (Waddington, Hanafy, & Kinsella, 1990). Significant cognitive impairment had been evident on initial assessment but further decline was not observed. Only a sub-group of 13 schizophrenic patients who had developed buccal-lingual tardive dyskinesia during the five year period declined in cognitive ability.

Changes in intelligence in chronic schizophrenics

(mean age = 56 years) over a period of 35 years were examined in another longitudinal study employing the Canadian Army M Test (Schwartzman & Rudolph, 1977). Normal controls and pre-morbid measures were incorporated in the investigation. In comparing the results of this study with those, earlier, covering 10 (Schwartzman & Douglas, 1962) and 17 years (Schwartzman et al., 1962), little difference was found in the magnitude of the loss in overall intellectual functioning from the 17 year to the 35 year follow-up point. The continuing loss in overall intellectual ability that did occur could be attributed to the effects of aging as opposed to ongoing influences of the disorder, hospitalization or medication. Some intellectual abilities seemed to be less subject to the impact of the disorder and its associated treatment conditions. Spatial problem-solving ability and arithmetic reasoning exhibited normal, age-related decline. However, vocabulary and abilities related to perceptual judgements in social contexts and to mechanical aptitude were observed to be the most vulnerable to effects of schizophrenic disturbance. Subjects with a higher number of hospital admissions tended to exhibit less intellectual decline. It was suggested that episodic schizophrenic symptomatology may be a more effective predictor of intellectual decline than length of hospitalization per se. The implication of stability of overall intellectual ability when comparing the results from

the 17 and 35 year follow-up investigations is consistent with the recent suggestion that cognitive decline is very gradual in chronic schizophrenia such that it may not be evident in comparing intervals covering less than 20 years and not involving subjects over 65 years of age (Davidson et al., 1995; Harvey et al., 1995).

Summary. The thrust of the results from longitudinal studies of intellectual function in schizophrenia, with and without premorbid measures, and covering different time frames, points to an intellectual course of a relatively static nature following an early emergence of deficits. The longitudinal evidence, suggestive of an eventual static temporal pattern of impairment in intelligence associated with schizophrenia, is consistent with previously-described results from cross-sectional studies (Chaikelson & Schwartzman, 1983; Davidson et al., 1995; Goldberg et al., 1993; Harrow et al., 1987; Harvey et al., 1995; Heaton & Drexler, 1987; Hyde et al., 1994). Some of the cross-sectional results based on wider age ranges posit a continuous and significant intellectual decline over six decades and more (Davidson et al., 1995; Harvey et al., 1995). These results, however, also highlight the gradual pace of this impairment such that cognitive change would likely be undetected in longitudinal test-retest intervals of less than 20 years and in studies not employing schizophrenic subjects older than 65 years of age. Inasmuch

as such cognitive findings challenge models of unremitting decline in schizophrenia, they are compatible, as well, with numerous descriptions of the course of more global aspects of functioning in schizophrenia (e.g., M. Bleuler, 1978; Harding et al., 1987b; Harding et al., 1992). The latter have reported significant heterogeneity, and not uniform deterioration, in the long term course of the disorder.

Influence of Illness Duration, Institutionalization and Medication

Interpretations of investigations of change over time in the cognitive performance of schizophrenic patients are hampered by the potentially confounding influences of duration of the disorder, institutionalization and prolonged treatment with neuroleptic medication. Several investigations have reported null findings with regard to the relation of amount of hospitalization and duration of illness to decline in cognitive function in schizophrenia (Goldstein et al., 1991; Kolakowska, Williams, Ardern, et al., 1985; Lawson et al., 1988). Length of hospitalization was unrelated to overall intellectual performance or to abstract reasoning ability in a study that also revealed no differences in the cognitive performance of continuously and intermittently hospitalized schizophrenics (Harrow, Marengo, Pogue-Geile, & Pawelski, 1987). Evidence for specific effects of schizophrenic psychopathology and, conversely, for the absence of a significant impact of hospitalization

on cognitive deficits, has been suggested by the greater level of impairment shown by 80 schizophrenic patients when compared to patients with manic-depressive psychosis having a similar history of long periods of institutionalization (Mathai & Gopinath, 1985). Further, in the longitudinal studies covering 17 (Schwartzman et al., 1962) and 35 years (Schwartzman & Rudolph, 1977), no significant association was observed between length of hospitalization and the change in intellectual performance of schizophrenic subjects over these time periods. A mean length of hospitalization of 17 years was reported by Schwartzman and Rudolph (1977) in their study with a 35 year test-retest interval. It was suggested that this sample may have passed a threshold of time spent in hospital beyond which there would be no impact of individual differences in duration of hospitalization.

In examining the issue of the significance of acute or cumulative medication effects on cognitive performance in schizophrenia, findings have indicated a lack of adverse effects. Comparisons of cognitive function of medicated and unmedicated schizophrenics and studies of effects of implementation or withdrawal of neuroleptic regimens have consistently reported nonsignificant differences in cognitive performance. (Berman, Zec, & Weinberger, 1986; Cassens, Inglis, Applebaum, & Gutheil, 1990; Davidson et al., 1995; Harvey et al., 1995; Heaton & Crowley, 1981; Heaton & Drexler, 1987; King, 1990; Paulman et al., 1990;

Furthermore, improvement in attentional performance has been observed in response to neuroleptic medication (Spohn & M. E. Strauss, 1989) even in very chronic patients (Serper, Bergman, & Harvey, 1990). Results consistent with indications of the absence of adverse effects have also emerged from correlational analyses (Davidson et al., 1995; Harvey et al., 1996; Kolakowska, Williams, Ardern, et al., 1985; Paulman et al., 1990; Taylor & Abrams, 1984)

In an investigation of cumulative medication impact the total amount of neuroleptic medication received, whether over the entire course of the disorder or during the initial 5 years of the presence of psychopathology, was reported to be unrelated to cognitive dysfunction (Mathai & Gopinath, 1985). Studies of medication effects in older schizophrenics, in whom cumulative effects might be expected, have been rare. In one of the few studies to examine medication effects in older (mean age = 60 years) chronic schizophrenics , cognitive impairment was unrelated to the amount of medication received in a very impaired group of 510 schizophrenics with a long history of neuroleptic treatment (Owens & Johnstone, 1980).

Performance on Neuropsychological Measures

Neuropsychology has contributed to the understanding of schizophrenia through efforts, often in conjunction with neural imaging techniques, to determine the specific

location of neuropathology associated with the disorder. The knowledge garnered from neuropsychological research on brain-behaviour correlates in patients with confirmed brain damage has underpinned efforts to identify dysfunctional brain structures or brain systems in schizophrenia (Benson & Stuss, 1990; Kolb & Whishaw, 1983; Levin et al., 1989; Serper & Harvey, 1994). An accompanying central emphasis of the neuropsychological approach has been the description of cognitive performance in schizophrenia both in terms of global performance patterns and selective functional deficits.

Investigations of global neuropsychological functioning in schizophrenia, using standardized test protocols and summary ratings, have frequently revealed impairment in schizophrenia varying from moderate to marked across samples (e.g., Braff et al., 1991; Goldberg et al., 1993; Hyde et al., 1994; Kolb & Whishaw, 1983; Klonoff et al., 1970; Saykin et al., 1991; Strauss, 1993). In addition to the influence of motivation (Shakow, 1962), the substantial variability in measured cognitive performance in schizophrenia has been ascribed to the heterogeneity of the disorder (Strauss, 1993). The most pronounced overall deficits have been observed in the chronic as opposed to the acute forms of schizophrenia (Golden et al., 1983; Heaton, Baade & Johnson, 1978; Heaton & Drexler, 1987; Owens & Johnstone, 1980; Schwartzman & Douglas, 1962). A review of

comparative neuropsychological studies involving chronic or process schizophrenics suggested that their performance showed a pattern of severe deficits similar to those seen in organic, brain-damaged patients (Heaton et al., 1978).

The applicability of these findings of neuropsychological impairment to a geriatric schizophrenic population remains relatively unexplored. The paucity of information focused on patterns of neuropsychological performance associated with chronic schizophrenia of very long duration in elderly patients has been repeatedly noted (Arnold & Trojanowski, 1996; Belitsky & McGlashan, 1993; Hyde et al., 1994; Goldberg et al., 1993).

Arguments for the heightened utility of neuropsychological approaches directed at identifying patterns of specific cognitive deficits and their presumed associated brain systems, rather than initiatives employing global impairment indices, have been advanced by several groups of researchers in the field (e.g., Braff et al., 1991; Levin et al., 1989; Saykin et al., 1991). Conclusions from such function-oriented investigations differ in terms of the localization of neural dysfunction and the nature of neuropsychological impairment proposed.

Some reports present observations supportive of models of left hemisphere dysfunction and overactivation in schizophrenia (e.g., Saykin et al., 1991). Verbal memory and learning tasks have been identified as relatively more

severely impaired in the context of general impairment on a range of neuropsychological functions (Saykin et al., 1991). The pattern of accentuated verbal learning and memory impairments was posited as reflective of a predominant left temporal-hippocampal involvement within a context of diffuse, but less marked, neural dysfunction.

Earlier reports also identified temporal-hippocampal anomalies in schizophrenic subjects (Gruzelier, Seymour, Wilson, Galley, & Hirsch, 1988; Kolb & Whishaw, 1983; Levin et al., 1989). Divergences with the Saykin et al. (1991) findings lie in the proposed specificity of function and brain region associated with neuropsychological performance in schizophrenia. Previous studies, rather than specifying left temporal-hippocampal involvement, hypothesized a more widespread neural dysfunction. For example, Gruzelier et al. (1988) reported that schizophrenic, in comparison with affective disorder and normal subjects, exhibited relatively greater impairment of the left frontal as well as the temporal-hippocampal system.

In terms of the specific nature of memory impairment in schizophrenia, visual, as well as verbal-recall deficits, implying bilateral, rather than exclusively left-hemisphere, abnormalities, have been reported (Kolb & Whishaw, 1983; Levin et al., 1989). Divergences of these reports from findings of specifically verbal memory deficits (Saykin et al. 1991) may be explained by methodological differences:

e.g., the use of an unmedicated sample in the Saykin et al. study; differences in the range, sensitivity and task difficulty of the measures employed; and differences in controls used for confounding variables, such as age, education and sex.

In contrast to suggestions of temporal-hippocampal involvement with neuropsychological deviance in schizophrenia, selective anomalies in the frontal system and in its subcortical inputs, have been proposed as critical by a number of researchers. Deficits in executive functions of cognitive flexibility, planning and working memory in schizophrenia have been reported recently (Morice & Delahunty, 1996). A series of investigations by the National Institute of Mental Health (NIMH), concluded that impairments in cognitive flexibility in schizophrenia, as indexed by the Wisconsin Card Sorting Test (WCST; Grant & Berg, 1948; Heaton, 1981) were strongly related to dysfunction of the dorsolateral prefrontal cortex (DLPFC) involving blood flow deficits in this region (Berman et al., 1986; Goldberg, Weinberger, Berman, Pliskin, & Todd, 1987; Weinberger, Berman, & Zec, 1986).

To examine the issue of selective executive function versus more generalized deficits, an extension of earlier investigations on the DLPFC incorporated a neuropsychological test battery rather than solely the WCST (Paulman et al., 1990). Findings suggested some refinement

in terms of the previously-hypothesized neural pathology and affected cognitive function. As in earlier investigations (e.g., Weinberger et al., 1986), left frontal cerebral blood flow deficits, in particular, were strongly implicated in schizophrenic dysfunction. However, in a variation of the previous hypotheses regarding the DLPFC, Paulman et al. (1990) posited a system of left frontal underactivation coexistent with left posterior temporal and occipital overactivation. Also different from earlier findings, memory and attention impairments were reported, in addition to the executive deficits which were the sole impairments indicated in the earlier studies. Frontal dysfunction was unrelated to medication status, level of autonomic arousal or motivation (Berman et al., 1986; Paulman et al., 1990). Dysfunction was, however, significantly correlated with the duration of the disorder (Paulman et al., 1990), suggesting a progressive degenerative process in the frontal lobes. These findings are consistent with some earlier results describing decline over time in executive functions (Smith, 1964; Klonoff et al., 1970). A neurodegenerative model of this sort, in which the development of the illness and its associated deficits is directly related, temporally, to the evolution of progressive neuropathology, is challenged, however, by evidence from postmortem and CT studies of chronic schizophrenia which posit early-occurring brain pathology, no longer active (Weinberger, 1987), or no

discernible neuropathological abnormalities (Arnold et al., 1995).

DLPFC dysfunction in schizophrenia was suggested as independent of medication effects because similar physiologic abnormalities were observed in groups of medicated and unmedicated schizophrenic subjects (Berman et al., 1986). Further, DLPFC blood flow deficits in schizophrenic subjects were not observed in an experiment with the Continuous Performance Task, a task requiring attention, vigilance and mental effort. This finding suggests that the observed physiologic dysfunction is not simply a product of nonspecific mental effort factors.

Although impairment in executive functions appears also to be associated with psychotic bipolar illness, the two diagnostic groups may exhibit significantly different information-processing deficits (Yurgelun-Todd, Craft, O'Brian, Kaplan, & Levin, 1988). Examination of the pattern of errors seen in schizophrenic and psychotic bipolar patients suggests executive functions weakened in schizophrenia by poor mental flexibility, resulting in elevated perseveration on the WCST. In comparison, bipolar patients may exhibit executive impairment linked more to a failure to self-regulate and to maintain a mental set.

In an alternative model of frontal system neuropathology, frontal lobe feedback mechanisms, involving mesocortical dopamine projections to the dorsolateral

frontal cortex, have been posited as critical to schizophrenic cognitive function (Levin, 1984a; 1984b; Levin et al., 1989). Frontal feedback processes are proposed as mediators of attention and motor behaviour. Within this framework, Levin (1984b) further delineated an extensive attention system, impairments to any of the components of which may be responsible for schizophrenic neuropsychological dysfunction. Arousal and motivation deficits in schizophrenia are proposed as the functional bases for the attributes of distractibility, inability to focus attention, slowness in nonreflexive responses and perseveration which influence neuropsychological performance.

In contrast to models proposing a selective neuropsychological dysfunction in schizophrenia, evidence suggestive of a more generalized and nonspecific pattern of neuropsychological impairment has been described (Braff et al., 1991; Goldstein, 1986; Seidman, 1983; Taylor & Abrams, 1984). Of particular interest is the finding of a relatively modest level of perseverative responses by schizophrenic subjects on the WCST within the context of a generalized pattern of deficits on an extended Halstead-Reitan neuropsychological battery (Braff et al., 1991). These results contrast with those of the NIMH studies which posited evidence of markedly elevated WCST perseverative responses in schizophrenia, as supportive of their regional

specification hypothesis (Berman et al., 1986; Goldberg et al., 1987; Weinberger et al., 1986). Considerations of sample characteristics and methodology may serve to elucidate the divergent findings. Pronounced WCST deficits may be associated with only a subgroup of particularly deteriorated schizophrenic subjects with severe psychosocial and neurocognitive deficits, such as the those employed in the NIMH studies. Consistent with such a formulation are the Braff et al. (1991) findings of accentuated executive function deficits restricted to a subgroup of elderly, very long-term schizophrenic subjects within their larger, more diverse and more globally impaired sample. The NIMH studies did not employ a range of neuropsychological measures, thus not permitting group comparisons capable of identifying selective cognitive performance deviance with greater confidence. Finally, the comparability of the WCST findings in these investigations remains at issue given the altered, computerized version of the WCST used in the NIMH studies.

Whether in schizophrenia a generalized deficit rather than a specific ability is assessed by cognitive tasks is an issue of interest (Strauss, 1993). This issue has been examined particularly in terms of the relation of general intellectual ability and executive functions in schizophrenia. Findings from young adult samples suggest an independence in schizophrenia of global intelligence measures and executive functions such as cognitive

flexibility (Braff et al., 1991; Klonoff et al., 1970; Smith, 1964) as well as planning and working memory (Morice & Delahunty, 1996). The question of the continued independence of executive abilities and global intelligence into late adulthood in schizophrenia remains to be examined.

Summary. Research concerned with the neuropsychology of schizophrenia has developed, in concertation with other neuroscience methodologies, to a level of model elaboration proposing systems of neural dysfunction associated with recognized cognitive impairment. Most studies are restricted to schizophrenic patients younger than fifty. A central theme of neuropsychological research in schizophrenia concerns the presence of specific versus generalized neuropsychological deficits. Specific loci of neural dysfunction have been posited in one group of models involving predominantly frontal lobe mechanisms and linked subcortical inputs. Functional deficits in schizophrenia of memory, attention, arousal and executive processes are attributed to anomalies within this neural system. Other models concur principally regarding anomalies in the left temporal-hippocampal region affecting verbal memory and learning functions.

Subtypes within schizophrenia may be associated with selective neuropsychological performance. In particular, severely deteriorated, chronic schizophrenic patients may

exhibit accentuated dysfunction of executive functions. The neuropsychological functioning associated with elderly cohorts of schizophrenic subjects with a very long course of the disorder remains relatively unexplored.

The issue of diagnostic specificity of observed deficits is largely unaddressed given the employment in most investigations of norm-based comparisons or matched normal controls. Identifying a selective impact of schizophrenic pathology on neuropsychological performance requires research designs to include subjects with other psychiatric diagnoses in addition to normal controls. Findings of executive function deficits in psychotic bipolar disorder patients are suggestive of a non-specific neural dysfunction related to psychosis. However, differences in the nature of the affected information-processing components underlying the executive functions may distinguish the two diagnostic groups.

Proposed Study

The present study proposes, as its primary focus, to examine the effects of long-term chronic schizophrenia on cognitive functioning, controlling for the effects of age and premorbid intellectual ability and employing non-schizophrenic psychiatric, alcoholic and normal comparison groups. As previously indicated, few studies have examined changes in cognitive functioning with age in schizophrenia, using a longitudinal format, with a premorbid base

comparison measure and control groups matched on age and education. No such longitudinal studies have examined cognitive performance in schizophrenia in subjects over the age of 70, with histories of over 45 years with the disorder.

The proposed research compared intellectual change over more than 45 years in long term schizophrenic and other psychiatric patients, alcoholic subjects, as well as non-institutionalized, psychiatrically normal, community residing subjects. Records of premorbid intellectual functioning in the schizophrenic group permitted clarification as to the degree of cognitive change associated with the progression of the disorder. The use of the control groups in this study of the long term change in intellectual performance allowed a clearer examination of whether changes in schizophrenia and other psychopathologies are a concomitant of normal aging, of non-specific psychopathology effects or are specifically associated with the diagnosis.

A comparison group of eleven subjects with non-schizophrenic psychiatric disorders other than alcoholism was included to permit exploration of the diagnostic specificity of aspects of cognitive functioning in schizophrenia. The issue of diagnostic specificity of cognitive impairment in schizophrenia has received limited attention (Aylward et al., 1984). Greater impairment in

schizophrenia relative to adjustment, dysthymic and anxiety disorders is suggested by previous reports (Aylward et al., 1984; Fabrega et al., 1989). Comparisons of cognitive function in schizophrenia with psychotic and personality disorders have revealed inconsistent results (Aylward et al., 1984; Fabrega et al., 1989; Lawson et al., 1988; Mathai & Gopinath, 1985; Mulsant et al., 1993). Comparison of cognitive function and its change over time in schizophrenia and other psychiatric disorders permits further examination of the question of whether deficits and change are attributable to general psychopathology effects or specifically to aspects of schizophrenia pathology. An additional justification for the inclusion of the psychiatric comparison is that it permits such contrasts of cognitive characteristics and change in elderly psychiatric subjects, an age category which has been studied only very rarely in this context.

As a further element in the effort to address the issue of the diagnostic specificity of cognitive ability in schizophrenia, the proposed study also included a group formed of subjects with a history of alcoholism. Contrasts of schizophrenic and alcoholic subjects have been very limited, particularly, as is also the case with non-schizophrenic, psychiatric disorders, in terms of long-term change patterns in elderly individuals. Findings from the few existent reports on single time-point comparisons across

diagnoses in younger subjects have shown some inconsistency (Aylward et al., 1984; Fabrega et al., 1989). Longitudinal comparisons of cognitive function in schizophrenic and alcoholic subjects have not been reported. Cross sectional studies of change in cognitive ability in long-term alcoholics have reported declines, with smaller deficits observed in short-term alcoholics and social drinkers (Parsons, 1986). However, few investigations of alcoholic subjects have provided controls for baseline differences in early intellectual ability. A study which did incorporate such controls for baseline intellectual ability, within a longitudinal design, reported no greater decline in intellectual ability in alcoholics over a period of more than four decades than that of non-alcoholics (Gold, Andres, Chaikelson, Schwartzman & Arbuckle, 1991). A continuation of that investigation examined the temporal pattern of intellectual ability across the adult life span in subjects who represented a full continuum (low, moderate and heavy) of lifetime drinking behaviour (Arbuckle, Chaikelson & Gold, 1994). Results revealed generally circumscribed effects of average lifetime weekly alcohol consumption on cognitive function after controlling for psychological distress and early adult intelligence levels. Declines in nonverbal intelligence were unrelated to levels of alcohol consumption. Effects of alcohol did, however, appear in relation to the failure of heavy drinkers to improve during

adulthood on verbal intellectual abilities. The proposed study sought to compare patterns of long-term change in intellectual function associated with heavy drinking and schizophrenia.

Three normal control groups were also included in the study to facilitate a more unambiguous interpretation of the data by controlling for age and early ability influences. One normal control group was comprised of community residing subjects matched with the schizophrenic group on wartime overall intelligence test performance, as well as on education and age. The change in intellectual performance of the chronic schizophrenic group was also compared to that of a group of elderly subjects who achieved the same level of performance on the Vocabulary subtest of the M Test at the initial intelligence testing more than four decades earlier. Some reports have indicated vocabulary as a function which may be spared the intellectual impairment generally associated with some forms of schizophrenia and therefore useful as a possible index of premorbid intelligence in patients with the disorder (Klonoff et al., 1970; Schwartzman & Douglas, 1962). Other findings have reported no differential temporal effects across subtests of intelligence measures (Hamlin, 1969) or, in contrast, reported verbal abilities as more vulnerable than nonverbal (Lubin, Giesking, & Williams, 1962).

The inconsistency in findings related to vocabulary

ability is also evident in analyses which have probed the chronic-acute dimension of schizophrenia. Compatible with an earlier specification of Yates (1956), vocabulary was seen to decline in the chronic schizophrenic subjects in the Schwartzman and Douglas (1962) study and in those in a later and longer longitudinal investigation (Schwartzman & Rudolph (1977). A longer interval may permit the detection of a gradual recovery of abilities, like vocabulary, following their decline in earlier phases of schizophrenia. Normal subjects have shown significant improvement in vocabulary ability over time spans varying from almost a decade (Schwartzman & Douglas, 1962) to more than 40 years (Gold et al., 1995; Schwartzman et al., 1987). The contrasting temporal decline observed in chronic schizophrenic subjects may reflect a reduced ability to use informal educational opportunities which contribute to verbal abilities like vocabulary. In the proposed study, the use of a control group matched on early adult vocabulary ability permitted a further exploration, now covering more than 45 years, of the temporal pattern of vocabulary ability in schizophrenia while controlling for the effects of aging. The inclusion of the two normal control groups matched on early adulthood total and vocabulary M test scores permits an appreciation of the pattern of long-term change in general and specific (vocabulary) intellectual ability in schizophrenia juxtaposed against cognitive courses associated with aging.

A normal control group was also selected specifically for comparisons involving Psychiatric group subjects. The inclusion of this group permitted comparisons, in relation to a normal group matched on intelligence in early adulthood, of the temporal pattern of cognitive performance in a group with identified psychopathologies other than schizophrenia. With the incorporation of this group, the patterns of cognitive change of the two psychopathology groups could be directly contrasted and, as well, each group's performance could be assessed in relation to normal aging effects.

Changes in intellectual performance were also examined in terms of their relation to indicators of global premorbid social functioning (e.g., education, occupational and marital status) and early adult intellectual ability. As well, treatment and chronicity dimensions (e.g., number of hospitalizations, total length of hospitalization, duration of illness) were surveyed in relation to variation in intellectual performance.

Finally, the current study included several neuropsychological measures in its test protocol in order to address the recognized need for research examining the issue of neuropsychological impairment in relation to elderly samples of chronic schizophrenic patients (Arnold & Trojanowski, 1996; Nederhe & Rusin, 1987; Heaton & Drexler, 1987). Few studies have employed elderly, non-

schizophrenic, psychiatric, as well as normal, control groups, matched on educational or IQ variables in order to discern the specific neuropsychological performance characteristics associated with schizophrenic psychopathology. The investigation of comparative neuropsychological functioning employed a range of tests sensitive to frontal, temporal and parietal lobe functioning in order to discern the presence of specific versus generalized neuropsychological deficits with their putative associated brain region dysfunctions.

Conflicting findings exist regarding the nature and scope of neuropsychological deficits in schizophrenia. Based on the limited number of existent findings in relation to elderly subjects with chronic schizophrenia, neuropsychological impairment might be expected to be more limited than generalized in scope. This expectation follows from the results of Chaikelson and Schwartzman (1983) showing that only four of ten neuropsychological measures that had distinguished schizophrenic subjects in their forties from normals continued to show such discriminating power for the groups in their sixties. Further reinforcing the expectation of particular versus generalized deficits in the schizophrenic group are previous reports (e.g., Berman et al., 1986; Braff et al., 1991) of accentuated executive task deficits in particularly chronic or elderly samples of schizophrenic subjects similar to the present sample.

Moreover, it is expected that global intelligence will be independent of executive function performance given the lack of association reported with younger samples.

With regard to the issue of the diagnostic specificity of neuropsychological deficit, it is expected that schizophrenic subjects will exhibit more impairment than the Psychiatric group subjects on tests of executive function. Physiologic dysfunction of the DLPFC, a brain region associated with executive function, has been suggested as a definitive element of schizophrenic neuropathology. (Weinberger et al., 1986).

Hypotheses of the Study

1. Given past cross-sectional (Davidson et al., 1995; Goldberg et al., 1993; Harvey et al., 1995; Hyde et al., 1994) and longitudinal (Schwartzman & Rudolph, 1977) findings of long-term cognitive impairment and decline in elderly patients with chronic schizophrenia, it was predicted that, after controlling for the effects of differences in early adult intelligence, the Schizophrenic group would exhibit decline in intellectual ability, and greater loss in intelligence compared to normal control groups matched on age and levels of education and on early adulthood vocabulary and general intellectual ability. Furthermore, given past findings with regard to shorter time intervals, it was expected that vocabulary ability would be

part of this pattern of loss associated with long-term schizophrenia and thus be contraindicated as an index of premorbid intellectual ability.

2. It was predicted that the Schizophrenic group would also exhibit more impairment in intellectual ability across adulthood than the Psychiatric and Alcoholic groups given preponderant past findings, primarily in younger samples, of more severe deficits associated with chronic schizophrenia than with groups diagnosed with depression, anxiety and personality disorders, and substance abuse (Aylward et al., 1984; Fabrega et al., 1989; Lawson et al., 1988; Mathai & Gopinath, 1985).

3. It was predicted that, in the Schizophrenic group, education and SES levels measured in early adulthood would predict premorbid intelligence test scores but would not be associated with the change in scores over the test-retest interval. Similarly, premorbid social competency was expected to be associated with premorbid intelligence but not with long-term intellectual change, given evidence of the attenuation of such relationships in the long-term chronic course of the disorder (McGlashan, 1986a; 1988). It was predicted that premorbid intelligence, alone, would show relationships with current intelligence and cognitive ability measures in the Schizophrenic group, given

descriptions of stronger premorbid predictor-outcome relationships within similar domains of functioning (Harding et al., 1992; McGlashan, 1986a; Strauss & Carpenter, 1974; Strauss, Klorman, & Kokes, 1977).

4. Given the inconsistency of findings regarding the nature and scope of neuropsychological deficits in schizophrenia and the very limited number of investigations in relation to geriatric schizophrenia, hypothesis formulation was restricted. Consistent with previous indications in relation specifically to samples of elderly schizophrenic subjects, it was predicted that neuropsychological impairment in schizophrenia would prove to be more limited than generalized in scope, with an accentuation of executive task deficits. It was also anticipated that executive task deficits would be independent of characteristics of general intelligence in the schizophrenic group. With regard to the issue of the diagnostic specificity of neuropsychological deficit, it was expected that more impairment on measures of mental flexibility in executive functions would be revealed in the Schizophrenic than in the Psychiatric group given propositions that deficits in mental flexibility differentiate schizophrenic psychopathology.

Method

Subjects

The sample of volunteer subjects consisted of male veterans of World War II for whom archival data from the period of their enlistment into the army were available at the Department of Defense in Ottawa. Scores on the Canadian Army Revised Examination "M" Test--an intelligence measure developed by the Canadian Army to screen enlistees during the Second World and administered from 1942 to 1945--formed part of this archival information, in addition to summary physical and mental status assessments. The subjects comprised six groups.

The first group (Schizophrenic) consisted of 22 chronic schizophrenic patients at the Ste. Anne de Bellevue Veterans' Hospital. Of these, 19 were in-patients and three attended an out-patient day centre program. All but one of the schizophrenic Ss were on maintenance doses of one of the phenothiazines. Fourteen of the subjects in this group had diagnoses of chronic schizophrenia without subtype specification, seven were diagnosed with paranoid schizophrenia and one had a diagnosis of undifferentiated schizophrenia. Thirteen subjects were French speaking and nine were English speaking.

The second group (Psychiatric) included 11 patients at the Ste. Anne de Bellevue Hospital with psychiatric diagnoses other than schizophrenia. Of these subjects,

seven were in-patients and four were residents of the less structured hospital unit already described. The diagnoses of this group included seven Ss with DSM-III-R (The Diagnostic and Statistic Manual of Mental Disorders, Third Edition, Revised, American Psychiatric Association, 1987) diagnoses of mood disorder, two with combined diagnoses of mood disorder and personality disorder, one with an anxiety and personality disorder and one with a mixed diagnosis of mood, anxiety and personality disorder. Nine of the subjects indicated French, and two English, as their mother tongue.

Subjects were selected for the Schizophrenic and Psychiatric groups on the basis of examination of hospital case records. Only subjects with consistent diagnoses of either schizophrenia or another psychiatric disorder, made by staff psychiatrists over their long periods of treatment, were selected for inclusion in the two groups. The most recent hospital diagnoses were made by staff psychiatrists employing DSM-III-R criteria. In addition, the Structured Clinical Interview for DSM-III-R Diagnosis (SCID) (Spitzer, Williams, Gibbon & First, 1988) was employed in the present study to confirm current diagnosis in 12 of the schizophrenic patients using a diagnostic protocol with verified reliability and validity. Due to the length of the structured interview, it was not used with ten of the schizophrenic patients. With these patients it was judged

that the time required for the intelligence and cognitive testing would be the maximum amount of interviewing time during which they could participate effectively.

Inclusion and exclusion criteria for the Schizophrenic group were as follows: A medical history of diagnosis and treatment for schizophrenia since early adulthood but subsequent to army enlistment; the meeting of DSM-III-R criteria for schizophrenia in archival and current case data; continuous treatment for schizophrenia for at least the past 20 years; no history of alcoholism or mental retardation; and no indication of gross organic brain syndrome. Initially, 29 subjects were selected who met these criteria, however records of enlistment intelligence test performance were available for only 22 of the selected group. Of the seven subjects for whom premorbid M Test scores were unavailable, five were tested in the present study, one refused to participate and one did not complete the testing.

The Psychiatric group was chosen using the same criteria as above, except for the DSM-III-R diagnosis of schizophrenia. Although fourteen subjects meeting the selection criteria were identified, only eleven of these proved to have enlistment Army "M" scores available.

Subjects for the three community control groups and the alcoholic group employed in this study were drawn from a sample of community-dwelling Canadian Army veterans who were

participants in an ongoing Concordia University study designed to determine whether intellectual change over a 40 year span was predictable on the basis of certain lifestyle variables (See Gold et al., 1991; 1995, for a description of the full sample). All subjects had been tested initially in 1984, as part of an investigation of the course of intelligence in adulthood (Schwartzman et al., 1987). At that time, the subjects were administered the complete M Test. In addition, 145 of these subjects were tested again in 1989, at which time they completed the M test as well as a number of neuropsychological measures (Arbuckle et al., 1994). Due to the exigencies of matching it was not possible to obtain the same French/English ratio in the control groups as in the Schizophrenic group.

The first control group (ConVoc) employed in this study consisted of 22 Ss (six French-speaking and 16 English-speaking) who were drawn from the community dwelling veterans who had been tested in 1984 and again in 1989. Subjects selected for the ConVoc group had no history of psychiatric conditions or significant physical disability requiring institutionalization. Data from the 1984 testing were employed in selecting the ConVoc group because subjects had not been administered the Mechanical section subtests of the M test at the 1989 date. The ConVoc group was selected case by case so as to match the Schizophrenic group on age, education and performance, at army enlistment, on the

Vocabulary sub-test of the M test.

A second normal, community-dwelling, control group (ConTot) comprised 22 veterans drawn from the same larger study samples referred to above. Twelve of the 22 ConTot group subjects were French speaking while ten were English-speaking. The ConTot group was constituted by matching subjects individually with the subjects of the Schizophrenic group on age, level of education and total score, at enlistment, on the M test. The requirements of matching resulted in three subjects in the ConTot group also being in the ConVoc group.

A third normal, community-dwelling control group (ConPsych) comprised 11 elderly veterans, also selected from the larger study samples. These subjects were individually matched with subjects in the Psychiatric group on current age, education and total enlistment M test scores. Four of the ConPsych subjects were French and seven were English-speaking.

A final control group (Alcoholic) was formed of 20 subjects (12 French, and nine English-speaking) from the community dwelling sample who had mean lifetime drinking levels that would be associated with alcoholism.

Measures

Socioeconomic status and premorbid social competence. Archival data on education, occupation and early social history were used to complete the Blishen Scale of

Socioeconomic Prestige (SES) (Blishen & McRoberts, 1976) and the Premorbid Social Competence Scale (Zigler & Phillips, 1961; Zigler & Levine, 1981). The Premorbid Social Competence Scale provides a broad measure of development or maturity determined by ranking on six variables reflective of cognitive, interpersonal and social functioning: age, intelligence, education, occupation, employment history and marital status. Each variable is divided into three categories which represent ascending levels of social competence (i.e., 0, 1 and 2)(see Appendix B for a description of the three category definitions for each variable). The mean of the six individual ratings is the overall social competence score. In this study, only five variables were incorporated into the overall score due to the unavailability of adequate employment history information. Zigler and Levine (1981, 1983) have indicated inter-rater reliability levels of over 99% for this scale. In relation to validity considerations, they have also reported that the overall social competence ratings are associated with psychiatric symptomatology and defenses employed, prognosis, and the paranoid-nonparanoid distinction in schizophrenia. The premorbid competence ratings were examined to assess the relationship of premorbid qualities in the schizophrenic and psychiatric subjects to measures of change over time in their cognitive functioning.

Alcohol use. Drinking levels were established in the sample from which the Alcoholic group was chosen using the Concordia Lifetime Drinking Questionnaire (CLDQ; Chaikelson, Arbuckle, Lapidus, & Gold, 1994). The CLDQ permits the calculation of measures of current and lifetime alcohol use. Quantity is measured in drinks, with one drink defined as 13.6 g (17ml) of absolute alcohol, an amount equivalent to the alcohol content of 1.5 g of distilled spirits, 5 oz. of table wine or 12 oz. of beer. Test-retest reliability of the CLDQ over 33.1 ± 4.3 months was reported as .76 for the lifetime drinking measure. For a more complete description of the instrument see Chaikelson et al. (1994). The section of the CLDQ on lifetime drinking was used in the selection of subjects for the Alcoholic group from the community-dwelling sample. For the purposes of the present study, subjects who had a mean weekly lifetime drinking level of 35 drinks or more per week were selected for the Alcoholic group.

Intelligence. All subjects were retested on the Canadian Army Revised Examination "M" test of Intelligence (M Test), a speeded test developed with English and French versions by the Canadian Army to facilitate the screening and assignment of army recruits in World War Two (See Appendix C for a description of test items). This timed measure is divided into three principal parts: Non-verbal, Mechanical and Verbal. The Non-verbal section consists of

the Picture Completion, Picture Anomalies and Paper Formboard tests. The two Mechanical measures are Mechanical Information and Tool Recognition. The Verbal section comprises Arithmetic, Vocabulary and Verbal Analogies.

The M Test total score is the sum of the total number of correct responses, with a maximum possible score of 211. Subjects are required to complete as much of each subtest as possible within a given time period. A wartime representative sample obtained a mean total M Test score of 127 with a standard deviation of 32.3. Normative studies carried out by the Personnel Selection Service of the Canadian army (Blair, 1959) revealed that the M Test correlated highly with well standardized, group-administered intelligence measures such as the American Army Alpha Examination (.80) and the Penrose-Raven Matrices (.72). The test-retest reliabilities for both total M Test and individual M Test scores have been observed to be at a high level (Schwartzman et al., 1987). The total M Test score showed a .95 test-retest correlation over a 40 year period. Coefficients for the eight subtests ranged from .63 for Picture Completion to .94 for Vocabulary; they were in the .95 range for the total M Test, .85 for the nonverbal section, .92 for the mechanical subtests, and .91 for the verbal measures. Standard procedures for the M Test were followed with one exception: subjects were seen individually rather than in groups.

Cognitive set. The Wisconsin Card Sorting Test (WCST) (Grant & Berg, 1948; Heaton, 1981) was employed to obtain an index of the ability to develop task set and to shift conceptual orientation. The task is considered to be sensitive to frontal lobe dysfunction in adults (Milner, 1963). Subjects are presented with four stimulus cards having designs differing in colour, form, or number. Subjects are asked to sort a pack of cards that vary along these dimensions. The correct sorting strategy is changed without warning to the subjects every time they sort 10 consecutive cards correctly. Testing ends when subjects successfully complete six categories or sort 128 cards, whichever comes first.

Fluency. The Newcombe Fluency Test (1969) and Benton Word Fluency Test (Benton and Hamsher, 1976) were used. The Newcombe Fluency Test, asks subjects to produce, orally, the names of as many animals as possible in one minute, the names of as many objects as possible in one minute, and to alternate in giving as many bird/colour/bird/colour, and so on, names as possible in one minute. For the Benton Word Fluency Test, subjects are required to say as many words as possible beginning with a particular letter (C, F and L) with a one minute time limit for each letter. The Newcombe Word Fluency Test has been found to be sensitive to left parietal/temporal (Newcombe, 1969), and the Benton to left frontal lobe function (Milner, 1964).

The Gotman Design Fluency Test (Jones-Gotman & Milner, 1977) was employed as the nonverbal analogue of the word fluency measures. It requires the subject to generate as many different, unnameable, figures as they can in five minutes. Performance on the Gotman Test has been linked to right frontal lobe damage.

Reproduction and recall. The Digit Span (forward and backward) Test of the Wechsler Memory Scale (Wechsler, 1945) was used to assess memory for digits in the standard format. It has been found to be sensitive to age differences and to left parietal damage (Newcombe, 1969).

The Rey Osterreith Complex Figure Design Test (REY) (Osterreith, 1944) was employed as a measure of visual motor copying and visual spatial construction ability, using its copying mode. It also serves as an index of visual motor/visual spatial memory using its design recall format. Test administration proceeded using an administrative protocol adapted for elderly subjects (Read, 1987). Subjects were requested to copy, as accurately as possible, the Rey Figure presented in successive components until the total figure had been presented (See Appendix D). Approximately five minutes after having copied the last component subjects were asked to reproduce as much of the total figure as they could remember. This measure is sensitive to right parietal and temporal function (Taylor, 1969).

Procedure

In the case of the Schizophrenic and Psychiatric groups, there were two test sessions, usually 24 hours apart. Testing was divided into two segments to accommodate subjects who might have found a more extended period of testing excessively taxing. Subjects were interviewed in their preferred language, English or French. Initially, each subject was given the M Test and then the REY. In the period between the copy and recall phases of the REY subjects were administered the Benton Verbal Fluency Test. The final tests administered in this first testing session were the Forward and Backward Digit Span sections of the Wechsler Memory Test. The second session consisted of the following tests administered in unvarying order: the Design Fluency Test, the Newcombe Category Fluency Test and the Wisconsin Card Sorting Test. The particular fixed ordering of tests with the Schizophrenic and Psychiatric groups, chosen in preference to a counter-balancing protocol, was established in order to elicit, sustain and enhance motivation and interest.

Normal subjects tested in the 1984 to 1986 testing were interviewed in one session in their homes. The majority of the normal subjects who were involved in the 1989 study were assessed at home and were interviewed in two to three sessions, usually over a period of no longer than one week. All normal subjects were interviewed in their preferred

language and were paid a small honorarium for their participation. Control subjects were involved in several other studies and thus were assessed with a number of social, psychological and neuropsychological measures in addition to those which are the focus of the present study involving the Schizophrenic and Psychiatric group subjects.

Results

The broad objectives of the data analyses were fourfold:

1. To assess the change in intellectual performance in long term schizophrenia, of over 47 years duration, by comparing the intelligence test performance of the Schizophrenic group with that of normal groups matched on intellectual abilities in early adulthood.

2. To compare intellectual performance patterns associated with chronic schizophrenia over a long-term period with those of individuals with other psychiatric diagnoses and alcoholism so as to assess the extent to which intellectual characteristics in schizophrenia may be diagnostic specific or associated with effects of general psychopathology.

3. To examine the performance of this elderly Schizophrenic group on a range of neuropsychological measures related to regional brain function with a view to determining performance characteristics specific to geriatric schizophrenia, distinct from patterns associated with normal aging and other psychopathologies.

4. To assess the relationship of demographic, premorbid and clinical characteristics of the Schizophrenic group to its identified patterns of intellectual and neuropsychological ability.

Intra-group Changes over Time in M Test Performance

Table 1 presents a global indication of the pattern of temporal change within each of the groups across adulthood. Differences between enlistment and current M Test performance on the three domains and the total score are shown for each group. Examination of the magnitude of change in M scores over time proceeded with Bonferroni-corrected *t*-tests for paired samples. The Bonferroni procedure resulted in uninflated, experiment-wise alpha levels, adjusted for multiple comparisons (Larzarele & Muliak, 1977). As expected, the Schizophrenic group declined significantly in total M score, a decrease of 41 points ($t(21) = -5.85$, $p < .0001$) over the time interval. This significant overall decline in the Schizophrenic group reflected significant decreases on the total Verbal ($t(21) = -4.50$, $p < .0001$), Nonverbal ($t(21) = -6.71$, $p < .0001$) and Mechanical ($t(21) = -4.14$, $p < .0001$) domains of the M Test.

The Psychiatric group showed a significant loss in total score ($t(10) = -4.17$, $p < .01$) of a magnitude similar to that of the Schizophrenic group, with significant reductions in Nonverbal ($t(10) = -7.79$, $p < .0001$) and Mechanical ($t(10) = -3.20$, $p < .01$) domain scores. The Psychiatric group's decline in total Verbal score showed a similar declining trend but was not significant ($t(10) = -2.07$, $p = .066$).

Contrastingly, global M Test performance of the other

Table 1

Mean Differences (and Standard Deviations) Between Enlistment and Current M Test Scores

Group	Schizophrenic n=22	Psychiatric n=11	ConVoc n=22	ConTot n=22	Alcoholic n=20
M Score					
Total	41.36***	34.64**	0.77	1.00	4.30
	(33.15)	(27.52)	(20.13)	(20.74)	(15.42)
Verbal	13.86***	8.09	-1.36	1.32	0.35
	(14.46)	(12.98)	(6.66)	(8.48)	(8.51)
Nonverbal	16.25***	16.09***	7.59***	4.50*	6.20**
	(11.36)	(6.84)	(7.59)	(7.67)	(8.10)
Mechanical	11.25***	10.45**	-5.45*	-4.82*	-2.25
	(12.73)	(10.85)	(10.92)	(10.60)	(5.67)

*$p < .05$

**$p < .01$

***$p < .001$

groups was essentially stable. The ConVoc and ConTot groups lost no more than a point during the intertest interval, while the Alcoholic group declined 4.3 points, all magnitudes which were not significant (ConVoc: $t(21) = -0.18$, $p = .859$; ConTot: $t(21) = -0.23$, $p = .823$; Alcoholic: $t(19) = -1.25$, $p = .227$). All three groups, like the two groups with psychiatric disorder, declined in total Nonverbal scores (ConVoc: $t(21) = -4.72$, $p < .0001$; ConTot: $t(21) = -2.75$, $p < .05$; Alcoholic: $t(19) = -3.43$, $p < .01$) but this loss was accompanied by a stability in overall Verbal scores. The total Mechanical scores of these groups increased, those of the ConVoc and ConTot groups significantly (ConVoc: $t(21) = 2.34$, $p < .05$; ConTot: $t(21) = 2.13$, $p < .05$).

M test Performance in Schizophrenia in Relation to Normals

Demographic and enlistment M test characteristics. The variables of interest were screened for accuracy of data entry, missing data, univariate outliers and normality of distribution. One of the subjects in the ConTot group who was missing data for age at enlistment was given the mean for the group on this variable. There were no outliers on any of the variables of interest and assumptions of normality of distributions were met.

The first analyses involved Bonferroni-corrected, t-test comparisons of the Schizophrenic group with the normal control groups on demographic and total enlistment M

Test performance to verify the matching procedure. Table 2 indicates that the normal groups were equivalent, in terms of group mean values, to the Schizophrenic group in current age and education levels. In total enlistment M score, the groups' mean scores were equivalent. Although the ConVoc group's total enlistment M Test score was higher than that of the Schizophrenic group in terms of conventional alpha levels, the difference proved nonsignificant after Bonferroni correction ($t(42) = -2.67$, $p > .05$).

Schizophrenic group M Test performance compared to the ConTot group. A Multivariate analysis of variance (MANOVA) followed by univariate analyses of variance (ANOVAS) was employed to identify differences between the Schizophrenic and the ConTot group on current performance on the eight subtests of the M Test. The two groups had been matched on total M Test scores at the time of enlistment in the army in World War Two. As Table 3 indicates, they also proved to have similar enlistment scores on each of the eight M subtests.

Pillai's criterion was employed to test for the significance of effects in this and the remaining multivariate analyses because its robustness makes it appropriate for studies, such as the present one, characterized by small sample sizes and unequal ns in some of the groups (Tabachnik & Fidell, 1989). Results revealed a significant multivariate main effect of group on current M

Table 2

Means and Standard Deviations on Demographic and Enlistment M Test Variables

	Group		
	Schizophrenic n=22	ConTot n=22	ConVoc n=22
Variable			
Enlistment Age	23.77	26.06	25.64
	(4.32)	(4.31)	(4.70)
Current Age	70.59	69.95	68.41
	(5.09)	(4.89)	(4.44)
Education	7.54	7.68	8.36
	(2.30)	(2.46)	(2.10)
Enlistment SES	31.75	36.79	40.99
	(9.86)	(8.20)	(11.27)
Enlistment M	107.45	109.86	134.09
	(32.00)	(29.90)	(34.10)

Table 3

Means and Standard Deviations For Enlistment and Current M Test Scores

	Enlistment		Current	
	Schizophrenic n=22	ConTot n=22	Schizophrenic n=22	ConTot n=22
M-Test Variables				
Picture Completion	12.43 (3.49)	12.73 (3.47)	7.50** (3.57)	11.55** (3.10)
Picture Anomalies	10.46 (4.52)	10.73 (4.24)	6.00** (3.38)	9.82** (2.82)
Paper Formboard	10.27 (4.68)	8.23 (4.01)	3.41 (3.17)	5.82 (4.10)
Tool Recognition	16.51 (4.83)	17.36 (6.11)	9.68** (5.44)	20.27** (4.56)
Mechanical Information	15.10 (6.59)	16.36 (5.18)	10.68** (6.75)	18.27** (6.53)
Arithmetic	7.69 (2.54)	8.95 (3.24)	4.18** (2.26)	8.04** (3.16)
Vocabulary	14.92 (6.24)	14.73 (6.57)	12.45 (8.05)	17.09 (4.47)
Verbal Analogies	20.08 (7.86)	20.77 (6.67)	12.18 (8.88)	18.00 (6.33)
Total M Test	107.45 (32.00)	109.86 (29.90)	66.09** (34.37)	108.86** (24.86)

Note. Comparisons are between group mean scores from the same test time point based on Bonferroni-corrected univariate *F* tests.

**Group means at test point differ at $p < .01$ or less

Test scores, F (1, 35) = 8.75, p < .0001 (See Summary table: Appendix E, Table 1) Univariate analyses indicated that the ConTot group, as had been predicted, had significantly higher current scores on all the subtests of the M Test. Table 3 reveals that after Bonferroni protection of alpha levels in the univariate analyses, five of these differences in subtest scores remained significant. The five subtests that continued to differentiate the two groups after using more stringent alpha levels were Picture Completion, Picture Anomalies, Tool Recognition, Mechanical Information and Arithmetic. Table 4, portraying results of Bonferroni-adjusted t-tests for paired samples on differences between enlistment and current scores, shows significant decline in these abilities in the Schizophrenic group (Picture completion: $t(21) = -5.19$, $p < .0001$; Picture anomalies: $t(21) = -3.93$, $p < .001$; Tool recognition: $t(21) = -4.26$, $p < .0001$; Mechanical information: $t(21) = -3.43$, $p < .01$; Arithmetic: $t(21) = -5.88$, $p < .0001$) and nonsignificant changes in the ConTot group. The Schizophrenic and ConTot groups were not differentiated on current Paper formboard, Vocabulary and Verbal analogies abilities (Table 3). As seen in Table 4, both groups declined significantly over time on the Paper formboard subtest (Schizophrenic: $t(21) = -6.74$, $p < .0001$; ConTot: $t(21) = -4.33$, $p < .0001$) As well, declines were seen in the two groups in Verbal analogies ability, although only the decrement of the Schizophrenic

Table 4

Mean Difference Between Enlistment and Current M Test Scores

	Group	
	Schizophrenic n=22	ConTot n=22
M-Test Variables		
Picture Completion	-4.93*** (4.45)	-1.18 (3.62)
Picture Anomalies	-4.46** (5.32)	-0.91 (3.70)
Paper Formboard	-6.86*** (4.77)	-2.41*** (2.61)
Tool Recognition	-6.83*** (7.52)	+2.91 (6.28)
Mechanical Information	-4.42* (6.05)	+1.91 (6.49)
Arithmetic	-3.51*** (2.80)	-0.91 (2.81)
Vocabulary	-2.46 (6.30)	+2.36 (4.86)
Verbal Analogies	-7.89*** (8.40)	-2.77 (5.87)
M Test Total	-41.36*** (33.15)	-1.00 (20.74)

*$p < .05$
**$p < .01$
***$p < .001$

group attained significance levels $t(21) = -4.41$, $p < .0001$. Finally, vocabulary proved to be a stable ability in both groups; Table 4 indicates a nonsignificant loss and gain in the scores of the Schizophrenic and ConTot group, respectively.

Schizophrenic group M Test performance compared to the ConVoc group. The subjects of these two groups had been matched individually on enlistment Vocabulary subtest scores in order to assess the assumption that current vocabulary ability may be an effective index of premorbid intellectual ability in studies of long-term schizophrenia. The total enlistment M Test and the eight subtest scores of the ConVoc group were higher than that of the Schizophrenic group, although only the superiority on the Picture completion subtest proved to be significant in relation to Bonferroni-adjusted alpha levels (Table 5). MANOVA followed by univariate analyses were performed on the current M subtest scores of the two groups. Results revealed a significant main effect of group, F (1, 35) = 16.51, $p < .0001$ (Summary table: Appendix E, Table 2). As shown in Table 5, Bonferroni-corrected univariate analyses indicated that, at current testing, the ConVoc group scored significantly higher than the Schizophrenic group on the Vocabulary as well as the other seven M subtests.

The results of adjusted t-tests on the intertest differences in M scores within each group, contrast the

Table 5

Means and Standard Deviations For Enlistment and Current M Test Scores

	Enlistment		Current	
	Schizophrenic n=22	ConVoc n=22	Schizophrenic n=22	ConVoc n=22
M-Test Variables				
Picture Completion	12.43* (3.49)	15.45* (2.74)	7.50*** (3.57)	14.55*** (3.29)
Picture Anomalies	10.46 (4.52)	13.55 (4.02)	6.00*** (3.38)	10.68*** (2.88)
Paper Formboard	10.27 (4.68)	12.68 (5.55)	3.41*** (3.17)	8.95*** (4.58)
Tool Recognition	16.51 (4.83)	19.82 (6.49)	9.68*** (5.44)	22.27*** (3.83)
Mechanical Information	15.10 (6.59)	20.91 (7.29)	10.68*** (6.75)	23.91*** (6.01)
Arithmetic	7.69 (2.54)	9.86 (2.80)	4.18*** (2.26)	8.91*** (2.84)
Vocabulary	14.92 (6.24)	16.36 (6.19)	12.45** (8.05)	20.50** (5.90)
Verbal Analogies	20.08 (7.86)	25.45 (6.59)	12.18*** (8.88)	23.64*** (6.95)
Total M Test	107.45 (32.00)	134.09 (34.10)	66.09*** (34.37)	133.32*** (25.97)

Note. Comparisons are between group mean scores from the same test time point based on Bonferroni-corrected univariate F tests.

* $p < .05$
** $p < .01$
*** $p < .001$

pattern of decline of the Schizophrenic group with the mixed pattern of stability, decrease and augmentation evident in the analyses of the intertrial differences in the ConVoc group's scores (Table 6). Like the Schizophrenic group (Picture anomalies: $t(21) = -3.93$, $p < .001$; Paper formboard: $t(21) = -6.74$, $p < .0001$), the ConVoc group declined in performance on the nonverbal Picture anomalies ($t(21) = -3.62$, $p < .01$) and Paper formboard ($t(21) = -4.27$, $p < .0001$)subtests. On the six other subtests, the ConVoc group's pattern was dissimilar to that of the Schizophrenic group. While the ConVoc group showed significant improvement in measured vocabulary ability ($t(21) = +4.67$, $p < .001$), the Schizophrenic group ability level was stable. On the remaining subtests, the stability evident in the ConVoc group performance is juxtaposed against the significant declines observed in the Schizophrenic group (Picture completion: $t(21) = -5.19$, $p < .0001$; Tool recognition: $t(21) = -4.26$, $p < .0001$; Mechanical information: $t(21) = -3.43$, $p < .01$; Arithmetic: $t(21) = -5.88$, $p < .0001$; Verbal analogies: $t(21) = -4.41$, $p < .0001$).

M test Performance of the Schizophrenic Group in Relation to the Psychiatric and Alcoholic Groups

The comparisons of the Schizophrenic group with the Psychiatric and Alcoholic groups were effected in an attempt to discern cognitive change characteristics in

Table 6

Mean Difference Between Enlistment and Current M Test Scores

	Group	
	Schizophrenic n=22	ConVoc n=22
M-Test Variables		
Picture Completion	-4.93*** (4.45)	-1.00 (3.64)
Picture Anomalies	-4.46** (5.32)	-2.86* (3.71)
Paper Formboard	-6.86*** (4.77)	-3.73*** (4.10)
Tool Recognition	-6.83*** (7.52)	+2.45 (6.39)
Mechanical Information	-4.42* (6.05)	+3.00 (6.14)
Arithmetic	-3.51*** (2.80)	-0.95 (1.09)
Vocabulary	-2.46 (6.30)	+4.14*** (4.16)
Verbal Analogies	-7.89*** (8.40)	-1.82 (3.70)
M Test Total	-41.36*** (33.15)	-0.77 (20.14)

*p < .05
**p < .01
***p < .001

schizophrenia that may differentiate it from other long-term disorders. The change in cognitive performance during adulthood of the Psychiatric and Alcoholic groups was compared with that of the Schizophrenic group in separate analyses. The scores on the Paper formboard and Vocabulary subtests and the total M Test score were analyzed in separate 2 (groups) by 2 (test occasions) ANOVAS with repeated measures on the second factor. In the analyses comparing the Alcoholic to the Schizophrenic group, total M Test scores at enlistment as well as early adult SES were used as covariates because the groups differed significantly on these variables. The Paper formboard and Vocabulary subtests were selected for analysis as measures of verbal and nonverbal ability because they have shown high levels of test-retest reliability across adulthood (Schwartzman et al., 1987).

Demographic, clinical and enlistment M Test characteristics in relation to the Psychiatric group. As seen in Table 7, Bonferroni-corrected t-test comparisons revealed the Psychiatric group to be similar to the Schizophrenic group in age, both at enlistment and current testings, education, SES as well as total enlistment M test performance. The Schizophrenic group had spent more time in hospital than the Psychiatric group, a difference which proved significant even after adjustment for inflated alpha level. Although the Schizophrenic group had more

Table 7

Means and Standard Deviations For Demographic, Clinical and M Test Variables

	Group	
	Schizophrenic n=22	Psychiatric n=11
Variables		
Enlistment Age	23.77 (4.32)	25.64 (4.30)
Current Age	70.59 (5.09)	73.91 (4.53)
Education	7.54 (2.30)	8.09 (2.34)
Enlistment SES	31.75 (9.86)	33.33 (7.75)
Enlistment M Test	107.45 32.00	130.18 28.05
Total Months in Hospital	256.29* (204.09)	89.27* (70.54)
Number of Hospitalizations	6.68 (6.57)	3.36 (2.38)
Years Since First Diagnosis	39.59 (8.30)	26.18 (15.17)
Premorbid Social Competency Rating[a]	0.68 (0.36)	1.02 (0.32)

[a]Range = 0 - 2 (Zigler & Phillips, 1961).

*Means differ at $p < .05$ following Bonferroni adjustment.

admissions, a longer period with a diagnosed psychiatric disorder and lower premorbid social competence, these differences were not significant when adjusted for multiple comparisons.

Change over time in the M test performance of the Psychiatric group compared to the Schizophrenic group. Contrary to the predictions of this study, the comparative analyses of the Psychiatric and Schizophrenic groups indicated a similar temporal pattern of intellectual ability in the two groups. The repeated measures ANOVA on the Paper Formboard scores of the Psychiatric and Schizophrenic group showed no main effect of group, $F(1, 31) = .09$, $p = .766$ (Summary Table: Appendix E, Table 3). Table 8, which presents scores and comparisons adjusted for inflated alpha levels, indicates that the performance of the groups on both occasions was similar. There was a significant main effect of time on the Paper Formboard scores of the two groups, reflecting the decline in this ability across both groups between early and late adulthood, $F(1, 31) = 63.74$, $p < .001$. The nonsignificant interaction, $F(1, 31) = .36$, $p = .555$, indicated that the relative levels of spatial reasoning ability in the two groups remained unchanged across adulthood.

The significant main effect of group on the enlistment and current Vocabulary scores of the M Test, $F(1, 31) = 4.51$, $p < .042$, denotes the superior performance of the

Table 8

Means and Standard Deviations of Enlistment and Current Paper Formboard and Vocabulary Subtest and Total M Scores

	Group	
	Schizophrenic n=22	Psychiatric n=11
M Test Variables		
Enlistment Paper Formboard	10.27 (4.68)	10.18 (4.98)
Current Paper Formboard	3.41 (3.17)	4.27 (3.55)
Enlistment Vocabulary	14.92 (6.24)	17.55 (5.13)
Current Vocabulary	12.45 (8.05)	19.09 (5.92)
Enlistment Total M	107.45 (32.00)	130.18 (28.05)
Current Total M	66.09 (34.37)	95.45 (33.91)

Psychiatric group considered across the two time points (Appendix E, Table 4). These differences in Vocabulary scores were not significant at the individual testing occasions, considered in isolation, however (Table 8). The main effect of time was not significant, $F(1, 31) = .15$, $p = .699$; performance on Vocabulary was stable over time across the two groups. Although vocabulary ability declined slightly in the Schizophrenic group and increased in the Psychiatric group over the intertrial period, the nonsignificant interaction, $F(1, 31) = 2.91$, $p = .098$, indicated that this difference between the groups in the direction of change in ability was not significant.

The significant main effect of group on the total M Test scores, $F(1, 31) = 6.15$, $p < .02$, reflected the superior performance of the Psychiatric group collapsed across both test points (Summary Table: Appendix E, Table 5). Although the Psychiatric group scored higher than the Schizophrenic group at both test points, Table 8 shows the differences between the groups to be nonsignificant following adjustment for multiple comparisons. A decline in the total M scores collapsed across the two groups is also evident, reflected in the significant main effect of time, $F(1, 31) = 42.83$, $p < .001$. Again, contrary to the predictions of the present study, the Schizophrenic group did not show a more severe loss in global ability. The similarity of the pattern of decline over the 45 year time

period in both groups is manifest in the nonsignificant interaction effect, F (1, 31) = .34, p = .567.

Demographic, clinical and enlistment M Test characteristics of the Schizophrenic and Alcoholic groups. Table 9 presents t-test comparisons, adjusted for alpha inflation, which show the Schizophrenic and Alcoholic groups to be similar in age, both at the time of the early adult testing and currently, and in level of education. The Alcoholic group had a higher SES level and total M Test score in early adulthood, differences that remained significant after adjustment for multiple comparisons. ANCOVAs, with both early M Test performance and SES as covariates, were used to control statistically for the differences between the groups on these early adult variables in the analyses of Paper formboard and Vocabulary subtests. SES was used as the covariate in the analysis of the total M Scores. ANCOVA did not alter the findings from the ANOVAs of the raw data, so the unadjusted data are presented here.

Change over time in the M test performance of the Alcoholic group compared to the Schizophrenic group. Table 10 presents the enlistment and current scores of the Schizophrenic and Alcoholic groups on the Paper formboard and Vocabulary subtest as well as on the overall M Test. Unlike the results involving the Psychiatric group, the findings in relation to the Alcoholic group are consistent

Table 9

Means and Standard Deviations For Demographic, and M Test Variables

	Group	
	Schizophrenic n=22	Alcoholic n=20
Variable		
Enlistment Age	23.77	23.55
	(4.32)	(4.27)
Current Age	70.59	68.80
	(5.09)	(4.02)
Education	7.54	9.40
	(2.30)	(4.36)
Enlistment SES	31.75*	42.82*
	(9.86)	(12.34)
Enlistment M Test	107.45*	135.85*
	(32.00)	(28.31)

*Means differ at $p < .05$ following Bonferroni adjustment for multiple comparisons.

Table 10

Means and Standard Deviations of Enlistment and Current Paper Formboard and Vocabulary Subtest and Total M Scores

	Group	
	Schizophrenic n=22	Alcoholic n=20
M Test Variables		
Enlistment Paper Formboard	10.27 (4.68)	12.35 (4.51)
Current Paper Formboard	3.41* (3.17)	9.40* (5.29)
Enlistment Vocabulary	14.92 (6.24)	16.50 (5.80)
Current Vocabulary	12.45* (8.05)	19.15* (5.80)
Enlistment Total M	107.45* (32.00)	135.85* (28.31)
Current Total M	66.09** (34.37)	131.55** (24.23)

*Means differ at $p < .05$ following Bonferroni adjustment.

**Means differ at $p < .01$ following Bonferroni adjustment.

with the prediction of differential intellectual impairment associated with schizophrenic disorder. Repeated measures ANOVA of Paper formboard scores showed a significant main effect of group, $F(1, 40) = 11.22$, $p < .01$ and time, F (1, 40) = 54.10, $p < .001$ (Summary Table: Appendix E, Table 6). The significant interaction, F (1, 40) = 80.19, $p < .01$, however, points to a difference in the pattern of change over time in the two groups on this spatial reasoning ability task. As Table 10 shows, both groups declined in ability. However, the loss in the Schizophrenic group was of significantly greater magnitude as indicated in the t-test for independent samples comparing the intertrial difference scores of the groups, t (39.21) = 2.97, $p < .05$.

The main effect of group on the Vocabulary subtest was significant, F (1, 40) = 4.91, $p < .05$ (Appendix E, Table 7), and there was a pattern of stability over time in the scores of the two groups taken together; the Schizophrenic group's slight decrease and the increase in the Alcoholic group's ability is reflected in the nonsignificant main effect of time, F (1, 40) = 0.01, $p = .906$. Of particular importance, however, is the contrasting direction of change over time in the groups, as attested to by the significant interaction effect, F (1, 40) = 10.34, $p < .01$. T-tests for paired samples indicated a significant gain in vocabulary ability in the Alcoholic group, $t(19) = 3.43$, $p < .01$ and a

nonsignificant loss in the Schizophrenic group, $t(21) = -1.83$, $p = .08$.

In the repeated measures ANOVA on total M Test scores at enlistment and current testing, the main effect of group proved to be significant, $F(1, 40) = 28.13$, $p < .001$ (Summary Table: Appendix E, Table 8) and the change in total M score over the intertest period was also significant, collapsed over both groups, $F(1, 40) = 32.72$, $p < .001$. As with the two subtest analyses, there was a significant interaction, $F(1, 40) = 22.30$, $p < .001$, reflecting a different temporal pattern in total M Test performance in the groups over the more than 45 year intertest period. The significant decline seen in the Schizophrenic group, $t(21) = -5.85$, $p < .001$, contrasted with the relative stability in the measured overall intellectual ability of the Alcoholic group, $t(19) = -1.25$, $p = .23$.

M Test Performance in the Psychiatric Group in Relation to the Normal Control Group

Demographic and enlistment M Test characteristics. The Psychiatric group was compared to a normal control group (ConPsych) that had been matched with it individually in terms of current age, education and early adult M Test performance. As indicated in Table 11, t-test comparisons of the two groups confirmed their similarity in terms of mean current age, education and total M Test score at the time they enlisted in the Canadian army during World War Two. The

Table 11

Means and Standard Deviations for Demographic, and M Test Variables

	Group	
	Psychiatric n=11	ConPsych n=11
Variable		
Enlistment Age	25.64 (4.30)	29.36 (5.45)
Current Age	73.91 (4.53)	71.82 (4.40)
Education	8.09 (2.34)	8.81 (2.18)
Enlistment SES	33.33 (7.75)	40.83 (13.71)
Enlistment M Test	130.18 (28.05)	131.45 (26.95)

groups also proved to be similar in terms of age at enlistment testing as well as early adult SES.

Psychiatric group M test performance compared to the ConPsych group. A MANOVA, followed by univariate ANOVAS, was employed to identify differences between the Psychiatric and the ConPsych group on current performance on the eight subtests of the M Test. Results revealed a significant main effect of group, F (1, 13) = 2.50, $p < .05$ (Summary Table: Appendix E, Table 9) reflected in the higher scores of the ConPsych group on all of the subtests (Table 12). In examining the M Test subtests for group differences, univariate analyses indicated that the ConPsych group had higher current scores on the Picture Anomalies, Tool Recognition and Arithmetic subtests of the M Test at conventional alpha levels. However, these differences were not significant when adjusting for multiple comparisons (Table 12).

Associations of M Test Performance with Demographic and Early Adulthood Variables

Pearson Product Moment correlations were used to examine the relations, in the groups, of age, education, early adult SES to M Test performance and change over time in that performance. The Multistage Bonferroni correction procedure was employed to adjust alpha for the large numbers of correlations tested (Harris, 1976; Lazelere & Mulaik, 1977). In particular, the relation to later cognitive

Table 12

Means and Standard Deviations For Current M Test Subtest Scores

	Group	
	Psychiatric n=11	ConPsych n=11
M-Test Variables		
Picture Completion	9.73 (4.10)	11.09 (3.83)
Picture Anomalies	7.09 (3.42)	10.18 (3.46)
Paper Formboard	4.27 (3.55)	6.46 (3.75)
Tool Recognition	14.73 (6.13)	21.09 (3.60)
Mechanical Information	17.27 (7.06)	20.27 (5.92)
Arithmetic	5.91 (2.02)	8.64 (3.17)
Vocabulary	19.09 (5.92)	19.64 (5.84)
Verbal Analogies	17.45 (8.23)	19.55 (6.36)

outcomes of premorbid social competency in an older chronic group of patients were of interest given previous positive findings with younger samples of psychiatric patients (e.g., Stoffelmeyer et al., 1983; Westermeyer & Harrow, 1987). The association to later intelligence of early adult (premorbid) intelligence, on its own, and not incorporated in a more global measure of competency such as the PMC, was a further consideration given propositions of low premorbid intelligence as a prognostic indicator for a more deteriorating course of schizophrenic disorder (Offord & Jones, 1975; Roff & Knight, 1980; Watt & Saiz, 1987).

Age and M Test performance. Results indicated limited relationships between age and M Test performance variables. As seen in Table 13, the only significant relationships involved the Schizophrenic group. Age at enlistment, r (22) = .61, $p < .05$, and age at current, r (22) = .62, $p < .05$, testings in the Schizophrenic group were significantly associated with change in M Test performance. Older schizophrenic subjects showed more decline in ability. There were no significant relationships between age and M Test performance and change in the other groups, examined separately (Tables 14-18).

Early adulthood variables and M Test performance. Premorbid social competency (PMC) in the Schizophrenic and Psychiatric groups showed limited association with

Table 13

Product-Moment Correlations of Demographic, PMC and Early Adult M with M Test Scores and Change in M Test Scores in the Schizophrenic Group (n=22)

	M Test Variables		
Variables	Enlistment M	Current M	Change in M
Enlistment Age	.17	-.43	.61*
Current Age	-.07	-.53	.62*
Early Adult SES	.17	.18	-.02
Education	.45	.19	.24
PMC	.63*	.39	.20
Enlistment M		.50	.44
Current M			.55

Note. A two-tailed multistage Bonferroni procedure (Larzelere & Mulaik, 1977) was used to test the significance of these and all correlational data presented. αF_W reflects the family-wise Type 1 error rate.

* $\alpha F_W < .05$.

Table 14

Product-Moment Correlations of Demographic, PMC and Early Adult M with M Test Scores and Change in M Test Scores in the Psychiatric Group (n=11)

	M Test Variables		
Variables	Enlistment M	Current M	Change in M
Enlistment Age	.20	-.41	.72
Current Age	.22	-.43	.76
Early Adult SES	.40	-.17	.62
Education	.46	.20	.22
PMC	.65	.01	.65
Enlistment M		.62	.25
Current M			.60

Table 15

Product-Moment Correlations of Demographic and Early Adult M with M Test Scores and Change in M Test Scores in the ConTot Group (n=22)

	M Test Variables		
Variables	Enlistment M	Current M	Change in M
Enlistment Age	.21	-.02	.33
Current Age	.26	.15	.20
Early Adult SES	.58	.76***	-.08
Education	.56	.38	.36
Enlistment M		.73***	.57
Current M			-.15

***αF_W < .01.

Table 16

Product-Moment Correlations of Demographic and Early Adult M with M Test Scores and Change in M Test Scores in the ConVoc Group (n=22)

	M Test Variables		
Variables	Enlistment M	Current M	Change in M
Enlistment Age	.25	-.05	.49
Current Age	.23	-.03	.43
Early Adult SES	.13	.29	-.16
Education	.27	.27	.11
Enlistment M		.81***	.65*
Current M			.08

* $\alpha F_w < .05$.

*** $\alpha F_w < .01$.

Table 17

Product-Moment Correlations of Demographic and Early Adult M with M Test Scores and Change in M Test Scores in the Alcoholic Group (n=20)

	M Test Variables		
Variables	Enlistment M	Current M	Change in M
Enlistment Age	.25	.11	.30
Current Age	.24	.25	.05
Early Adult SES	.56	.33	.51
Education	.55	.30	.53
Enlistment M		.84***	.52
Current M			-.03

*** $\alpha F_W < .001$.

Table 18

Product-Moment Correlations of Demographic and Early Adult M with M Test Scores and Change in M Test Scores in the ConPsych Group (n=11)

	M Test Variables		
Variables	Enlistment M	Current M	Change in M
Enlistment Age	.41	.12	.68
Current Age	.41	.20	.52
Early Adult SES	.67	.76	-.09
Education	.65	.40	.63
Enlistment M		.90***	.37
Current M			-.07

** $\alpha F_w < .001$.

intellectual performance (Tables 13 and 14). The only significant finding was the relationship between PMC ratings and early adult intelligence in the Schizophrenic group, r (22) = .63, p < .05 (Table 13). As expected, however, PMC proved not to predict later intellectual ability or change in that ability in either the Schizophrenic or the Psychiatric group. As tables 13 through 18 indicate, individual differences in intelligence scores proved to be highly stable across adulthood in all but the Schizophrenic and Psychiatric groups. Test-retest correlations for the M Test across adulthood were strong for the ConTot, r (22) = .73, p < .001 (Table 15); ConVoc, r (22) = .81, p < .001 (Table 16); Alcoholic, r (20) = .84, p < .001 (Table 17); and ConPsych, r (11) = .90, p < .001 (Table 18) groups. The lack of relationship, in the Schizophrenic group, of premorbid intelligence, alone, with current intellectual ability measures, was unexpected given hypotheses of stronger premorbid predictor-outcome relationships in chronic schizophrenia within similar domains of functioning (Strauss et al., 1977).

As anticipated, there were no significant associations between the other early adult variables and later intellectual performance in the Schizophrenic group. Among the remaining groups, there were two significant associations between early adult variables and later intellectual performance. Early adult SES in the ConTot

group was significantly related to late adulthood total M Test scores, r (22) = .76, p < .001. In the ConVoc group, early intelligence predicted change through adulthood in intellectual ability, r (22) = .65, p < .05.

Treatment-related Variables and M Test Performance in the Schizophrenic and Psychiatric Groups

The relationships of certain variables of treatment history to the course of intelligence in the elderly Schizophrenic and Psychiatric subjects were also examined. The duration of time afflicted with the disorders, the total time spent in institution, and the total number of admissions to hospitals were the variables assessed in terms of their significance for the intellectual characteristics of the two psychopathology groups.

Following Bonferroni adjustment, no significant associations were revealed in either of the groups (Appendix F: Tables 1 and 2). Similar to patterns in previous findings, these quantitative variables indexing chronicity and institutionalization predicted neither current M Test performance nor the change over time in these scores.

Neuropsychological Measures

Three of the groups--the Schizophrenic, Psychiatric and ConVoc--had been administered neuropsychological measures at the time of current testing. These results were examined with the principal goal of evaluating group differences in the pattern of neuropsychological performance and to

indicate associations of impairment possible regional brain anomalies.

Associations of Demographic and M Test variables with neuropsychological performance.

There were limited associations in the groups between demographic, M Test variables, early adult social competency and current neuropsychological function. In the Schizophrenic group, only one association proved significant after controlling for inflated alpha levels. The total score on the Newcombe Verbal Fluency Test was seen to be related to the current total M Test score, r (22) = .79, $p < .01$ (Appendix G, Table 1). In the ConVoc group, current age was positively related to the number of nameable drawings in the Design Fluency Test, r (22) = .76, $p < .01$ (Appendix G, Table 3). No significant associations were revealed in the Psychiatric group (Appendix G, Table 2).

Associations of treatment-related variables and neuropsychological performance in the Schizophrenic and Psychiatric groups. Performance on neuropsychological measures was examined in relation to variables of duration of illness, total time spent in hospital and the number of hospitalizations experienced by the subjects in the Schizophrenic and Psychiatric groups. As shown in Table 19, in the Schizophrenic group, more years with the diagnosis of schizophrenia was associated with fewer original drawings (DFNOVEL) produced on the Design Fluency Test, r (22)= -.68,

Table 19

Product-Moment Correlations between Treatment-Related Variables and Neuropsychological Test Scores in the Schizophrenic Group (n=22)

	Neuropsychological Test Scores						
Variables	DFNOVEL	DFPERSEV	SQDFNAME	DIGSFWD	DIGSBKWD	REYCOPY	REYRECALL
Total Time in Hospital	-.54	.04	.35	-.07	-.42	-.10	-.32
Number of Hospitali-zations	.54	-.14	-.23	.05	.01	.02	.01
Duration of Illness	-.68*	-.11	.25	-.30	-.45	.16	-.10

Variables	BENTTOT	BENTREPT	NEWCTOT	NEWCREPT	CATCOMP	UNIQUE	TOTERR	PERSEV
Total Time in Hospital	-.19	-.22	-.35	.02	-.45	.12	.33	.04
Number of Hopitali-zations	.22	.26	.18	-.10	.73**	-.16	-.58	-.44
Duration of Illness	-.51	-.28	-.37	-.06	-.44	.36	.26	.44

Note. **DFNOVEL**=Design Fluency: Number of original drawings; **SQDFNAME**=Square root of number of nameable drawings; **DFPERSEV**=Number of perseverative responses; **DIGSFWD**=Digits Forward score; **DIGSBKWD**=Digits Backward score;**REYCOPY**=Rey Osterreith complex Figure Design Copy score; **REYRECALL**=Rey Osterreith Complex Figure Design Recall Score; **BENTTOT**=Benton Fluency Test: Number of acceptable words; **BENTREPT**=Benton Fluency Test: Number of repetitions; **NEWCTOT**=Newcombe Fluency Test: Number of acceptable words; **NEWCREPT**=Newcombe Fluency Test: Number of repetitions; **CATCOMP**=Wisconsin Card Sorting Test: Number of categories completed; **UNIQUE**=Wisconsin Card Sorting Test: Number of unique responses; **TOTERR**=Wisconsin Card Sorting Test: Number of errors; **PERSEV**=Wisconsin Card Sorting Test: Number of perseverations.

*$\alpha F_W < .05$; **$\alpha F_W < .01$.

$p < .05$. Further, a greater number of hospitalizations among the Schizophrenic group subjects was associated with a higher number of completed categories (CATCOMP) on the Wisconsin Card Sorting Test, r (22) = .73, $p < .01$. In the Psychiatric group there were no significant associations between treatment-related variables and neuropsychological scores (Appendix G: Table 4).

Group comparisons of neuropsychological performance. One way multivariate analyses of covariance were employed to determine the effect of group appurtenance on the neuropsychological test performance of subjects in the Schizophrenic, Psychiatric and ConVoc groups. Multivariate ANCOVAS were done for the following five sets of dependent variables: the number of original figures drawn (DFNOVEL), the number of perseverations (DFPERSEV), and the number of nameable drawings produced (DFNAME) on the Gotman Design Fluency test; the scores from the Digits Forward (DIGSFWD) and Digits Backward (DIGSBKWD) components of the Wechsler Memory Test; scores on the Copy (REYCOPY) and Recall (REYRECALL) portions of the Rey-Osterreith Complex Figure Design Test (REY); the total number of acceptable words and total number of repetitions on the Benton Verbal Fluency Test (BENTTOT and BENTREPT) and on the Newcombe Verbal Fluency Test (NEWCTOT and NEWCREPT); the number of categories completed (CATCOMP), the number of perseverations (PERSEV), the total number of errors (TOTERR) and the number

of unique responses (UNIQUE) on the Wisconsin Card Sorting Test (WCST).

Current M Test performance was employed as a covariate in all of the MANCOVAs. The groups differed in current total M Test scores and these differences might have confounded differences in neuropsychological performance associated with group status. As well, as reported previously, there were some significant correlations in the groups involving total M Test performance with some of the neuropsychological scores. In the Schizophrenic group, current total M Test score correlated significantly, after Bonferroni correction, with the total score on the Newcombe Verbal Fluency Test, r (22)=.79, $p < .01$ (Appendix G, Table 1). In addition, in the ConVoc group, a higher number of nameable drawings in the Design Fluency Test was significantly and positively related to current age, r (22) = .76, $p < .01$ (Appendix G, Table 3).

Inspection of the data revealed, in the Psychiatric group, one case of missing data on the Copy score of the REY test and two cases of missing data on the Recall score of the same test. One subject was unable to complete the test and another did not wish to participate in the recall portion after completing the copy segment of the test. In this latter instance it was deemed acceptable to substitute the group mean score for the recall portion because the subject's score on the copy portion was near the mean for the group. There were no univariate or multivariate outliers

on any of the variables.

Results of evaluation of assumptions of normality, homogeneity of variance-covariance matrices, linearity and multicollinearity were satisfactory with one exception. Due to severe skewness of the distribution of scores in the ConVoc group on the number of nameable drawings in the Design Fluency test (DFNAME), a square root transformation of that variable (SQDFNAME) was employed in the analyses. Finally, there was some heterogeneity of variance in the scores of the three groups on the DFPERSEV score. Again in the analyses of these results, the more conservative Pillai criterion for significance of *F* was employed. The Pillai test is less affected by heterogeneity than other tests and is also robust in the context of small sample sizes and unequal *n*s (Tabachnik & Fidell, 1989).

A multivariate ANCOVA was performed on the mean scores of the three groups on the DFNOVEL, DFPERSEV and the square root of their scores (SQDFNAME) on the DFNAME components of the Gotman Design Fluency Test. The analysis revealed a significant multivariate effect of group, F (6, 100) = 2.50, $p < .05$ (Summary table in Appendix H, Table 1). Univariate *F* tests, however, revealed nonsignificant group effects on the DFNOVEL, DFPERSEV and SQDFNAME measures of the test.

The multivariate ANCOVA with DIGSFWD and DIGSBKWD scores as dependent variables also produced a significant effect of group, F (4, 102) = 2.90, $p < .05$ (Appendix H,

Table 2). Univariate *F* tests revealed the DIGSFWD variable to contribute significantly to the multivariate effect of group, F (2, 51) = 5.75, $p < .01$. As Table 20 indicates, Tukey multiple comparisons showed the Psychiatric group to have higher DIGSFWD scores than both the Schizophrenic and the ConVoc groups.

The only other analysis to reveal a significant group effect was the multivariate ANCOVA with scores--CATCOMP, PERSEV, TOTERR, UNIQUE--from the WCST as dependent variables, F (8, 98) = 2.11, $p < .05$ (Appendix H, Table 3). Two of the dependent variables were revealed in univariate *F* tests to have significant effects of group: CATCOMP, F (2, 51) = 4.04, $p < .05$; and PERSEV, F (2, 51) = 4.48, $p < .05$. Contrary to expectations, neither of the significant group differences on these variables involved the Schizophrenic group. The ConVoc group completed a significantly higher number of categories (CATCOMP) on the WCST than did the Psychiatric group. Correspondingly, the ConVoc group produced significantly fewer perseverative responses (PERSEV) than the Psychiatric group (Table 20).

The remaining two multivariate analyses resulted in nonsignificant outcomes. A nonsignificant multivariate effect of group was revealed in the multivariate ANCOVAs involving the Recall and Copy scores of the REY test, F (4, 102) = 1.13, $p = .35$ (Appendix H, Table 4) and the total and repetition scores on the Newcombe and Benton Fluency tests,

Table 20

Adjusted Means for Neuropsychological Scores

	Group		
	Schizophrenic n=22	Psychiatric n=11*	ConVoc n=22
Neuropsychological Score Variables			
DFNOVEL	9.32	15.95	11.79
DFPERSEV	2.49	2.54	7.98
SQDFNAME	0.78	0.45	0.50
DIGSFWD	5.19_a	6.43_b	5.55_a
DIGSBKWD	3.78	3.95	3.58
REYCOPY	25.68	27.49	26.78
REYRECALL	7.84	10.38	10.58
NEWCTOT	29.34	40.99	42.34
NEWCREPT	1.97	2.07	2.19
BENTTOT	22.74	23.49	23.44
BENTREPT	1.00	0.91	1.67
CATCOMP	1.18	0.52_a	2.07_b
TOTERR	76.07	81.92	68.53
UNIQUE	9.82	3.28	8.92
PERSEV	58.10	72.45_a	43.57_b

Note. *n=10 for REYCOPY and REYRECALL scores.

Means with different subscripts differ at $p < .05$.

Discussion

The particular interest of this study lies in the opportunity to situate cognitive performance and long term change in intelligence in schizophrenia within a context of patterns observed in normal aging and in non-schizophrenic psychiatric disorders. The access to systematic records of intellectual performance in early adulthood, before the appearance of identified schizophrenic symptomatology, provided the baseline for the comparative analyses of the groups. The availability of normal control groups matched on education, early adult intellectual ability (global and vocabulary) and age allowed for a more certain differentiation of cognitive effects associated with psychopathology. In the same manner, controlled comparisons with groups with non-schizophrenic disorders permitted attention to diagnostic-specific effects in chronic schizophrenia. In sum, this type of comparative analysis of the performance of the groups permits a heightened distillation of intellectual characteristics, including patterns of change, specific to schizophrenia in the elderly.

The discussion will focus first on the current intelligence test performance of the groups and the patterns of change across the intertest interval. The significance of the findings in terms of the nature and specificity of cognitive deficits in schizophrenia will be examined. In

this context, consideration will also be given to findings regarding the relation of intellectual ability in schizophrenia and long term change in that ability to premorbid characteristics and treatment-related variables. Finally, the comparative neuropsychological performance of the Schizophrenic group will be analyzed in relation to possible schizophrenia-specific cognitive function deficits and their putative associated brain regions.

Intellectual Ability in Long-Term Chronic Schizophrenia

The present study of very long-term chronic schizophrenic subjects replicates previous findings of substantial intellectual impairment associated with chronic schizophrenia in younger samples (Aylward et al., 1988; Fabrega et al., 1989; Heaton et al., 1978; Lawson et al., 1988; Mathai & Gopinath, 1985; Schwartzman & Rudolph, 1977; Schwartzman et al., 1962). It is also consistent with more recent reports of cross-sectional studies, including elderly, long-institutionalized subjects, that find declines in cognitive function culminating in levels consistent with severe dementia in the oldest age group (Arnold & Trojanowski, 1996; Davidson et al., 1995; Goldberg et al., 1993; Harvey et al; 1995; Hyde et al., 1994). The total M Test score of the Schizophrenic group in the present study with a mean age of 70.6 years, a history of close to 40 years with the disorder, and more than 20 years spent in hospital, was 66.09 (SD: 38.37). This global measured

ability was significantly lower than that of a group of subjects (ConTot), of equivalent early adult SES, with which it was individually matched on overall measured premorbid intellectual ability, education level and age. These findings are subject to the limitations of small sample sizes and the constraints of generalization associated with the limited representivity of this long-institutionalized, low SES, male sample. However they do serve to contribute, with some added methodological strengths, to the limited body of results concerning the population of elderly schizophrenic patients. The presence of matched controls and premorbid measures within a longitudinal format add weight to earlier cross-sectional findings suggestive of severe intellectual impairment in at least a portion of elderly chronic patients with schizophrenia.

Change over time in cognitive abilities in long term schizophrenia. Notable in the present study are findings related to particular cognitive skills and their course over time. Although overall intellectual ability and all but the Vocabulary subtest scores of the M Test were seen to decline significantly in the Schizophrenic group, certain cognitive abilities would appear to be more vulnerable to the effects associated with long-term schizophrenia. The abilities tapped by the Picture completion, Picture anomalies, Tool recognition and Mechanical information and Arithmetic subtests may be more subject to the influence of the

disorder. The conservative, Bonferroni-corrected analyses of the current scores showed the Schizophrenic group to have significantly lower scores on these subtests than the control group (ConTot) matched on early global intelligence and having similar enlistment subtest scores. While the Schizophrenic group revealed declines in all these abilities, the ConTot group showed nonsignificant changes in these abilities. It would appear then that the decline in perceptual discrimination in social contexts (Picture completion and Picture anomalies), mechanical aptitude and arithmetic reasoning ability may not be explained solely by effects of aging in schizophrenia.

The findings in this investigation of specific vulnerability in schizophrenia to declines in Picture completion, Picture anomalies, Tool recognition and Mechanical information are consistent with earlier 35 year follow-up evidence employing the same measures (Schwartzman & Rudolph, 1977). The present study differs from this earlier investigation in that deficits relative to controls were observed as well in the arithmetic reasoning ability of the current study's Schizophrenic group. The earlier investigation, while reporting decline in arithmetic reasoning ability in schizophrenia, found a similar decline in a normal control group. The abilities tapped by the Picture completion, Picture anomalies and Arithmetic subtests have been linked to the construct of fluid

intelligence (Gold et al., 1995). Fluid abilities may be largely determined by the physiological state of the organism and appear to decline with age in normal samples (Horn, 1978), including the larger sample group from which the present study's control groups were drawn (Schwartzman et al., 1987; Gold et al., 1995).

Age-related attrition, augmented by disuse of skills in long-term schizophrenia, may determine the greater declines relative to normals of the Schizophrenic group revealed in the present study. Exigencies of daily living in post-war institutional psychiatric treatment environments may have comprised less need for exercising skills related to social perception and arithmetic reasoning than would the demands of community life. The finding of a decrement in arithmetic ability in schizophrenia relative to normals after 45 years, but not in an earlier 35 year follow-up, suggests that the accentuated decline associated with the disorder may emerge after longer periods and as such is consistent with reports of slowly emerging cognitive deficits in long-term schizophrenia (Davidson et al., 1995; Harvey et al., 1995).

Evidence of mechanical aptitude deficits of the Schizophrenic group relative to normals in this study are similar to findings from an earlier 35 year follow-up study (Schwartzman & Rudolph, 1977). The increase in mechanical subtest scores of the normals over the 45 year period and the contrasting declines in the Schizophrenic group likely

reflect differential post-war occupational experience in the two groups. It has been noted in relation to the larger normal sample, from which the present study's normal groups were selected, that some of the veterans had received mechanical training in the army and had experience with machinery maintenance during and after the war (Gold et al., 1995; Schwartzman et al., 1987). The significant institutional confinement of the Schizophrenic group veterans and resultant limited opportunity for occupational involvement--mechanical or other--seem relevant in relation to their observed long-term decline in mechanical aptitude.

That certain cognitive abilities may be less affected by the clinical state associated with very long-term schizophrenia is also apparent in the present findings. Paper formboard, Verbal analogies and Vocabulary subtest performance in the present sample of schizophrenic patients appear to be subject to changes equivalent to those seen in normal aging. These abilities proved to be similar in the Schizophrenic and the ConTot group. Both the Schizophrenic and the ConTot group declined on the Paper formboard and Verbal analogies subtests, significantly so in the case of Paper formboard ability. The mental manipulation component of the Paper formboard and Verbal analogies subtests links them conceptually to the skills included in formulations of fluid intelligence or the mechanics of intelligence (Gold et al., 1995; Horn, 1978). The declines seen in the present

study are consistent with evidence of age-related decline in such fluid abilities and, in the case of the long-term schizophrenic subjects, argue against the preponderant influence of processes linked to the psychopathology.

Effects in addition to those associated with aging may be implicated in the findings regarding performance on the Vocabulary subtest. The Schizophrenic group's current performance did not differ significantly from that of the ConTot group. Vocabulary declined slightly but nonsignificantly in the Schizophrenic group while showing an increasing trend in the control group. The earlier, 35 year longitudinal study found vocabulary ability on the M Test to decline significantly in a schizophrenic group with a configuration of low education, SES and early intelligence levels similar to that of the present study's sample (Schwartzman & Rudolph, 1977). These findings in relation to vocabulary ability in long-term schizophrenia might be productively examined in relation to evidence regarding the influence of early ability and lifestyle factors on the course of verbal cognitive ability. Measures of skills such as those required by the Vocabulary subtest index primarily crystallized intelligence that may be influenced significantly by lifestyle factors and cumulative cultural experience (Gold et al., 1995; Horn, 1978; Hultsch et al., 1993). Over the life span, such abilities appear to be less subject to deleterious effects associated with aging.

Verbal intelligence may reflect more the influence of early intellectual ability in interaction with early life opportunity features, such as SES and education, that affect possibilities for a cognitively challenging lifestyle. Significant increase in vocabulary ability, in particular, has been reported over the adult life span in the larger normal sample from which the present study's control groups were chosen (Gold et al., 1995; Schwartzman et al., 1987). In addition, the other normal control group (ConVoc) in the present study, matched with the Schizophrenic group on early vocabulary ability, but with higher general early intellectual ability, did increase its Vocabulary score, even when assessed with stringent alpha levels. The ConTot group, chosen so as to match the Schizophrenic group in overall intelligence in young adulthood, had wartime intellectual abilities, SES and education levels lower than those of both the larger normal sample and the ConVoc group. The stability of vocabulary ability in the ConTot group, contrasting with the increase seen in the larger normal sample and the ConVoc group in the present study, suggests the inhibitory effect of less favourable early life experience--low SES and education--and relatively low early adult intelligence. In comparison, the Schizophrenic group's tendency to decline in vocabulary ability might suggest, as in the ConTot group, the effect of low young adult intelligence and restricted life opportunity, but with

an added lifestyle impact of likely reduced social and intellectual demands in long-term institutional living. The environment of post-war institutional psychiatric treatment facilities may have provided limited access to the type of complex decision-making involvement believed to facilitate the preservation or strengthening of intellectual ability (Schaie, 1983; Schooler, 1984).

If such an inhibitory effect of restricted early ability, opportunity and lifestyle variables acts in long-term schizophrenia to affect verbal abilities over the life span, then the present findings suggest that such effects may be present in other diagnostic groups with similar histories of long-term disorder and institutionalization. The Psychiatric group, similar to the Schizophrenic group in SES and education levels, also revealed a stability in vocabulary ability through adulthood despite a higher early adult level of general intellectual ability. The difference in early overall intellectual ability with the Schizophrenic group was significant in terms of conventional, but not Bonferroni-corrected alpha levels. Like the Schizophrenic group, the Psychiatric group had a history of long periods of institutionalization--a mean of 7.4 years of time spent in psychiatric institutions--although this cumulative period was less than that of the Schizophrenic group. In the face of the stability of vocabulary ability in the Psychiatric group, the question emerges as to the relative roles of

factors associated with opportunity, long-term disorder and levels of early cognitive ability in the constriction of development of verbal abilities such as vocabulary. The sample size restrictions of the present study necessarily limit conclusions. However, the finding of similar stable temporal patterns in vocabulary ability of the Psychiatric and Schizophrenic groups in this study points to the merit of larger scale explorations of possible general inhibitory lifestyle effects associated with different long-term disabilities and psychiatric treatment environments.

The sample of community-dwelling alcoholic subjects in this study, designated as alcoholic based on a lifetime pattern of heavy drinking, is of interest in relation to this issue of variations in type and history of disability and their consequences for the course of vocabulary ability. The Alcoholic group had a level of early adult intelligence, education and SES equivalent to that of the Psychiatric group but not a history of institutionalization. Vocabulary ability in the Alcoholic group was seen to increase in contrast to the stability observed in the Psychiatric and Schizophrenic groups. Similarly, an earlier study revealed an increase in vocabulary ability through adulthood in a group of alcoholic subjects selected according to different criteria than those used in the present study (Gold et al., 1991). Apart from the influence of clinical features, including possibly different neurobiological substrates, the

contrasting temporal patterns of vocabulary ability in the Alcoholic and the two psychopathology groups in this investigation suggest the effects of differing treatment regimens and living environments in these samples. Investigations incorporating more sensitive controls for treatment environment variables might serve to elucidate the relationship of the course of vocabulary ability and specific long-term disorders.

Vocabulary ability as an index of premorbid intelligence. Another issue in this study, related to vocabulary ability, concerns its employment as an index of premorbid intelligence. Scores on the Vocabulary subtest in this and earlier investigations (Gold et al., 1995; Schwartzman et al., 1987) were seen to have a high test-retest reliability and also to correlate highly with overall M Test performance. These characteristics of measured vocabulary ability, as well as earlier indications of its temporal stability in schizophrenia, have served to support its use as an index of the premorbid intellectual ability of samples of schizophrenic subjects in studies lacking information on cognitive functioning prior to the onset of the disorder. In the Schizophrenic group in the present study, the Vocabulary subtest was the only one of the eight subtests on which ability levels did not decline significantly. Findings here of stability of vocabulary ability contrast with earlier indications of significant

decline over a 35 year interval in chronic schizophrenia (Schwartzman & Rudolph, 1977). The differing temporal patterns indicated in the two long-term studies with samples of schizophrenic subjects of similar early adult intelligence education and SES suggest that lability or plasticity may characterize vocabulary ability in chronic schizophrenia. Alternatively, subtype differences in long-term schizophrenia may contribute to the differences in the developmental course of vocabulary and other cognitive abilities in individuals with the disorder (Braff et al., 1991; Carpenter & Kirkpatrick, 1988; Harding et al., 1992). Controls for such differences in subtype would be required in order to reliably discern the course of vocabulary ability in individuals with long histories of schizophrenia.

In addition to providing information regarding the course of vocabulary ability within the Schizophrenic group, the present study permitted examination of the issue of the merits of matching normal control groups with schizophrenic groups on current vocabulary as a control for early adult intelligence. As well as the problems, described earlier, associated with the possible heterogeneity of the long-term course of vocabulary in schizophrenia, the findings involving the ConVoc group in this study raise further questions regarding such matching procedures. The contrasting temporal patterns of vocabulary ability in the Schizophrenic and ConVoc groups in the present study--

stability in the Schizophrenic versus increase in the ConVoc group--argue against the appropriateness of matching based on assumptions of shared stability. The increase in vocabulary ability seen in the ConVoc group is consistent with earlier findings in normal samples (Gold et al., 1995; Schwartzman et al., 1987). Matching based on current vocabulary scores might therefore lead to an overestimation of early adult ability in some normal control groups. Such an overestimation would perhaps not occur in the case of matching control groups with lower levels of overall ability as suggested by the stable pattern of vocabulary in the other control group (ConTot) in this study. However, taken together, the findings here regarding the temporal pattern of vocabulary ability in the normal and Schizophrenic groups suggest a heterogeneity of patterns, perhaps associated with early ability levels. As such, the findings call into question the assumptions underlying a reliance on current vocabulary levels as reliable indices of early performance.

The Diagnostic Specificity of Intellectual Impairment

As well as indicating cognitive impairment and long-term decline in schizophrenia beyond that attributable to effects of aging, the present study's findings permit cautious reflections regarding the question of whether distinctive patterns of change in cognitive ability differentiate schizophrenia from other long-term psychiatric disorders. Again, interpretation of these findings is

constrained given the limited representivity and size of the samples. However the possibility of assessing very long-term temporal patterns in cognitive ability in groups with differing disorders, while controlling for early or premorbid ability levels, supports the inclusion of these results in the consideration of this issue. The results of the comparative analyses of the Schizophrenic with the Psychiatric and the Alcoholic groups attest to the importance of incorporating the dimensions of time, developmental stage, diagnosis and different domains of cognitive ability in studies of intellectual functioning in psychopathology.

The change in intellectual ability across adulthood in individuals with a lifetime history of heavy drinking appears to be clearly differentiated from that linked to long-term schizophrenic psychopathology. Indications of significant decline over time in general intellectual ability in schizophrenia contrast with the generally stable long-term course of intelligence seen in the Alcoholic group. Vocabulary ability in the group of heavy drinkers strengthened over the course of adulthood while it remained unchanged in the schizophrenic sample. Both schizophrenia and a history of heavy drinking appear to be associated with loss in fluid intelligence abilities such as spatial reasoning. However, it would seem that a greater vulnerability of fluid ability characterizes schizophrenic

psychopathology.

The findings here of a definite differentiation of the course of cognitive ability in schizophrenia from that associated with heavy lifetime alcohol consumption are of interest in the context of an earlier review involving younger samples which also described cognitive deficits in schizophrenia relative to alcoholism (Aylward et al. 1984) and a recent report suggesting a more mitigated appraisal of impairments in schizophrenia compared to those linked to alcoholism (Fabrega et al., 1989). Differing sample characteristics and methodological frameworks may contribute to some of the divergence in findings. The earlier reports described results of single time point examinations of the cognitive performance of considerably younger samples without controls for differences in early intellectual ability. Differences in premorbid ability may thus have been confounds obscuring the actual effects over time of the disorders. With such controls available, the present study permits a more unambiguous conclusion regarding cognitive decline and deficit as differentiating long-term schizophrenia from a history of heavy drinking across adulthood.

Related to the question of specific effects of psychopathology, the temporal pattern of cognitive ability seen in the Alcoholic group in the present study may not reflect particular influences of a disorder associated with

lifetime heavy drinking. Although they were not directly compared, the patterns of intellectual change seen in the Alcoholic group resembled those of the two normal control groups in the present study. As well, recent reports have suggested relatively circumscribed long-term effects on intellectual ability of alcohol consumption (Arbuckle et al., 1994; Gold et al., 1991)

The results of analyses in the Schizophrenic and Psychiatric groups, as they relate to the issue of differential intellectual change, suggest a more nuanced interpretation than findings involving the Alcoholic group. Direct comparison of the present study's samples of schizophrenic and primarily depressive subjects suggests that the two groups may have substantially similar long-term courses of intellectual ability. Both groups revealed significant declines across adulthood in general intellectual ability. This similarity was also evident in the comparative temporal trajectories of specific cognitive abilities. Spatial reasoning ability would thus seem not to be affected through adulthood in a distinct way by schizophrenic as opposed to depressive and personality disorders. As well, vocabulary ability may follow a similar stable long-term course in both groups. These findings are consistent with a recent report of essentially similar cognitive profiles in groups of elderly schizophrenic and depressed patients examined during their treatment in acute

care psychiatric facilities (Mulsant et al., 1993). Taken together, the similarity in cognitive profiles in these two groups with differing psychopathologies appears to lend support to propositions of the primacy of general psychopathology rather than diagnostic-specific effects on cognitive ability. The findings are consistent with suggestions referring to generalized cognitive deficits as a "cognitive final pathway" (Braff et al., 1988, p.218) for a range of psychiatric disorders.

The results of the comparison of the Psychiatric group with a control group (ConPsych) matched specifically and individually with it on variables of age, education and early intellectual ability may, however, call into question such an interpretation supporting the primacy of general psychopathology effects. Differences in current M Test ability levels in the Psychiatric and ConPsych groups were nonsignificant after Bonferroni correction, suggesting that cognitive deficits associated with the depressive and personality disorders may reflect influences of aging rather than either general or specific psychopathology effects. Before ruling out effects of psychopathology however, and ascribing only age effects to the Psychiatric group, it is perhaps fruitful to consider the configuration of the weight of evidence from earlier investigations and, as well, other results within the present investigation. Cognitive performance deficits relative to normals have been reported

in a review of cognition in the affective disorders (Johnson & Magaro, 1987). Others have suggested a spectrum of cognitive disturbance in psychiatric patients, with schizophrenic patients presenting the most severe deficits and depressive patients showing milder, albeit significant, disturbance (Harrow et al., 1986).

Caveats in interpreting the findings involving the Psychiatric group and its normal control group are also suggested by other comparisons within the present study. Although the Psychiatric group was seen to have somewhat higher current M Test scores than the Schizophrenic group, the pattern of change across adulthood in the two groups were equivalent. Further, the comparisons involving the Schizophrenic and the two normal control groups indicated that this pattern of intellectual change in the Schizophrenic group was significantly distinct from a course identified with normal aging effects. Finally, there was a trend in the Psychiatric group towards a profile of current intellectual deficits in relation to normals that parallelled those of the Schizophrenic group. The three abilities--Picture anomalies, Tool recognition and Arithmetic--that differentiated the Psychiatric from its matched control group, before Bonferroni correction, were also part of the group of five subtests on which the Schizophrenic group scored significantly more poorly than its similarly matched control group.

In addition to the weight of earlier evidence and suggestive findings in this study, the present investigation's methodological limitations inhibit definite conclusions regarding the issue of general psychopathology effects in depressive and schizophrenic disorders. Comparisons involving larger and more diagnostically homogeneous psychopathology group samples, constituted on the basis of similar diagnostic protocols, would undoubtedly serve to assess this question with greater assurance. Although the Psychiatric group in the present study was composed primarily of individuals with diagnoses of depressive disorder, some of those diagnoses were of the mixed type, with concomitant personality and anxiety disorders. Comparability with samples of depressive disorders with greater diagnostic homogeneity is compromised. A further limitation of the present study stems from the absence of measures of the severity of general psychopathology. Given the limited amount of time that subjects and personnel were available for interview and testing, such ratings were not possible. Clearly, the investigation of differential effects of psychopathology on cognition would be strengthened by the inclusion of such measures. In the context of these methodological limitations, the present study's mixed findings argue for further, more systematic exploration of general psychopathology effects on long-term cognitive function.

Associations of Cognitive Outcomes with Premorbid Variables

Premorbid and treatment-related variables do not appear to have significant association with the impairment and decline observed in both psychopathology groups. Neither current test domain nor total scores, nor change in these, showed significant relations with the PMC ratings although some association was seen in relation to premorbid intelligence. This pattern of findings with regard to the PMC measure tends to support the proposals of the generally limited predictive power of premorbid indicators in long-term schizophrenia (McGlashan, 1980; 1986a). In addition, the lack of association between early (premorbid) and late intelligence in the Schizophrenic group argues against the suggested greater potency of within domain predictor-outcome relationships (Strauss et al., 1977), at least for long-term time frames. The attenuation of predictive potency suggested by McGlashan (1986a) may extend to within domain relationships when longer time periods are considered in chronic schizophrenia.

Premorbid intellectual ability and its relation to later cognitive outcomes is relevant also in terms of the findings in the two earlier longitudinal studies covering 17 (Schwartzman et al., 1962) and 35 years (Schwartzman & Rudolph, 1977), and the present investigation with its 45 year intertest interval. Although the three samples differed substantially in premorbid intelligence, they each

exhibited substantial declines. The sample measured over 17 years exhibited a premorbid M Test performance of 123.4 M Test points which was close to the mean for the Canadian Army standardization sample of the test (Schwartzman et al., 1962). In contrast, the 35 year (Schwartzman & Rudolph, 1977) and this 45 year sample had considerably lower premorbid scores of 109.25 and 107.45, respectively. If lower premorbid intelligence were a significant prognostic indicator for greater intellectual loss, both the 35 and 45 year samples might have been expected to exhibit greater decline than that covering 17 years. Yet only the 45 year sample exhibited greater decline. The 17 and 35 year samples showed similar loss in total M Test scores despite the lower premorbid intelligence level of the 35 year sample. This comparison of decline over time in the context of differences in premorbid intelligence in these three samples suggests that premorbid intelligence is not a primary determining influence in relation to later cognitive outcomes in schizophrenia.

Correlational results in the longer studies offer support for this indication of the lack of prognostic quality of premorbid intelligence. The 35 year study (Schwartzman & Rudolph, 1977) revealed positive associations between premorbid intelligence and loss in scores over the test interval. In general, schizophrenic subjects with higher premorbid intelligence tended to exhibit more

intellectual decline. In the present study, premorbid intelligence did not predict later course of ability. Both the 35 year and present samples were characterized by subjects with limited education, working class backgrounds and very lengthy periods of institutionalization. Higher premorbid intelligence would not appear to have served a protective function against significant intellectual decline in such samples. Conversely, lower premorbid intelligence, in these samples, was not a specific prognostic marker for accentuated intellectual deterioration. This pattern contrasts with earlier reports, involving younger schizophrenic patients with much shorter histories of the disorder, of greater intellectual decline and deficits in schizophrenics with lower premorbid IQ levels (Offord & Jones, 1975; Roff & Knight, 1980; Watt & Saiz, 1987). The present results appear to lend support, particularly in relation to long-term schizophrenia, to the view of low intelligence as a characteristic which is not intrinsically associated with risk for a more debilitating course of the disorder (Meehl, 1989; 1990; Pogue-Geile, 1991).

The associations of SES and education levels with intellectual performance, and change in same, can also be examined in the context of the issue of premorbid influences. SES and education ratings were based on archival army enlistment records and as such reflect premorbid status on these variables. Interestingly, neither variable

differentiated the two psychopathology groups in this study nor were they associated with later intellectual performance. These findings in relation to the Schizophrenic group are consistent with a pattern of results which suggest that prior to the onset of the disorder, schizophrenics may have relatively mild cognitive deficits that do not interfere significantly with their developmental progress in occupational and educational domains (Hyde et al., 1993; Pogue-Geile et al., 1991).

Associations of Cognitive Outcomes with Treatment-related Variables

The present study's null findings with regard to associations of duration and hospitalization with cognitive outcomes replicate results from a number of earlier investigations, with generally younger samples having shorter treatment histories (e.g., Goldstein et al., 1991; Harrow et al., 1987; Kolakowska et al., 1985b; Lawson et al., 1988; Mathai & Gopinath, 1985; Schwartzman & Rudolph, 1977). It is noteworthy that such null findings are reported here in relation to individuals with very long histories of treatment. Presumably, if these variables were influential in terms of cognitive course over time, they might be expected to have contributed to greater impairment in the Schizophrenic group in comparison with the Psychiatric group, since its subjects had significantly longer time in hospital and duration of disorder.

Alternatively, it is possible that, as suggested in relation to an earlier investigation (Schwartzman & Rudolph, 1977), that in both groups the periods of treatment involved have reached a magnitude beyond which individual differences are not salient, at least in terms of their associations with cognitive outcomes.

The influence of medication. The issue of the possible effect of current and cumulative doses of psychotropic medication on intellectual performance requires consideration. Changes in intellectual performance may be, to a significant extent, epiphenomena of acute or cumulative medication exposure. All subjects in the Schizophrenic and Psychiatric groups were receiving psychotropic medications at the time of current testing and all had been recipients of medications for a considerable period. Due to unavailability of consistent records of medication over the period of the disorders, it was not possible to reliably investigate the relationship of cumulative drug exposure to intellectual performance. However, a lack of association between current neuroleptic drug status or doses and degree of impairment or decline has been consistently reported (Berman et al., 1986; Buhrich et al., 1988; Davidson et al., 1995; Harvey et al., 1995; Kolakowska et al., 1985; Mathai & Gopinath, 1985; Paulman et al., 1990; Schwartzman & Rudolph, 1977). Further arguing against immediate adverse medication effects are results describing nonsignificant changes in

neuropsychological performance following neuroleptic withdrawal, and either unchanged or slightly improved cognitive function associated with neuroleptic regimens (Cassens et al., 1990; Davidson et al., 1995; Harvey et al., 1995; Heaton & Crowley, 1981; Heaton & Drexler, 1987; King, 1990; Serper et al., 1990; Spohn & Strauss, 1989; Zec & Weinberger, 1987).

Effects of neuroleptic treatment may, however, emerge only after long term exposure such as that experienced by the present sample. Previous investigations of cumulative neuroleptic treatment effects have reported nonsignificant correlations between indices of long-term neuroleptic exposure and cognitive performance (Kolakowska et al., 1985; Mathai & Gopinath, 1985; Owens & Johnstone, 1980). In the present study, only indirect indications regarding cumulative medication impact are available. Presumably the longer exposure of the Schizophrenic group to psychopathology and institutionalization might be associated with greater cumulative exposure to drug treatments and their suggested nocive impacts on intellectual function. Yet the Schizophrenic group, with a mean of 13 years longer history of disorder and almost three times the total period of hospitalization, declined no more than the Psychiatric group. Still, long-term effects of psychotropic medication cannot be precluded in this sample because there may be a cut-off point in cumulative medication treatment beyond

which any further effects of differential cumulative dosage are not evident.

The Temporal Pattern of Change in Intelligence in Schizophrenia

The schizophrenic patients in this sample lost 41 points in total M Test score over their inter-test period of close to 47 years. The intellectual decline involved significant losses on all subtests and domains of the M Test with the exception of the Vocabulary subtest. The 41 point loss in M score over a 47 year interval in this sample of chronic schizophrenics compares with a decline of 27 M Test points in patients after 17 years (Schwartzman et al., 1962) and a 28 point decrement in the sample tested at a 35 year interval (Schwartzman & Rudolph, 1977). With an additional 10 years in inter-test period, schizophrenic subjects in this sample thus showed an additional 13 point decline in total M Test score.

Several interpretations of the additional loss over the longer time period may be offered. The observed decline in this group may have occurred in a relatively early period of the disorder and have been followed by a stabilization in performance. Such a "stable deficit state" (Hyde et al., 1994; p. 494) pattern of temporal change would be compatible with previous proposals of cognitive decline in schizophrenia coinciding with the first two decades of the disorder (Goldberg et al., 1993; Hyde et al., 1994.,

Klonoff, Fibiger & Hutton, 1970; McGlashan, 1988; Smith, 1974; Schwartzman, Douglas & Muir, 1962b; Schwartzman & Rudolph, 1977; Waddington, Hanafy & Kinsella, 1990).

Assuming such an early-phase timing of intellectual loss, it is necessary to attempt to explain the greater magnitude of decline at this phase observed in the present sample of elderly chronic schizophrenics compared to the 35 year sample. As indicated previously, premorbid intelligence levels were similar in both groups, yet the 45 year sample showed greater loss. Differences in environment and treatment characteristics of the samples might be suggested as salient in regard to a greater putative early phase decline in intelligence in the present sample. Interestingly, however, the sample, of similar SES characteristics, in the Schwartzman & Rudolph (1977) study covering 35 years, had close to 18 years of cumulative hospitalization. This was similar to the 20 years mean total time in hospitalization for the present sample. A more subtle differential influence on cognitive deterioration might be exposure to community treatment environments. In the 35 year study, 13 of the 32 subjects were living either in community half-way houses or foster homes, whereas in the present study all but three of the 22 schizophrenic subjects were hospitalized. The greater opportunity for engagement and autonomy offered in the community-based environments may have served to mitigate the

effects on cognitive function associated with the psychopathology, or even to restore some elements of ability. Suggestive evidence of the rehabilitative and protective impact of psychosocial environment variables on large samples of elderly, deteriorated schizophrenic patients with similar lengths of disorder and institutionalization, has been reported recently by Harding (1987a; b; 1992). Assuming an early occurrence of decline in intellectual function, access to more favourable treatment and residential milieux might act to mitigate deterioration and/or to partially restore functioning in some areas. This perspective on the difference in impairment in the 35 year as compared to the present study's sample of schizophrenic patients suggests the merit of a more sensitive operationalization of the construct of institutional or environmental effects on cognition in future work. Comparing outcomes in samples of suitably matched schizophrenic patients differing in exposure to qualitatively differentiated treatment environments would be a constructive focus.

Another interpretation of the greater decline in total M Test score observed in the present sample as compared with that reported over a 35 year interval, requires an assumption of a different temporal pattern of intellectual outcome in schizophrenia. Rather than situating the intellectual decline within an early phase--perhaps the

first two decades--of the disorder, deterioration might instead be seen as extending over a longer period, perhaps throughout the duration of the psychopathology. Of note, in this regard, are correlational results from the present sample indicating that older schizophrenic subjects showed greater cognitive decline. Contrastingly, in the earlier 35 year study, age was negatively associated with deficits (Schwartzman & Rudolph, 1977).

Heterogeneity of Outcome in Schizophrenia.

Propositions suggestive of heterogeneity in outcomes (M. Bleuler, 1978; Ciompi, 1980; Huber et al., 1980; Shepherd et al., 1989) and of different subtypes associated with differing outcome paths in very long-term chronic schizophrenia (Braff et al.,1991; Carpenter & Kirkpatrick, 1988; Harding et al., 1992; Owens & Johnstone, 1980) are perhaps germane in the context of such hypotheses of differing courses of cognitive change over time. Subtypes of chronic schizophrenics, possibly defined by, among other variables, different configurations of genetically or environmentally-determined neuropathology, and early life experience influences, may reveal differing intellectual courses over the life span (Mednick et al., 1994; Pogue-Geile, 1991; Zubin & Spring, 1977). Life history factors such as early limitations in socioeconomic opportunity and education, the cumulative effects of environmental restriction, in interaction with distinct pathophysiology,

may contribute to variations in later course and outcome (McGlashan, 1988). In this sample, the subjects' limited exposure to stimulating and engaging non-institutional environments might be advanced as a significant influence, alone, or perhaps in interaction with neuropathological variables, on the hypothesized extension of the period of cognitive decline. The relative absence of the suggested protective and mitigating influence of rehabilitative contexts (Harding, 1987a;b; 1994) may have served to prolong the period of decline in psychosocial competencies, including those indexed by measures such as the M Test.

The findings of only mild cognitive deficits in a sample of community-residng schizophrenic patients admitted to an acute care facility (Mulsant et al., 1993), is also suggestive in regard to such propositions of heterogeneity of long-term outcomes in schizophrenia. That this community-residing sample had a history of only episodic hospitalization and had more education than the sample in the present study (mean education: 10.8 versus 7.5 years, respectively) may be salient in relation to the issue of clinical heterogeneity. The lack of information on the premorbid intellectual ability in this sample precludes definite comparisons. However, the differing characteristics of intellectual ability, psychopathology and life history in these two elderly samples suggest the merit of studying subtypes of schizophrenia in the late adult

phase of schizophrenia. The presence or absence of continued impaired intellectual ability in late adulthood schizophrenia might serve as one of the proposed phase-specific features (Carpenter & Kirkpatrick, 1988) that would permit an effective definition of late-stage schizophrenic subtypes for further study.

Neuropsychological Performance in Long-Term Schizophrenia

The results of the three groups that were administered the neuropsychological tests are noteworthy for their indication of a lack of impairment in the elderly Schizophrenic group relative to the normal sample and, with one exception, relative to the Psychiatric group matched on age and education. Thus the prediction, based primarily on earlier findings with younger samples, of some areas of differential impairment in long-term schizophrenia was not supported. On only one measure, and this in relation to the Psychiatric group, was a deficit indicated in the Schizophrenic group. On the Digits Forward measure, the Psychiatric group obtained a higher score than the Schizophrenic group. However, the Psychiatric group's performance was also superior to that of the normal control group, suggesting that the source of the difference between the two psychiatric patient groups may not necessarily involve variables associated with psychopathology. Rather, the differences between the two psychopathology groups may reflect differential susceptibility to distraction because

this task has been associated with freedom from distractibility (Newcombe,1969).

These results, suggesting limited deficits in schizophrenia, support suggestions of an earlier investigation, based on a more extensive battery of measures--the Halstead-Reitan Neuropsychological Test Battery--that cognitive deficits in schizophrenics may be essentially equivalent to those seen in normal aging rather than related to indices of neurophysiological abnormality or long-term institutionalization (Goldstein et al., 1991). Consistency of the null findings in the present study is also seen in relation to the indication from the Chaikelson and Schwartzman (1983) cross-sectional investigation that indicated more accentuated negative aging effects on neuropsychological performance in a normal as compared with an elderly schizophrenic group. Only four of the ten measures that had differentiated the young schizophrenic sample from normals continued to do so in the case of the older groups. The suggested perspective of a stabilization or amelioration of some neuropsychological functions in chronic schizophrenia may find support in results such as those in the present study.

Consistent with some earlier findings with younger adult samples, the present study's results intimate an independence in schizophrenia of abilities indexed by global intelligence and neuropsychological measures. Executive

functions such as cognitive flexibility (Braff et al., 1991; Klonoff et al., 1970; Smith, 1964) as well as planning and working memory abilities (Morice & Delahunty, 1996), have shown independence of measured intelligence in younger samples of schizophrenic patients. The neuropsychological and intelligence findings in this study suggest the continued independence into late adulthood, in at least some forms of long-term schizophrenia, of global intelligence and several other cognitive abilities. The pattern of independence of general intelligence and neuropsychological function suggested in this study's results is, however, reversed; significant general intellectual deficit was accompanied by a lack of differential neuropsychological impairment. Such findings are also consistent with suggestions that no definite configuration of neuropathology underlies cognitive deficits in schizophrenia (Kolakowska, Williams, Jambor & Ardern, 1985; Kolakowska et al., 1985).

The present study's indications of a lack of deficit compared to normals, do, however, contrast with previous findings of generalized neuropsychological impairment in younger samples (Braff et al., 1991; Saccuzzo & Braff, 1986). The findings in relation to the WCST are noteworthy since no significant differences involving the Schizophrenic group with the Psychiatric or the normal groups were observed on these measures. Several previous investigations, involving younger samples, have proposed

executive functions associated with the WCST as operations on which schizophrenics are particularly impaired and concluded that the locus of cerebral dysfunction in schizophrenia is found in the frontal regions (Berman et al., 1986; Paulman et al., 1990; Weinberger et al., 1987). The present study found only the Psychiatric group to show impairment on the WCST, specifically a higher number of perseverative responses and a corresponding lower number of completed categories than the normals.

The refinement of the frontal dysfunction hypothesis as advanced by Braff et al. (1991) is also not supported by the present results. Accentuated executive deficits were proposed as associated only with a particularly deteriorated sub-group of schizophrenic patients. In this group of long-term schizophrenic subjects with histories of significant intellectual decline and long institutionalization, executive deficits were not observed.

To begin to understand the possible sources of the divergence of the present findings from earlier reports it is instructive to consider the age differences of the samples. Neuropsychological deficits in schizophrenia have been reported for the most part in studies with samples considerably younger than that of this investigation. Amelioration or stabilization in schizophrenic neuropsychological ability, accompanied by negative aging effects in normals, as suggested by the Chaikelson &

Schwartzman (1983) study, might lead to the similarity in ability levels at later ages. The employment of longitudinal research designs would serve to elucidate such hypothesized differential temporal patterns of neuropsychological ability.

In addition to divergences due to age, differences in reported findings may also result from a complex array of factors that most probably include other sampling and methodological issues. The employment of unmedicated samples in some research protocols (Saykin et al., 1991) may produce differences, in relation to studies of medicated subjects, such as the present one, that are independent of specific psychopathology effects. Differences in duration of illness and in the length and quality of institutional care may also be confounding factors. Equally, the use of different test batteries and, in some cases, of different administration protocols are certainly plausible as confounding procedural influences (e.g., Berman et al., 1986). Although its measures were chosen for their sensitivity to regions of neural function proposed as underlying differential impairment in schizophrenia, it may be that the present study's tests were not sufficiently sensitive to particular deficits in the disorder. Replication with differing, and/or more extensive test batteries, such as those used in the Goldstein et al. (1991) and Chaikelson & Schwartzman (1983) studies, would buttress

the thrust of these findings concerning differential impairment in long-term schizophrenia.

Beyond sampling and methodological influences on the divergent outcomes of studies of neuropsychological function in schizophrenia, the effect of subtype differences, again, merits consideration. As with reported differences in relation to general intellectual ability, divergent neuropsychological performance profiles in geriatric schizophrenia may also be associated with distinctive subtypes, defined by variations in underlying neuropathology, psychopathology, treatment and environmental history as well as by developmental level. Heterogeneity in cognitive, as well as other outcome domains, particularly over long time frames, would be compatible with such complex configurations of influences.

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Appendix A

Subject Consent Forms

INFØRMATIØN FØR CØNSENT

A research project sponsored by Concordia University is now being undertaken with the goal of understanding changes in psychological functioning over long periods of time in individuals with different life experiences. This study will be conducted at Ste. Anne's Hospital and we are asking Canadian Army veterans if they would be willing to participate in our research study. We would now like to describe our research to you. We hope that you will find our project interesting that you will want to participate in it.

During the war, the routine enlistment procedure included giving the Army "M" test, a measure of aptitude and intelligence, in order to assign recruits to the appropriate army unit. In addition, health and personality records were kept and are currently stored in Public Archives Canada. All this information is strictly confidential and usually is not accessible. Our wish is to look at the records of only those army veterans for whom we have permission to do so.

Should you give us your permission, we will examine your army files in Archives Canada and also make a current assessment of your psychological functioning. This would involve an the completion of some standard questionnaires and tasks measuring present aptitudes. We would also like to examine your medical files to obtain relevant information. This information will help determine the effects of chronic medical conditions on cognitive functioning in men as they grow older. It is hoped that ultimately the results we find will help improve the delivery of health care to veterans and to older people with long-term medical conditions.

Please note that this information will be treated as strictly confidential. This means that information obtained from the records will be coded immediately by number and not by name so that names will never appear on our research documentation. We will be happy to provide you with a final report of our general research findings, if you wish. In addition, if you are willing, we would place a copy of the results of the psychological tests in your hospital file since it might be helpful in your treatment. But all information that we would obtain about your life history would be strictly confidential and would be given to no one.

May we express our appreciation in advance for your assistance with our study.

DECLARATION OF CONSENT

1. I consent to participate in the research project on changes in psychological functioning over time in individuals with different life experiences. This research is being conducted by Michael Ashton under the supervision of Dr. June Chaikelson of Concordia University and in collaboration with Drs. Aronoff and Barriga of Ste. Anne's Hospital. I understand that my participation will include providing information about my life history, responding to a series of questionnaires and doing tasks relevant to adult development.

2. I agree to allow access to my army files in Public Archives Canada for the purposes of the above-described research. I understand that all information related to me will be kept confidential.

3. I agree to the placement of a copy of the results of the psychological tests administered in this study in my file at Ste. Anne's Hospital.

Signature: _____ Date: _____

Code Number: _____

Appendix B

The Premorbid Social Competence Scale

Premorbid Social Competence Scale Score Variables

(Zigler & Phillips, 1961)

Variables are divided into three categories with each category conceptualized as representing a step along a social competence continuum.

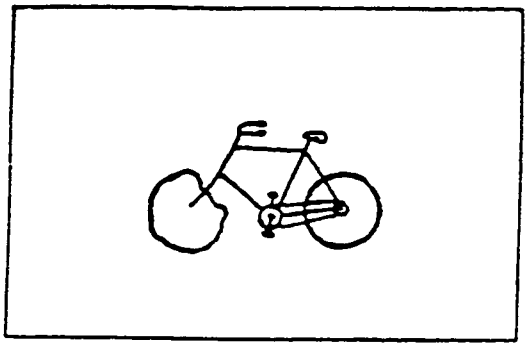
Age	0.	24 years and below
	1.	25-44 years
	2.	45 years and above
Intelligence	0.	IQ (or equivalent) of 84 or less
	1.	85-115
	2.	116 and above
Education	0.	None or some grades including ungraded or special classes
	1.	Finished grade school, some high school or high school
	2.	Some college or more
Occupation	0.	Unskilled or semi-skilled
	1.	Skilled and service or clerical and sales
	2.	Professional and managerial
Marital status	0.	Single
	1.	Separated, divorced, remarried or widowed
	2.	Single continuous marriage

Appendix C

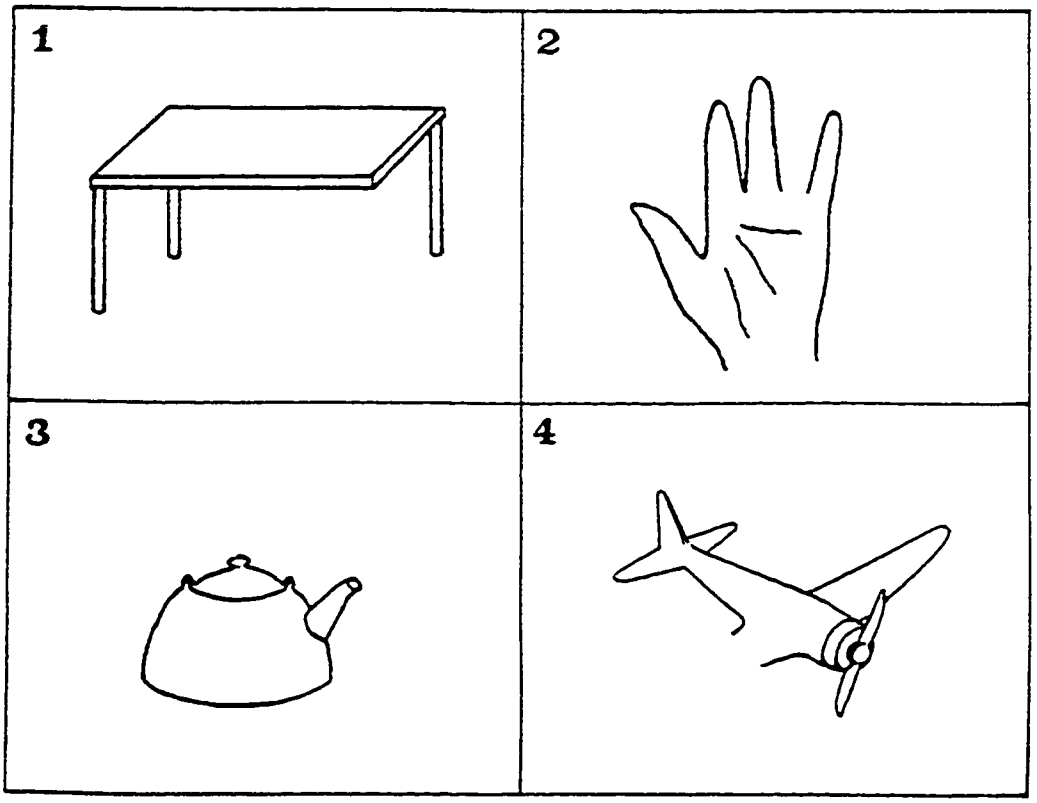
The Revised Examination "M" (M Test) Subtests

The M Test Picture Completion Subtest

EXERCISE 1

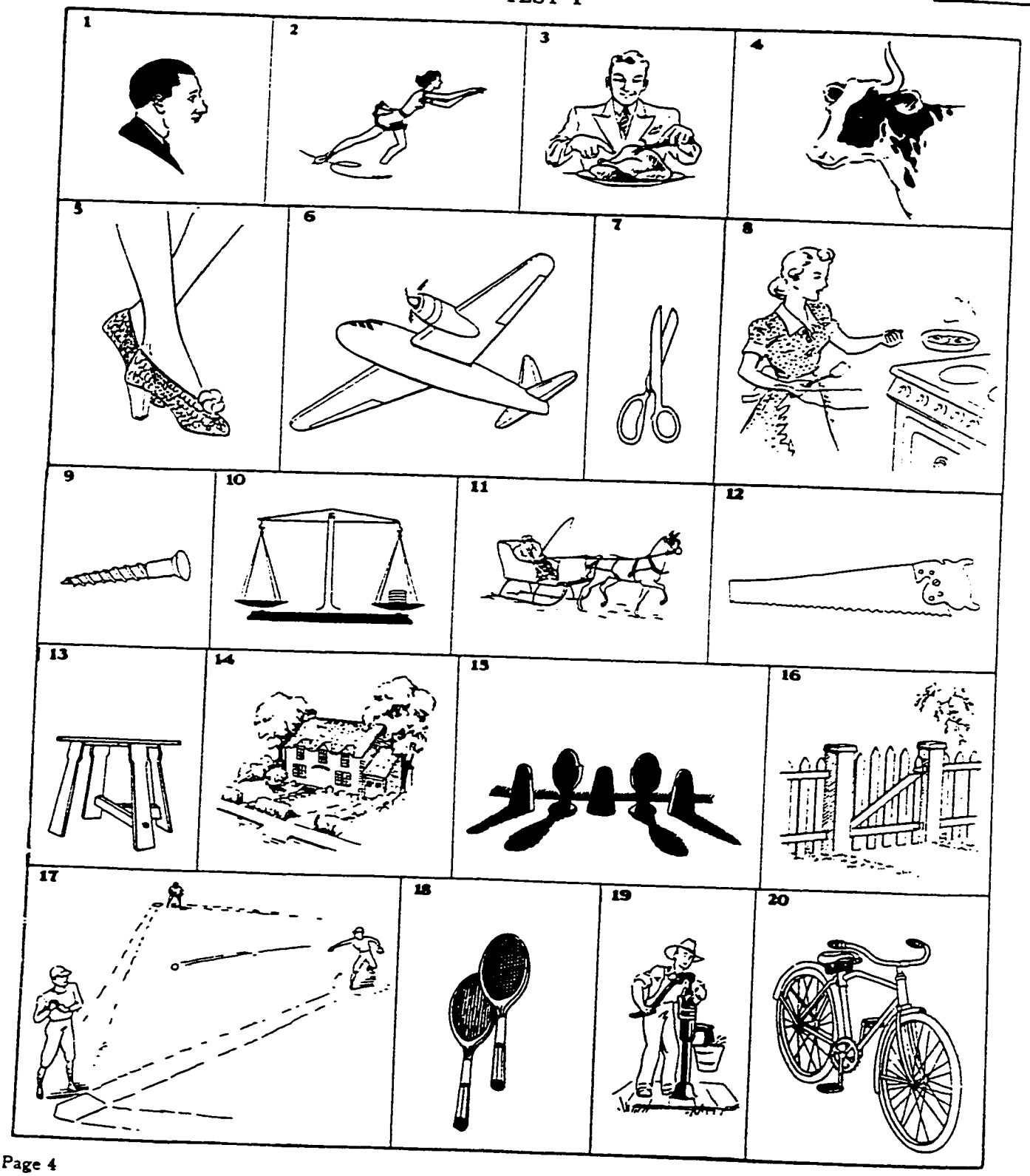


In each picture something has been left out. Draw it in quickly.



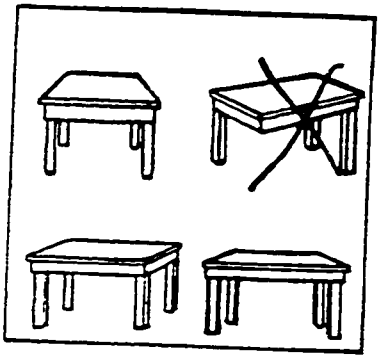
TEST 1

2½ minutes

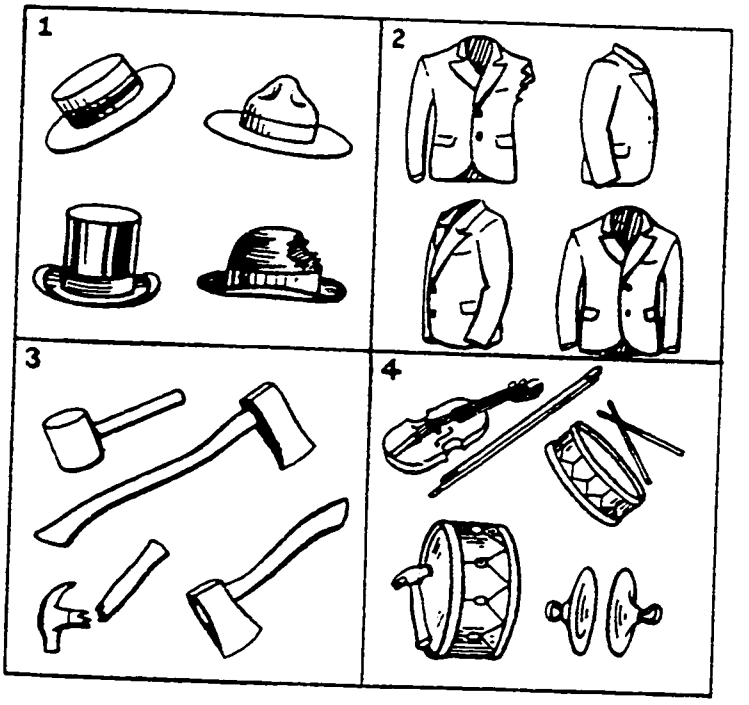


The M Test Picture Anomalies Subtest

EXERCISE 2



In each square mark the thing that is wrong.

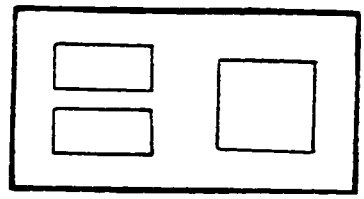


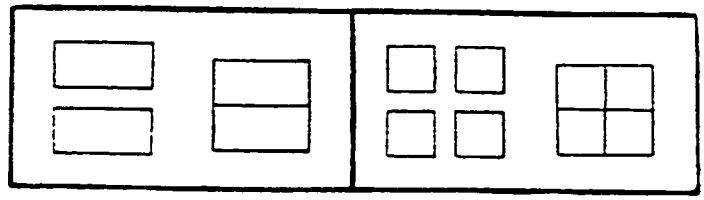
3 minutes

TEST 2

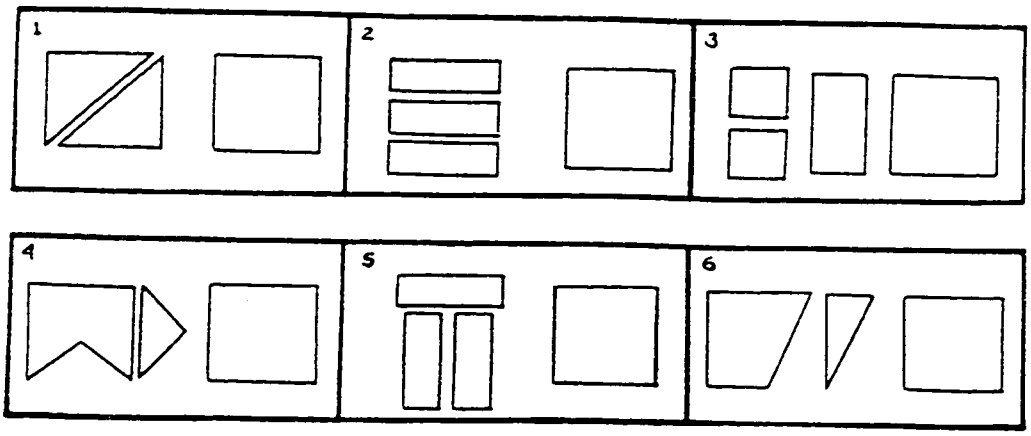
The M Test Paper Formboard Subtest —

EXERCISE 3





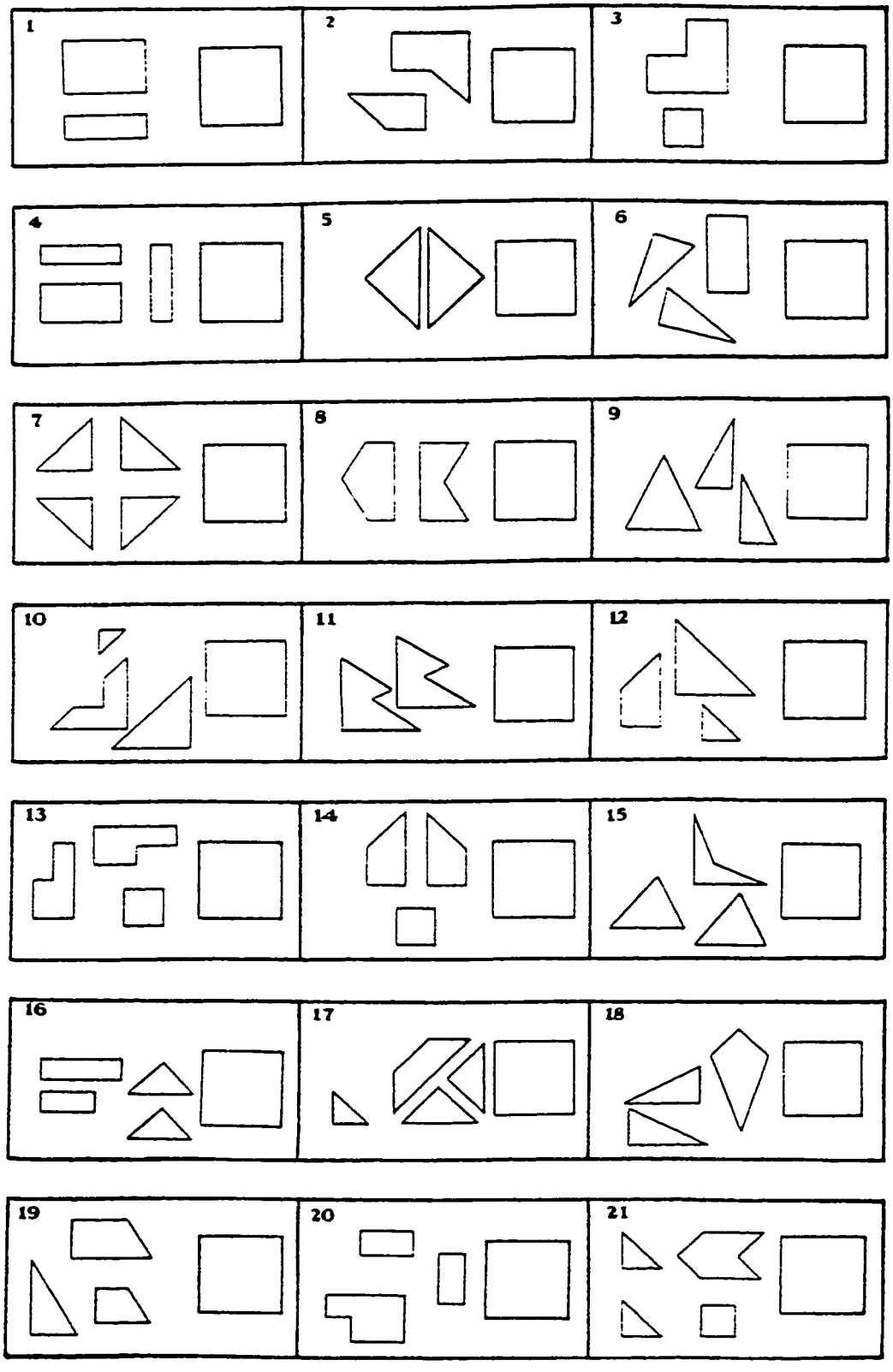
Mark each square to show how it can be cut to make the pieces.



Do not turn this page until told.

5 minutes

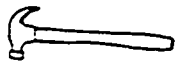
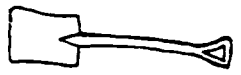
TEST 3



The M Test Tool Recognition Subtest

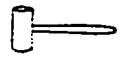
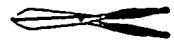
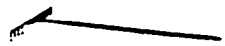
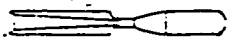
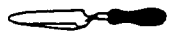
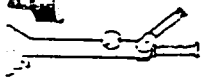
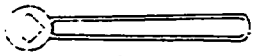
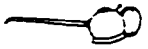
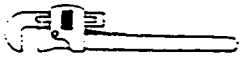
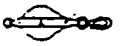
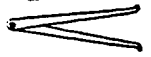
EXERCISE 4

Draw a line under the name of the tool shown at the left

	chisel	cleaver	hammer	mallet
	pliers	scissors	file	dividers
	screwdriver	gauge	ratchet	awl
	fork	shovel	wrench	coupling
	dowel	scythe	hatchet	hand-saw
	wood-clamp	level	shears	vise

3 minutes

TEST 4

1		spade	wrench	mallet	saw
2		can opener	shears	tin snips	pliers
3		rake	pencil	fork	axe
4		monkey wrench	nut cracker	glass cutter	boxwood rule
5		funnel	needle	level	screw
6		scraper	gauge	chisel	file
7		awl	spade	shovel	trowel
8		punch	pruner	scissors	pliers
9		mitre box	depth gauge	grease cap	floor clamp
10		jack	piston	bevel	auger
11		screwdriver	shoe knife	draw knife	cold chisel
12		alligator wrench	box wrench	angle wrench	monkey wrench
13		sprayer	syringe	pump oiler	water can
14		bit	chisel	nail set	bolt
15		hand drill	angle wrench	end nippers	pipe wrench
16		bow brace	spoke shave	bench plane	chisel
17		reamer	brace	masher	punch
18		hacksaw	backsaw	pruning saw	fret saw
19		pipe wrench	socket wrench	"S" wrench	monkey wrench
20		bit	auger	awl	die
21		blacksmith's tongs	taper tips	calipers	iron clamp
22		snapswivel	plane	block	wood clamp
23		frame clamp	mitre box	draw knife	bevel
24		vise	chuck	reamer	brace
25		inside calipers	outside calipers	dividers	compass
26		iron clamp	nail punch	wire thimble	expansion bit
27		angle valve	trap	stopper	air valve
28		try square	dividers	pitch gauge	pinch dogs
29		butt gauge	wire gauge	thickness gauge	snap swivel
30		rip saw	coping saw	cross cut saw	grooving saw

The M Test Mechanical Information Subtest

EXERCISE 5

In each sentence you have four choices for the last word; only one of them is correct. Draw a line under the word on the right that makes each sentence true.

1. A hammer is used to drive a nail into	steel	wood	glass	water
2. A saw is used to	cut	drill	sift	punch
3. The number of wheels on a wagon is usually	seven	four	six	three
4. Windows are made of	tin	wool	glass	silver
5. A jack-knife will cut	granite	iron	steel	wood
6. A chisel is used to	chip	soften	twist	polish

Do not turn this page until told.

5 minutes

TEST 5

1. A bit is used in	boring	planing	moulding	filing
2. Asbestos will not	tear	warp	crack	burn
3. The exhaust of an automobile engine gives off poisonous	carbon monoxide	hydrogen	oxygen	nitrogen
4. Most paper is made from	wood	straw	hemp	rags
5. To change a tire, we must have	an air pump	a hammer	a jack	a screw-driver
6. An electric current flows easily through	rubber	porcelain	mica	copper
7. Emery cloth is used for	tents	dusting	smoothing	overalls
8. In cutting iron, we use a	rip saw	buck saw	coping saw	hack saw
9. A magnet attracts	iron	brass	copper	zinc
10. Vulcanizing is a process used on	steel	paint	wood	rubber
11. Asphalt is used for	paving	insulating	grinding	blasting
12. A trowel is used by	an electrician	a mason	a carpenter	a plumber
13. Flux is used in	soldering	painting	tempering	plastering
14. A barometer measures	temperature	pressure	speed	time
15. Most paint contains a compound of	manganese	magnesium	lead	phosphorus
16. To clean a drain pipe, we use	oil	lye	ammonia	gasoline
17. Bricks are made of	limestone	sandstone	clay	gravel
18. An engine has valves in the	commutator	manifold	cylinder block	piston
19. The end of a soldering iron is made of	copper	tin	iron	aluminum
20. Mechanical power is changed into electrical power by a	motor	rheostat	dynamo	transformer
21. A dowel is used for	cutting	marking	boring	fastening
22. The "Stillson" is a	hammer	level	wrench	saw
23. Alcohol is used in	putty	paint	varnish	shellac
24. Electrical pressure is measured in	volts	watts	amperes	ohms
25. A wire gauge is used to measure	length	thickness	strength	weight
26. The sheathing for a roof is fastened to the	rafters	joists	beams	sills
27. The amount of electricity used in a building is measured by	an ammeter	a rheostat	a wattmeter	a voltmeter
28. Unused tools should be protected with	turpentine	shellac	vaseline	linseed oil
29. The binding material used in plaster is	glue	hemp	cotton	hair
30. "Bessemer" is a kind of	steel	insulation	oil	saw
31. The term "set" refers to a	chisel	saw	file	drill
32. Inside threads are cut by a	tap	gimp	counter	die
33. Carborundum is used for	lubricating	heating	grinding	painting
34. The term "bastard cut" refers to a	saw	plane	drill	file
35. A bearing is most often made of	cast iron	bronze	tool steel	zinc

The M Test Arithmetic Subtest

EXERCISE 6

Get the answers to these examples as quickly as you can. Use the side of the page to figure on if you need to.

---

1. How many are 5 men and 10 men?.....Answer ( )

2. If you walk 4 miles an hour for 3 hours, how many miles do you walk?.....Answer ( )

3. A man owes $15.00. He makes a payment on it of $5.00. How much does he still owe?.....Answer ( )

4. A man pays $10.00 for 5 shirts. How much does one shirt cost.....Answer ( )

5 minutes

TEST 6

1. How many are 50 tents and 8 tents? ..... ( )
2. If you save $5.00 a month for 7 months, how much will you save? ..... ( )
3. Mike had 12 cigars. He bought 2 more and then smoked 7. How many cigars did he have left? ..... ( )
4. A company advanced 7 miles and retreated 2 miles. How many miles was it then from where it started? ..... ( )
5. How many hours will it take a truck to go 65 miles at the rate of 5 miles an hour? ..... ( )
6. If 40 men are divided into squads of 8, how many squads will there be? ..... ( )
7. A regiment marched 40 miles in five days. The first day they marched 9 miles, the second day 6 miles, the third 10 miles, the fourth 11 miles. How many miles did they march the last day? ..... ( )
8. How many pencils can you buy for 30 cents at the rate of 2 for 5 cents? ..... ( )
9. If you buy 2 packages of tobacco at 7 cents each and a pipe for 55 cents, how much change should you get from a two-dollar bill? ..... ( )
10. If it takes 7 men 2 days to dig a 140-foot drain, how many men are needed to dig it in half a day? ..... ( )
11. A dealer bought some mules for $1,000. He sold them for $1,200, making $20. on each mule. How many mules were there? ..... ( )
12. A rectangular bin holds 300 cubic feet of lime. If the bin is 10 feet long and 5 feet wide, how deep is it? ..... ( )
13. At a baseball park there are 25,000 people. Four fifths of them came by street-car. If there are 80 persons in each car, how many cars are needed to carry those who travel by street-car? ..... ( )
14. If 4½ tons of clover cost $36.00, what will 2½ tons cost? ..... ( )
15. A ship has food to last her crew of 800 men 4 months. How many months would it last 1,200 men? ..... ( )
16. If a train goes 150 yards in 10 seconds, how many feet does it go in a fifth of a second? ( )
17. A submarine goes 10 miles an hour under water and 20 miles an hour on the surface. How long will it take to cross a 100-mile channel if it has to go one-fifth of the way under water? ..... ( )
18. If 341 squads of men are to dig 6,138 yards of trench, how many yards must be dug by each squad? ..... ( )
19. A certain division contains 4,000 artillery, 15,000 infantry, and 1,000 cavalry. If each branch is expanded proportionately until there are in all 22,000 men, how many will be added to the artillery? ..... ( )
20. A dealer who had already supplied 1,897 barrels of apples to an army camp delivered the remainder of his stock to 27 mess halls. Each mess hall received 56 barrels. What was the total number of barrels supplied? ..... ( )

The M Test Vocabulary Subtest

EXERCISE 7

Draw a line under the word or phrase which explains best what the first word means.

1. DOG	tree	highway	animal	flag
2. GUN	for writing	for swimming	for fishing	for shooting
3. FAST	quick	heavy	ready	soft
4. SAILOR	policeman	seaman	milkman	truck-driver
5. PUDDLE	large house	sharp knife	pool of water	bright light

4½ minutes

TEST 7

1. CHEESE	money	hat	house	food
2. BLONDE	dark-haired	weak-minded	quick-tempered	fair-haired
3. CLOAK	noise	joy	dress	help
4. FUEL	for eating	for walking	for burning	for opening
5. CYCLONE	storm	wheel	drug	giant
6. TONSIL	machine	on the road	in the mouth	weight
7. JESTER	butcher	joker	jeweller	grumbler
8. FRACTURE	force	break	fall	cut
9. REGIME	government	vegetable	country	queen
10. JEOPARDY	beast	danger	candy	pleasure
11. ZENITH	old man	fine thread	small stone	high point
12. DISCLOSURE	doorway	statement	rule	covering
13. INDIGO	colour	island	tribe	finger
14. SEISMOGRAPH	for navigation	for finances	for earthquakes	for electricity
15. SUPERFLUOUS	fluid	extra	excellent	strong
16. ENIGMA	insect	puzzle	dream	flag
17. ASSET	altitude	young donkey	property	poor man
18. ELIMINATE	remove	make	enquire	copy
19. INTREPID	imperfect	rapid	feeble	brave
20. ACRIMONY	bitterness	vegetable	crime	poverty
21. DIFFIDENCE	kindness	shyness	difference	size
22. INHIBIT	to hope	to throw	to stop	to drink
23. CHRONOMETER	paper	compass	thermometer	clock
24. ABRIDGE	to weaken	to jump over	to shorten	to give up
25. IMMACULATE	contented	unfriendly	spotless	young
26. CERAMICS	carpentry	drapery	history	pottery
27. PLATITUDINOUS	noisy	woven	ordinary	faulty
28. PREHENSILE	grasping	pushing	dividing	smoothing
29. TURPITUDE	wickedness	good fortune	water animal	grease
30. PILOSE	dirty	hairy	round	soft

The M Test Verbal Analogies Subtest

EXERCISE 8

1. The SKY is BLUE; GRASS is..... (walk cow green lawn)
2. BREAD is food for MAN; GRASS for the ..... (walk cow green lawn)

3. fish—swims : : man—..... (paper time walks woman)
4. bird—sings : : dog—..... (fire barks snow flag)
5. eat—bread : : drink—..... (water iron lead stones)
6. sit—chair : : sleep—..... (rest bed wake snore)
7. horn—blow : : bell—..... (ring church fire tree)
8. mouth—taste : : nose—..... (see hear smell touch)

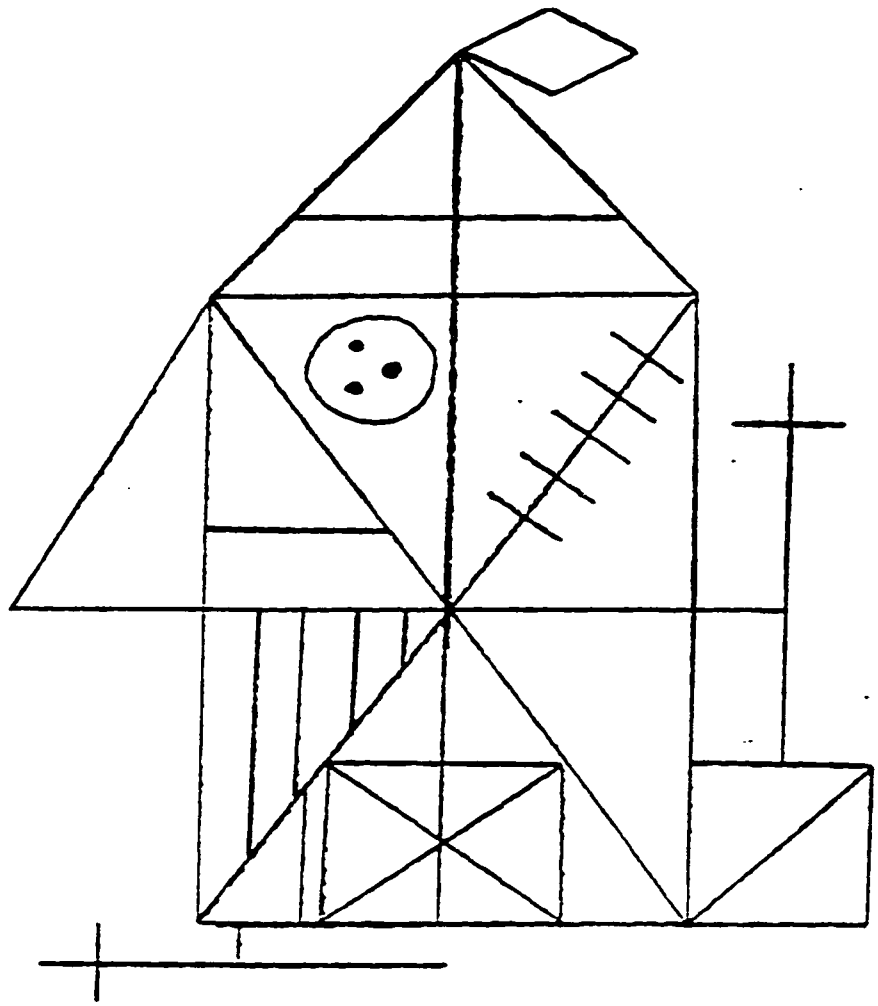
5 minutes

TEST 8

1. good—bad : : white—	(black	blue	red	green)
2. steam—hot : : ice—	(wet	gas	cold	hot)
3. hand—arm : : foot—	(head	leg	table	boot)
4. lamp—light : : stove—	(work	day	sea	heat)
5. swim—water : : fly—	(sea	air	wall	land)
6. palace—king : : stable—	(horse	wood	house	prince)
7. table—wood : : window—	(room	milk	glass	legs)
8. large—small : : rich—	(money	poor	man	equal)
9. buy—sell : : come—	(take	give	fish	go)
10. navy—admiral : : army—	(private	general	captain	township)
11. food—eat : : books—	(shelf	print	pictures	read)
12. clothes—suitcase : : money—	(inside	purse	stolen	strong)
13. bear—cub : : dog—	(cat	kitten	puppy	horse)
14. sweet—sour : : honey—	(vinegar	bee	sugar	taste)
15. hammer—nail : : screwdriver—	(tool	force	screw	bolt)
16. up—down : : above—	(there	below	sky	again)
17. man—sword : : bee—	(ant	gun	wound	sting)
18. hat—head : : glove—	(hand	toe	sew	needle)
19. west—east : : left—	(north	south	right	wrong)
20. reward—hero : : punish—	(soldier	medal	prison	traitor)
21. table—legs : : cart—	(chair	wheels	arms	horse)
22. blood—vein : : water—	(lead	hot	carry	pipe)
23. wool—sheep : : fur—	(clothes	bird	cat	warm)
24. high—low : : far—	(near	deep	distance	tall)
25. leg—knee : : arm	(elbow	shoulder	wrist	thigh)
26. bright—light : : loud—	(dull	lamp	noise	hard)
27. book—author : : statue—	(airman	sculptor	writer	clay)
28. before—after : : early—	(late	now	then	never)
29. bird—fish : : airplane—	(pilot	battleship	submarine	fins)
30. horse—carriage : : locomotive—	(bus	truck	driver	train)
31. joy—sorrow : : comedy—	(pain	play	tragedy	music)
32. parent—child : : mother—	(daughter	sister	brother	father)
33. surround—occupy : : outside—	(capture	army	above	inside)
34. game—referee : : trial—	(lawyer	judge	prison	sport)
35. true—false : : proud—	(ashamed	humble	fine	weak)

Appendix D

Figure From the Rey Osterreith Complex Figure Design Test



Appendix E

MANOVA and ANOVA Summary Tables of Group Comparisons on M Test Scores

Appendix E Table 1

MANOVA Summary Table of the Effect of Group Status on Current M Test Subtest Scores of the Schizophrenic and ConTot Groups

	Pillai's	SS	MS	df	F
	.6666			8	8.75***
Picture Completion		180.02	180.02	1	16.12***
Picture Anomalies		160.36	160.36	1	16.54***
Paper Formboard		63.84	63.84	1	4.75
Tool Recognition		1233.84	1233.84	1	49.02***
Mechanical Information		633.84	633.84	1	14.37***
Arithmetic		164.01	164.01	1	21.76***
Vocabulary		236.45	236.45	1	5.58
Verbal Analogies		372.36	372.36	1	6.26
Error				35	
Picture Completion		468.95	11.17		
Picture Anomalies		407.27	9.70		
Paper Formboard		564.59	13.44		
Tool Recognition		1057.14	25.17		
Mechanical Information		1853.14	44.12		
Arithmetic		316.53	7.53		
Vocabulary		1781.27	42.41		
Verbal Analogies		2497.27	59.46		

***$p < .001$

Appendix E Table 2

MANOVA Summary Table of the Effect of Group Status on Current M Test Subtest Scores of the Schizophrenic and ConVoc Groups

	Pillai's	SS	MS	df	F
	.7905			8	16.51***
Picture Completion		532.02	532.02	1	45.15***
Picture Anomalies		241.11	241.11	1	24.42***
Paper Formboard		338.27	338.27	1	21.78***
Tool Recognition		1743.84	1743.84	1	78.83***
Mechanical Information		1924.57	1924.57	1	47.14***
Arithmetic		245.82	245.82	1	37.26***
Vocabulary		712.02	712.02	1	14.29***
Verbal Analogies		1443.27	1443.27	1	22.72***
Error				35	
Picture Completion		494.95	11.78		
Picture Anomalies		414.77	9.88		
Paper Formboard		652.27	15.53		
Tool Recognition		929.14	22.12		
Mechanical Information		1714.59	40.82		
Arithmetic		277.09	6.60		
Vocabulary		2092.95	49.83		
Verbal Analogies		2668.36	63.53		

***$p < .001$

Appendix E Table 3

ANOVA Summary Table for the Effect of Group Status and Time on M Test Paper Formboard Scores of the Schizophrenic and Psychiatric Groups

Source	df	MS	F
Between			
Group (G)	1	2.19	.09
Error	31	24.35	
Within			
Time (T)	1	598.10	63.74***
T x G	1	3.33	.36
Error	31	9.38	

***$p<.001$

Appendix E Table 4

ANOVA Summary Table for the Effect of Group Status and Time on M Test Vocabulary Scores of the Schizophrenic and Psychiatric Groups

Source	df	MS	F
Between			
Group (G)	1	314.84	4.51*
Error	31	69.84	
Within			
Time (T)	1	3.07	.15
T x G	1	58.85	2.91
Error	31	20.21	

*$p<.05$

Appendix E Table 5

ANOVA Summary Table for the Effect of Group Status and Time on Total M Test Scores of the Schizophrenic and Psychiatric Groups

Source	df	MS	F
Between			
Group (G)	1	9983.77	6.15*
Error	31	1623.95	
Within			
Time (T)	1	21179.17	42.83***
T x G	1	165.98	.34
Error	31	494.51	

*$p<.05$

***$p<.001$

Appendix E Table 6

ANOVA Summary Table for the Effect of Group Status and Time on M Test Paper Formboard Scores of the Schizophrenic and Alcoholic Groups

Source	df	MS	F
Between			
Group (G)	1	341.05	11.22**
Error	40	30.41	
Within			
Time (T)	1	504.37	54.10***
T x G	1	80.19	8.60**
Error	40	9.32	

**p<.01

***p<.001

Appendix E Table 7

Anova Summary Table for the Effect of Group Status and Time on M Test Vocabulary Scores of the Schizophrenic and Alcoholic Groups

Source	df	MS	F
Between			
Group (G)	1	359.12	4.91*
Error	40	73.15	
Within			
Time (T)	1	.19	.01
T x G	1	136.83	10.34**
Error	40	13.24	

*$p<.05$

**$p<.01$

Appendix E Table 8

Anova Summary Table for the Effect of Group Status and Time on Total M Test Scores of the Schizophrenic and Alcoholic Groups

Source	df	MS	F
Between			
Group (G)	1	43078.82	28.13***
Error	40	1531.33	
Within			
Time (T)	1	11032.26	33.72***
T x G	1	7519.16	22.30***
Error	40	337.22	

***p<.001

Appendix E Table 9

Manova Summary Table of the Effect of Group Status on Current M Test Subtest Scores of the Psychiatric and ConPsych Groups

	Pillai's	SS	MS	df	F
	.6832			8	3.50*
Picture Completion		10.23	10.23	1	.65
Picture Anomalies		52.55	52.55	1	4.44
Paper Formboard		26.18	26.18	1	1.96
Tool Recognition		222.73	222.73	1	8.82
Mechanical Information		49.50	49.50	1	1.67
Arithmetic		40.91	40.91	1	5.78
Vocabulary		1.64	1.64	1	.05
Verbal Analogies		24.05	24.05	1	.44
Error				13	
Picture Completion		315.09	15.75		
Picture Anomalies		236.55	11.83		
Paper Formboard		266.91	13.35		
Tool Recognition		505.09	25.25		
Mechanical Information		848.36	42.42		
Arithmetic		141.45	7.07		
Vocabulary		691.45	34.57		
Verbal Analogies		1081.45	54.07		

*$p<.05$

Appendix F

Product-Moment Correlations of Treatment-related Variables and M Test Scores

Appendix F Table 1

Product-Moment Correlations of Treatment-related Variables and M Test Scores for the Schizophrenic Group (n=22)

	Current M Scores				Change in M Scores			
Variables	Verbal	Nonverbal	Mechanical	Total	Verbal	Nonverbal	Mechanical	Total
Total Time in Hospital	-.24	-.48	-.33	-.35	.06	.07	.11	.10
Number of Hospitalizations	.08	.22	.08	.12	.003	.05	-.04	.003
Duration of Illness	-.56	-.48	-.50	-.57	.23	-.04	.11	.13

Appendix F Table 2

Product-Moment Correlations of Treatment-related Variables and M Test Scores for the Psychiatric Group (n=11)

	Current M Scores				Change in M Scores			
Variables	Verbal	Nonverbal	Mechanical	Total	Verbal	Nonverbal	Mechanical	Total
Total Time in Hospital	.23	-.22	-.36	-.10	-.15	-.56	.09	-.16
Number of Hospitalizations	.26	-.30	-.05	.005	-.50	-.43	.03	-.33
Duration of Illness	-.43	-.44	-.49	-.51	-.57	.39	.42	.53

Appendix G

Product-Moment Correlations Involving Neuropsychological Test Scores

Appendix G Table 1

Product-Moment Correlations Between Demographic, PMC, M Test Variables and Neuropsychological Test Scores in the Schizophrenic Group (n=22)

	Neuropsychological Test Scores						
Variables	DFNOVEL	DFPERSEV	SQDFNAME	DIGSFWD	DIGSBKWD	REYCOPY	REYRECALL
Current Age	-.49	-.07	.06	-.11	-.21	-.08	-.32
SES	.30	-.14	.06	-.03	-.21	-.24	-.15
Education	.04	-.29	.08	-.13	.15	.17	.13
PMC	.27	-.28	.04	.19	.26	-.01	.22
Enlistment M	.25	-.37	.22	.34	.46	.21	.30
Current M	.45	.26	-.16	.26	.48	.17	.45
Change in M	-.23	-.38	-.04	.06	-.05	.02	-.18

Variables	BENTTOT	BENTREPT	NEWCTOT	NEWCREPT	CATCOMP	UNIQUE	TOTERR	PERSEV
Current Age	-.49	-.48	-.67	-.30	-.26	.12	.30	-.10
SES	.14	.21	.04	-.16	.51	-.09	-.42	.32
Education	.19	.34	.10	.07	.16	.09	.04	-.26
PMC	.38	.30	.14	.14	.02	-.06	.19	-.36
Enlistment M	.50	.23	.26	.28	.04	.06	.24	.16
Current M	.68	.30	.79**	.63	.11	-.36	.03	.42
Change in M	.21	.05	-.57	-.39	-.07	.43	.30	-.28

Note. **DFNOVEL**=Design Fluency: Number of original drawings; **SQDFNAME**=Square root of number of nameable drawings; **DFPERSEV**=Number of perseverative responses; **DIGSFWD**=Digits Forward score; **DIGSBKWD**=Digits Backward score; **REYCOPY**=Rey Osterreith complex Figure Design Copy score; **REYRECALL**=Rey Osterreith Complex Figure Design Recall Score; **BENTTOT**=Benton Fluency Test: Number of acceptable words; **BENTREPT**=Benton Fluency Test: Number of repetitions; **NEWCTOT**=Newcombe Fluency Test: Number of acceptable words; **NEWCREPT**=Newcombe Fluency Test: Number of repetitions; **CATCOMP**=Wisconsin Card Sorting Test: Number of categories completed; **UNIQUE**=Wisconsin Card Sorting Test: Number of unique responses; **TOTERR**=Wisconsin Card Sorting Test: Number of errors; **PERSEV**=Wisconsin Card Sorting Test: Number of perseverations.

**$\alpha F_{U} < .01$.

Appendix G Table 2

Product-Moment Correlations Between Demographic, PMC, M Test Variables and Neuropsychological Test Scores in the Psychiatric Group (n=11)*

	Neuropsychological Test Score						
Variables	DFNOVEL	DFPERSEV	SQDFNAME	DIGSFWD	DIGSBKWD	REYCOPY	REYRECALL
Current Age	-.60	-.73	.28	.01	.13	.58	-.16
SES	.22	-.003	.28	.30	-.12	-.05	.09
Education	.09	.11	.43	.19	.20	.58	-.16
PMC	.19	.57	.26	.13	.26	.09	.54
Enlistment M	.27	-.52	-.12	.31	.45	.21	.38
Current M	.75	.56	-.43	.43	.59	.57	.53
Change in M	-.65	-.58	.28	-.22	-.27	-.48	-.27

Variables	BENTTOT	BENTREPT	NEWCTOT	NEWCREPT	CATCOMP	UNIQUE	TOTERR	PERSEV
Current Age	-.59	-.31	-.32	-.63	-.04	.36	-.06	-.18
SES	.02	.44	.06	.11	.51	.67	-.43	-.70
Education	.04	.50	.07	-.06	.09	.28	-.01	-.14
PMC	.08	.08	.12	.00	.21	.68	-.30	-.23
Enlistment M	.36	.49	.44	.09	.21	.18	-.37	-.52
Current M	.77	.47	.81	.48	.08	-.49	-.29	-.17
Change in M	-.58	.08	-.56	-.49	.12	.80	-.02	.003

Note. * n for REYCOPY and REYRECALL was 10

DFNOVEL=Design Fluency: Number of original drawings; **SQDFNAME**=Square root of number of nameable drawings; **DFPERSEV**=Number of perseverative responses; **DIGSFWD**=Digits Forward score; **DIGSBKWD**=Digits Backward score;**REYCOPY**=Rey Osterreith complex Figure Design Copy score; **REYRECALL**=Rey Osterreith Complex Figure Design Recall Score; **BENTTOT**=Benton Fluency Test: Number of acceptable words; **BENTREPT**=Benton Fluency Test: Number of repetitions; **NEWCTOT**=Newcombe Fluency Test: Number of acceptable words; **NEWCREPT**=Newcombe Fluency Test: Number of repetitions; **CATCOMP**=Wisconsin Card Sorting Test: Number of categories completed; **UNIQUE**=Wisconsin Card Sorting Test: Number of unique responses; **TOTERR**=Wisconsin Card Sorting Test: Number of errors; **PERSEV**=Wisconsin Card Sorting Test: Number of perseverations.

Appendix G Table 3

Product-Moment Correlations Between Demographic, PMC, M Test Variables and Neuropsychological Test Scores in the ConVoc Group (n=22)

	Neuropsychological Test Scores						
Variables	DFNOVEL	DFPERSEV	SQDFNAME	DIGSFWD	DIGSBKWD	REYCOPY	REYRECALL
Current Age	-.22	.09	.76**	-.48	-.11	.06	-.09
SES	.20	-.06	-.40	.39	.17	.32	.21
Education	.21	-.005	-.02	.02	.13	.10	.44
Enlistment M	.14	-.30	.34	.28	.58	.35	.30
Current M	.04	-.15	.09	.31	.54	.36	.44
Change in M	.18	.39	.49	.08	.29	.12	-.07

Variables	BENTTOT	BENTREPT	NEWCTOT	NEWCREPT	CATCOMP	UNIQUE	TOTERR	PERSEV
Current Age	-.09	.002	-.31	-.20	-.03	-.29	.12	.23
SES	.19	-.04	.37	.30	.24	.05	-.47	-.55
Education	-.13	-.24	-.07	.29	.33	-.13	-.31	-.29
Enlistment M	.42	-.16	.23	.29	.46	-.06	-.43	-.30
Current M	.50	-.19	.29	.24	.34	.00	-.49	-.35
Change in M	.07	-.03	.01	.17	.33	-.10	-.09	-.03

Note. **DFNOVEL**=Design Fluency: Number of original drawings; **SQDFNAME**=Square root of number of nameable drawings; **DFPERSEV**=Number of perseverative responses; **DIGSFWD**=Digits Forward score; **DIGSBKWD**=Digits Backward score;**REYCOPY**=Rey Osterreith complex Figure Design Copy score; **REYRECALL**=Rey Osterreith Complex Figure Design Recall Score; **BENTTOT**=Benton Fluency Test: Number of acceptable words; **BENTREPT**=Benton Fluency Test: Number of repetitions; **NEWCTOT**=Newcombe Fluency Test: Number of acceptable words; **NEWCREPT**=Newcombe Fluency Test: Number of repetitions; **CATCOMP**=Wisconsin Card Sorting Test: Number of categories completed; **UNIQUE**=Wisconsin Card Sorting Test: Number of unique responses; **TOTERR**=Wisconsin Card Sorting Test: Number of errors; **PERSEV**=Wisconsin Card Sorting Test: Number of perseverations.

**$\alpha F_W < .01$.

Appendix G Table 4

Product-Moment Correlations between Treatment-Related Variables and Neuropsychological Test Scores in the Psychiatric Group (n=11)*

	Neuropsychological Test Scores							
Variables	DFTOT	DFNOVEL	DFPERSEV	SQDFNAME	DIGSFWD	DIGSBKWD	REYCOPY	REYRECALL
Total Time in Hospital	.12	.11	-.13	-.16	-.18	.26	.16	.15
Number of Hospitali-zations	-.26	-.15	-.01	-.36	-.48	.01	-.29	.07
Duration of Illness	-.20	-.21	-.36	-.24	-.26	-.35	-.53	-.10

Variables	BENTTOT	BENTREPT	NEWCTOT	NEWCREPT	CATCOMP	UNIQUE	TOTERR	PERSEV
Total Time in Hospital	.16	-.17	.06	-.08	-.16	-.24	.03	.10
Number of Hospitali-zations	-.26	-.56	-.09	-.39	-.46	-.40	.32	.42
Duration of Illness	-.39	-.26	-.22	.06	-.37	.50	.44	.13

Note. * n for REYCOPY and REYRECALL was 10

DFNOVEL=Design Fluency: Number of original drawings; **SQDFNAME**=Square root of number of nameable drawings; **DFPERSEV**=Number of perseverative responses; **DIGSFWD**=Digits Forward score; **DIGSBKWD**=Digits Backward score;**REYCOPY**=Rey Osterreith complex Figure Design Copy score; **REYRECALL**=Rey Osterreith Complex Figure Design Recall Score; **BENTTOT**=Benton Fluency Test: Number of acceptable words; **BENTREPT**=Benton Fluency Test: Number of repetitions; **NEWCTOT**=Newcombe Fluency Test: Number of acceptable words; **NEWCREPT**=Newcombe Fluency Test: Number of repetitions; **CATCOMP**=Wisconsin Card Sorting Test: Number of categories completed; **UNIQUE**=Wisconsin Card Sorting Test: Number of unique responses; **TOTERR**=Wisconsin Card Sorting Test: Number of errors; **PERSEV**=Wisconsin Card Sorting Test: Number of perseverations.

Appendix H

Mancova Summary Tables for Neuropsychological Measures

Appendix H Table 1

Mancova Summary Table for the Effect of Group Status on Design Fluency Scores With Current Total M Test Score as the Covariate

	Pillai's	SS	MS	df	F
Source					
Covariate	.1296			3	2.43
DFNOVEL				1	5.56*
DFPERSEV				1	0.07
SQDFNAME				1	1.08
Group	.2607			6	2.50*
DFNOVEL		296.98	148.49	2	3.03
DFPERSEV		223.05	111.52	2	3.06
SQDFNAME		0.76	0.38	2	0.49
Error				51	
DFNOVEL		2495.24	48.93		
DFPERSEV		1860.33	36.48		
SQDFNAME		39.32	0.77		

Note. DFNOVEL = Design Fluency: Number of Original Drawings

SQDFNAME = Design Fluency: Square Root of Number of Nameable Drawings

DFPERSEV = Design Fluency: Number of Perseverations

*$p < .05$

Appendix H Table 2

Mancova Summary Table for the Effect of Group Status on Digits Forward and Backward Scores with Current Total M Test Score as the Covariate

	Pillai's	SS	MS	df	F
Source					
Covariate	.2668			2	9.10***
DIGSFWD				1	5.56*
DIGSBKWD				1	18.22***
Group	.20435			4	2.90*
DIGSFWD		10.73	5.37	2	5.75**
DIGSBKWD		0.87	0.44	2	0.40
Error				51	
DIGSFWD		47.62	0.93		
DIGSBKWD		55.89	1.10		

Note. DIGSFWD = Digits Forward Score; DIGSBKWD = Digits Backward Score.

*$p < .05$

**$p < .01$

***$p < .001$

Appendix H Table 3

Mancova Summary Table for the Effect of Group Status on Wisconsin Card Sorting Test Scores with Current Total M Test Score as the Covariate

	Pillai's	SS	MS	df	F
Source					
Covariate	.14084			4	1.97
CATCOMP				1	1.95
TOTERR				1	3.01
UNIQUE				1	4.14
PERSEV				1	0.27
Group	.29375			8	2.11*
CATCOMP		14.57	7.28	2	4.04*
TOTERR		1089.98	544.99	2	1.76
UNIQUE		333.53	166.76	2	1.00
PERSEV		5108.86	2554.43	2	4.48*
Error				51	
CATCOMP		91.90	1.80		
TOTERR		15819.05	310.18		
UNIQUE		8517.57	167.01		
PERSEV		29088.80	570.37		

Note. CATCOMP = Number of categories completed
TOTERR = Number of errors
UNIQUE = Number of unique responses
PERSEV = Number of perseverations

*$p < .05$

Appendix H Table 4

Mancova Summary Table for the Effect of Group Status on REY Copy and Recall Scores with Current Total M Test Score as the Covariate

	Pillai's	SS	MS	df	F
Source					
Covariate	.23865			2	7.84***
Recall				1	11.47***
Copy				1	6.22*
Group	.08476			4	1.13
Recall		55.56	27.78	2	2.00
Copy		21.52	10.76	2	0.52
Error				51	
Recall		707.59	13.87		
Copy		1054.69	20.68		

Note. REY = Rey-Osterreith Complex Figure Design Test

*p < .05

**p < .01

***p < .001

Appendix H Table 5

Mancova Summary Table for the Effect of Group Status on Newcombe and Benton Fluency Scores with Current Total M Test Score as the Covariate

Source	Pillai's	SS	MS	df	F
Covariate	.50977			4	12.48***
NEWCTOT				1	31.52***
NEWCREPT				1	9.62**
BENTTOT				1	33.24***
BENTREPT				1	0.51
Group	.26009			8	1.83
NEWCTOT		1206.69	603.34	2	6.15**
NEWCREPT		0.26	0.13	2	0.04
BENTTOT		4.23	2.11	2	0.03
BENTREPT		3.92	1.96	2	1.11
Error				51	
NEWCTOT		5000.69	98.05		
NEWCREPT		178.71	3.50		
BENTTOT		3529.08	69.20		
BENTREPT		89.87	1.76		

Note. NEWCTOT = Newcombe Fluency Test: Number of acceptable words

NEWCREPT = Newcombe Fluency Test: Number of repetitions

BENTTOT = Benton Fluency Test: Number of acceptable words

BENTREPT = Benton Fluency Test: Number of repetitions

**$p < .01$

***$p < .001$