PERFORMANCE OF PSYCHIATRIC AND HEAD INJURY PATIENTS
ON THE GENERAL NEUROPSYCHOLOGICAL DEFICIT SCALES

DISSERTATION

Presented to the Graduate Council of the
University of North Texas in Partial
Fulfillment of the Requirements

For the Degree of

DOCTOR OF PHILOSOPHY

By

Lisa M. Collingwood, B.A., M.S.
Denton, Texas
August, 1997

Reitan and Wolfson's General Neuropsychological Deficit Scale and Left and Right Neuropsychological Deficit Scales were applied to Halstead-Reitan test data of individuals with psychotic or substance abuse disorders with and without a head injury. There were 4 groups with 15 subjects in each group. Comparisons of the mean performances of each group were made. Although all groups were in the impaired range when compared to published norms, there were no significant differences among the groups. There was one significant interaction between diagnosis and head injury indicating that subjects who were both psychotic and head injured did significantly worse on one subscale of the GNDS than did any other group. This study expanded the data available on the GNDS by providing information on populations for whom there was no GNDS data. It also appears to have substantiated the scale's utility as a measure of impairment across a variety of populations since all groups scored well above that typically scored by normals according to published norms.
PERFORMANCE OF PSYCHIATRIC AND HEAD INJURY PATIENTS
ON THE GENERAL NEUROPSYCHOLOGICAL DEFICIT SCALES

DISSERTATION

Presented to the Graduate Council of the
University of North Texas in Partial
Fulfillment of the Requirements

For the Degree of

DOCTOR OF PHILOSOPHY

By

Lisa M. Collingwood, B.A., M.S.
Denton, Texas
August, 1997
TABLE OF CONTENTS

Page

LIST OF TABLES ........................................ iv

Chapter

I. INTRODUCTION ............................................. 1

   General Neuropsychological Deficit Scale
   Psychosis and Neuropsychological Performance
   Psychosis and Hemispheric Lateralization
   Substance Abuse and Neuropsychological Performance
   Substance Abuse and Lateralization

II. METHOD .................................................... 38

   Subjects
   Subject Demographics
   Materials
   Procedure

III. RESULTS .................................................. 49

IV. DISCUSSION ............................................... 55

APPENDICES .................................................. 61

REFERENCES .................................................. 77
LIST OF TABLES

Table                                Page

1. Comparative Performance Means and Standard Deviations on the GNDS and Subscales, LNDS, RNDS, and Impairment Index for Subjects with Psychotic and Substance Abuse Disorders With and Without Head Injuries.......................... 70

2. Analysis of Variance of Summary Indices of Impairment........................................ 71

3. Means and Standard Deviations of Halstead Subtests by Group.................................. 72

4. Accuracy of Classification of Psychotic and Substance Abuse Disorders with and without Head Injuries at Various Cut-off Scores for the General Neuropsychological Deficit Scale........... 73

5. Correlations between GNDS and Halstead subtests.................................................. 74

6. Distribution of Scores on the GNDS of Psychotic and Substance Abuse Patients With and Without Head Injuries ......................................................... 75

7. Numbers of Subjects Falling into Each GNDS Impairment Category .............................. 76
CHAPTER I

INTRODUCTION

The practice of clinical neuropsychology began in the latter part of the 19th century. Broca, Wernicke, and Hughlings Jackson were a few of the researchers conducting patient studies at that time. As proponents of the functional localization theory, these men believed that discrete areas of the brain were responsible for specific cognitive functions and attempted to prove this in their patient research.

In the 1940's, Ward Halstead developed a series of tests designed to measure what he called biological intelligence. He thought this type of intelligence represented the state of functioning of the central nervous system as opposed to the educational and learning opportunities of the patient (Parsons, 1986). He administered a battery of 27 tests to 50 adult males who had recently recovered from head injuries. He then chose 13 of the 27 tasks for factor analyses. The result was four factors believed to represent the major components of biological intelligence. The 13 tests were then administered to 50 neurological patients and 30 controls in order to determine the cut-off points which are still used today (Parsons, 1986). These cut-off points
are used in Halstead's Impairment Index which differentiates between people with brain damage and those without.

In 1955, one of Halstead's former doctoral students, Ralph Reitan confirmed the ability of the tests to discriminate between brain damaged and non-brain damaged patients. Numerous studies on a wide variety of disorders (e.g., alcoholism, epilepsy, cerebrovascular disorders, head trauma, etc.) followed. Reitan modified Halstead's battery by eliminating some tests and adding others. These changes resulted in the Halstead-Reitan battery. Shortly thereafter, Reitan began to give his now well-known, workshops where he presented the test battery and several case studies. These workshops have helped to make widespread the standardized use of the Halstead-Reitan battery. This, in turn, lead to increased use of the battery in clinical and research settings.

The Russian psychologist, Alexander Luria used an individualized approach to neuropsychological assessment. He developed a series of tests based on his functional systems theory of cerebral organization. In 1985, Charles Golden and colleagues used Luria's work to create the Luria-Nebraska Neuropsychological Battery (LNNB) in order to standardize Luria's techniques. This battery is comprised of 269 items. From these items, Golden derived 11 ability scales that measure abilities in 11 ability areas, two sensorimotor scales, a pathognomic scale, and a series of
localization and factor scales. Test data are interpreted through analyses of performance patterns on all of the scales, on individual items and qualitative variables. The LNNB's Pathognomic scale does well to differentiate between normal and brain damaged subjects. It also provides a measure of the degree to which the brain damaged subject has compensated for the damage (Golden & Maruish, 1986). This scale was an attempt to create a general Index of impairment.

Currently, there are three basic schools of assessment within the field of neuropsychology: a) the behavioral neurology practitioners, b) those that take a client-centered normative approach when conducting a neuropsychological evaluation, and c) clinicians that favor the use of a neuropsychological battery (Beaumont, 1996).

The work of the Russian psychologist, Alexander Luria is at the root of the behavioral neurology approach. This method focuses on the individual and is clinically based. Here, the objective of an assessment is to obtain a qualitative, rather than quantitative, picture of the client's deficits. Thus, instead of using psychometric instruments and statistical norms to identify how an individual's performance differs from that of members of the normal population, a behavioral neurology exam determines a deficit exists when the client cannot generate a behavior that any normal person of similar age, background, and
ability should be able to perform. These evaluators attend to both how the behavior is performed as well as to the level at which it is demonstrated (Beaumont, 1996).

The British born, individual-centered approach appears to be the most widely used today. Evaluators using this method combine a formal psychometric approach with the flexibility of an individualized assessment. Several psychometric tasks, usually with normative data, are chosen based on the particulars of the case being evaluated. The goal of such an assessment is to obtain a description of the client's deficits and level of function rather than to simply diagnose the individual (Beaumont, 1996).

The neuropsychological battery approach involves the use of a number of individual tasks, each presumably tapping one or more specific abilities, used together in order to obtain a comprehensive measure of a broad range of functions. Strengths and deficits are determined by comparing the client's performance scores with those of the normed sample. Users of this method also utilize actuarial procedures in order to identify the location and type of cerebral trauma. A primary criticism of this approach is that most batteries over-emphasize the use of specific scores or measures to the neglect or exclusion of tasks that tap the highest level of processing and the abilities involved in daily living. Therefore, the batteries tend to yield measures of a variety of skills without providing a picture of overall
level of functioning. In other words, users of the battery approach often "can't see the forest for the trees".

The need for a general Index of severity was first addressed by W.R. Russell in 1932 when he proposed that the amount of time from the point of trauma until the patient regains full consciousness or the duration of the Post-traumatic Amnesia (PTA) be used as an indicator of severity of brain impairment. Russell held that a person was fully conscious when he or she was able to demonstrate a continuous recall of events occurring in his or her environment (Reitan & Wolfson, 1993). Researchers Jennett and Teasdale currently advocate the use of this Index. They use subject self-report to determine the time at which memory function is restored. Obviously, as Reitan and Wolfson (1988b) point out, an impaired person may not provide accurate information, thus making the use of this measure to predict severity of damage and future functioning a questionable practice. Despite this significant weakness, the Index is fairly widely used. Jennett and Teasdale (1981) employ the following guidelines for determining the extent of trauma based on time spent unconscious: fewer than 5 minutes, Very mild; 5 minutes to 1 hour, Mild; 1 hour to 1 day, Moderate; 1 day to 1 week, Severe; 1 week to 1 month, Extremely Severe (Reitan & Wolfson, 1993).

Another, more widely used measure of severity also authored by Teasdale and Jennett is the Glasgow Coma Scale.
This instrument assesses patient function in the areas of Eye opening, Motor Response, and Verbal Response. Behaviors scored on the Eye Opening scale range from no opening activity to unelicited opening of the eyes. The Motor Response scale includes the assessment of no motor activity to "extensor response, abnormal flexion, withdrawal, localization of the stimulus, or spontaneous compliance." Responses scored on the Verbal scale are no response, in comprehensible sounds, incorrect words, illogical conversation, and normal verbal communication (Reitan & Wolfson, 1993).

Both the PTA and Glasgow measures have been criticized for being too simplistic and having little in common with the comprehensive neuropsychological exam necessary to accurately assess severity of damage and predict future functioning. In addition, the Glasgow has received criticism related to difficulties in obtaining a standardized interpretation of what is meant by "purposeful" motor activity and the general distinctions between consciousness and unconsciousness (Levin, et al, 1982).

A third Index of severity is the Galveston Orientation and Amnesia Test (GOAT) developed by Levin and colleagues in 1979. This instrument assesses prospective instead of retrospective amnesia following cerebral trauma. Scores on this test yield a recovery curve used to describe the initial phase of recuperation in the noncomatose patient.
Two similar measures are currently used as general indices of impairment. These are the Halstead Impairment Index developed by Halstead (1947) and Russell, et al's (1970) Average Impairment Rating. Although both of these instruments are based on several factors and do reliably distinguish between patients with and without cognitive impairment, neither is comprehensive enough to yield a measure of general neuropsychological function.

Furthermore, as Reitan and Wolfson (1993) assert, "...neither assesses the subject's degree of deficit regarding the principal of the neuropsychological methods of inference (level of performance, patterns and relationships among test results, specific deficits characteristic of brain injury, and comparisons of functional efficiency on the two sides of the body using the same tasks)".

While a subject's performances on specific tasks can provide information about the location of maximal cerebral damage, they tend to detect lesions most easily found by conventional neurological techniques such as the MRI. Therefore, this type of patient is not often referred to a neuropsychologist for evaluation. However, in the case of diffuse or generalized damage, conventional diagnostic procedures are less efficient. Oftentimes, the results of a neuropsychological exam are the only indication that such damage exists (Reitan & Wolfson, 1993). These examples along with the limitations of the five existing measures of
severity underscore the need for a complete summarizing Index of brain-behavior relationships for individuals with cerebral trauma. Reitan and Wolfson's recent development of the General Neuropsychological Deficit Scale (GNDS) meets this need. The GNDS is based on data obtained in the Halstead-Reitan Neuropsychological Battery (HRNB) which does provide both general and specific indices of neuropsychological function.

**General Neuropsychological Deficit Scale**

The GNDS was designed to assess clients aged 15 years and older. It is a summary of the subject's performance on 42 factors taken from the HRNB. These factors are organized into one of four groups reflective of deficits consistent with each of the methods of neuropsychological inference: (1) Level of Performance (factors 1-19), (2) Pathognomonic signs (factors 20-31), (3) Patterns and Relationships among Test Results (factors 32 and 33), and (4) Right-left Differences (factors 34-42). Each of these categories yields one score and there is a total score for all 42 factors.

Each factor, excluding pathognomonic signs, is scored on a scale ranging from 0 to 3 points. A 0 signifies a normal performance. A 1 is within the normal range but a less than perfect performance. A 2 indicates mild to moderate impairment while a 3 suggests severe neuropsychological dysfunction. The pathognomonic signs are
taken from the Reitan-Indiana Aphasia Screening Test. Because each sign represents brain dysfunction and not a range of responses extending from normal to severe impairment, these factors are scored differently from the other variables. Each of the signs has been given a score from 1 to 3 based on the degree to which each of the types of deficit were correlated with other deficits (Reitan, 1984). After scoring the signs, the Examiner adds the scores in each of the 4 sections of the GNDS and then sums those 4 scores to yield a total GNDS score.

Validation of the GNDS was done by comparing four groups: a non-brain-damaged control group and groups of subjects with generalized cerebral damage, left cerebral damage, and right cerebral damage. The control group obtained a mean GNDS of 17.20 points indicative of a normal performance. Most of these points came from Level of Performance factors which collectively had the same approximate weight as the two factors representing Patterns and Relationships. As would be expected, pathognomonic signs were rare in the control group. Right-left Differences carried an intermediate weight.

When looking at a combination of the three experimental groups (labeled Heterogeneous Brain-Damaged group), this group yielded a mean total GNDS of 51.34 points with each of the 42 factors representing an average of 1.22 points. The Level of Performance variables contributed more per item to
the total than did the other categories. Patterns and Relationships and Right-left Differences made intermediate contributions. Consistent with Reitan's 1984 finding that specifically impaired performances are comparatively rare even in the cases of cerebral lesions, pathognomonic signs were responsible for the least number of points.

The average scores for the generalized, left, and right cerebral damage groups were about equal in all instances. There was no significant difference between the total score for each of these conditions. This suggests that the GNDS generates an equal degree of impairment for brain-damaged individuals regardless of whether neurological information indicates that he or she has generalized, left, or right cerebral damage. The subjects with vascular disease routinely yielded a slightly more impaired total score than did those with heterogeneous generalized, left, or right cerebral damage. This is consistent with the 1982 finding of Horn and Reitan that individuals with lateralized cerebrovascular lesions had more striking impairments than subjects with lateralized intrinsic brain tumors or left or right damage caused by a head injury.

Individuals with brain damage due to head injury obtained similar total scores on the GNDS independent of their category of brain damage (diffuse, left, or right). The scores obtained by the head injured subjects were also similar to the level of impairment seen in the groups with
heterogeneous brain damage. For the total 169 brain damaged subjects the Level of Performance factors contributed most per item in the total score. Patterns and Relationships and Right-left differences took intermediate positions. Pathognomonic signs contributed the least to the total GNDS score. When comparing subjects with generalized, left and right cerebral lesions across categories of heterogeneous, cerebrovascular, and traumatic damage, the total GNDS scores are similar independent of whether the damage was general or in the left or right hemisphere. The mean scores were 52.87, 55.80 and 51.21 respectively.

Based on the above results, it is apparent that the GNDS can be used to accurately categorize patients with normal, mildly impaired, moderately impaired, and severely impaired neuropsychological functioning and is the much needed general Index of function. Along with the GNDS, Reitan and Wolfson developed two complementary scales that provide measures of function of each of the cerebral hemispheres. These are the Left and Right Neuropsychological Scales (LNDS and RNDS). The LNDS is derived from performances on 21 HRNB measures and the RNDS comes from 13 measures on the HRNB. Both of these scales make use of the interrelatedness of sophisticated neuropsychological activities, differences in performances on the two sides of the body, and the presence of specific or pathognomonic deficiencies. The score on each of the
LNDS and RNDS variables is converted to a score ranging from 0 to 3 that is indicative of the degree of difference in left or right cerebral functions. A score of 0 reflects a normal performance. A score of 1 is in the normal range but does indicate that the performance may represent a slight deviation toward different functions of the cerebral hemispheres. A score of 2 is reflective of a mild to moderate amount of deviation between left and right dysfunction. A score of 3 represents significant, lateralized deviations.

The LNDS and RNDS allow for both the identification of impaired function in one or both of the hemispheres and for comparison of function within an individual. Thus, because of the very nature of these two scales, they are not useful for comparisons of differential function of the hemispheres among normal subjects.

In the validation research of the LNDS and RNDS, Reitan and Wolfson (1993) used the same groups of subjects they used to validate the GNDS. There was a total of 79 subjects with brain damage divided into groups of general, left, and right cerebral damage. They were compared to a control group of 41 subjects without evidence of cerebral damage. The LNDS and RNDS were also used with subjects within the etiological categories of cerebrovascular disease and traumatic brain injury who had left, right, or generalized cerebral damage.
The 15 individuals with left cerebrovascular lesions carried the following diagnoses: one person had middle cerebral artery aneurysm, another had middle posterior cerebral artery thrombosis, two had anterior cerebral artery thrombosis, four had internal carotid artery thrombosis, and two had arteriovenous malformations. In the right cerebrovascular lesion group, five had middle cerebral artery thrombosis, one had posterior cerebral artery thrombosis, and nine had internal carotid artery thrombosis. Of the 15 individuals with generalized cerebrovascular disease, four carried diagnoses of hypertensive encephalopathy, 10 had cerebral arteriosclerosis, and one had bilateral partial carotid artery occlusion.

The research protocol involved the administration of the HRNB to each subject, by a trained technician who was blind to the subjects' diagnoses and to the purpose of the study. All of the study participants received neurological exams from neurologists and neurological surgeons who made diagnoses independent of psychological test results. The statistical analyses of the LNDS and RNDS involved the computations of means, standard deviations, and t-ratios.

The group without cerebral damage had a mean LNDS score of 2.59 and a mean RNDS score of 2.39 with a 0.20 difference between these two scores. This difference is not statistically significant.
Regarding the groups with varied sources of brain damage, the left cerebral damage group had a mean LNDS score of 18.80 and an average RNDS score of 3.48. The right cerebral damage group obtained a mean RNDS score of 17.00 and a mean LNDS score of 2.61. The fact that the differences between these two values is significant, suggests that the LNDS and RNDS do accurately reflect the condition of the hemisphere involved (Reitan and Wolfson, 1993).

As might be expected, analyses of the generalized cerebral damage group scores did not yield a significant difference between the LNDS and RNDS scores. This finding also suggests that the sensitivity of these scales is restricted to lateralized dysfunction.

The fact that the cerebrovascular disease groups had somewhat higher absolute values for LNDS and RNDS than did the heterogeneous groups is consistent with the 1982 finding by Hom and Reitan indicating that cerebrovascular disease typically results in general impairment in neuropsychological tasks. The differences between the LNDS and RNDS consistent with lateralization of damage were even more impressive than those found among the heterogeneous group members. As seen earlier, LNDS and RNDS mean scores of the group with generalized cerebral disease were not significant.
A similar pattern was found among the traumatic brain injury groups. The difference between the LNDS and RNDS for these groups was nonsignificant. Both brain injured groups with lateralized damage yielded significant differences between the scales' scores with the right damage group having its highest mean score on the RNDS and the left damage group having its largest mean score on the LNDS. The foregoing results strongly suggest that the LNDS and RNDS are can be successfully used to both identify the presence of impaired function in one or both of the hemispheres and to do an intraindividual comparison of functions.

Because of the newness of the GNDS, LNDS, and RNDS there is little preliminary data available. It is imperative that researchers not only attempt to replicate Reitan's validation study but also apply these scales to other populations so that validation can occur. This is one of the goals of the current study. It will apply the GNDS, LNDS, and RNDS to subjects in each of four conditions: (1) individuals with psychotic disorders who have sustained cerebral trauma, (2) subjects with psychotic disorders without a history of cerebral trauma, (3) individuals with substance use disorders with a history of cerebral trauma, and (4) subjects with substance use disorders without cerebral trauma. First a review of neuropsychological
performance of subjects with psychotic and substance abuse disorders is necessary.

**Psychosis and Neuropsychological Performance**

Studies examining neuropsychological correlates of psychotic disorders have generally found that these subjects are more impaired than normal controls on measures of concentration and attention, abstraction skills, psychomotor speed, and the ability to shift cognitive set or cognitive flexibility. The following studies explored how psychotic individuals differ in HRNB performance from subjects with other types of cerebral damage.

In 1994, Gold, et al., administered a neuropsychological battery including several HRNB subtests to 66 schizophrenic subjects and 101 subjects with Temporal Lobe Epilepsy (TLE). They hypothesized that lateralized, developmental temporal lobe dysfunction was responsible for cognitive impairment in schizophrenia and attempted to test this theory by comparing the neuropsychological performance of the two groups. The schizophrenic subjects differed from the TLE individuals in that they exhibited attentional deficits in auditory and visual tasks and superior verbal memory and vocabulary not demonstrated by the TLE group. Therefore, this study did not support the authors' theory but did provide information about strengths and weaknesses in neuropsychological function in this sample of schizophrenic subjects.
In their 1978 comparison of polydrug users, psychotic patients, and normal controls, Grant, et al examined HRNB performance differences between the three groups. While the polydrug using subjects exhibited language-related and perceptuomotor deficits, the psychotic group demonstrated impaired performances only on perceptuomotor tasks.

Heaton, et al. (1979) compared the WAIS and HRNB scores of four groups: Schizophrenics, normal controls, subjects with acute brain disorders and subjects with chronic brain dysfunction. These researchers found that although the schizophrenic group members were more impaired than the controls, their deficits were less severe than either brain disordered group.

Another study lead by Heaton (Heaton, et al., 1994) compared three groups of schizophrenic patients to normal controls and to individuals with Alzheimer's disease. In order to examine the age variable, schizophrenics were divided into three groups: 1) early onset-young, 2) early onset-old, and 3) late onset. Neuropsychologically, there were no differences between these three groups. The schizophrenic group as a whole did differ from the normal controls and the Alzheimer subjects. While the schizophrenics did exhibit the expected impairments on tasks involving abstraction, attention, verbal skills, and memory, they did not demonstrate the inefficient learning and rapid forgetting patterns seen in the Alzheimer patients. Thus,
age and time of onset did not appear to be related to cognitive impairment in schizophrenics.

A study done by Chelune, et al. (1979) also compared schizophrenics with brain damaged individuals. They did this by analyzing the differences in performance on the WAIS and the Average Impairment Rating (AIR) variables of the HRNB of subjects with schizophrenia, participants with diffuse brain damage, and normal controls. Consistent with the findings of Heaton's 1979 study just described, the schizophrenic subjects performed at a higher level than that of the brain damaged subjects on both the WAIS and the AIR. There were no significant differences between the three groups regarding their patterns of performance on the two batteries.

In another study comparing schizophrenics to brain damaged subjects, Fredericks and Finkel (1978) also looked for patterns in the performances of schizophrenics, normal controls, and brain damaged individuals. The normal subjects exhibited performances superior to that of the schizophrenic subjects on the Category, Tactual Performance Test Memory and Location subtests. Again consistent with the two studies involving psychotic and brain damaged subjects described earlier, the schizophrenic group members performed better than the brain damaged individuals on every subtest except for the Category Test. While it is useful to try to control for confounds by studying subjects who are
either brain damaged or psychotic, these disorders are often found together in the same person. Therefore, it is necessary to study subjects who have both conditions.

Psychosis and Hemispheric Lateralization

Another area of research regarding neuropsychological performance of psychotic patients has to do with the lateralization of both the damage and related performance deficits. The results of studies testing the lateralization of psychotic disorders hypothesis have been mixed. While most researchers have found evidence for lateralization to the left in schizophrenia, a few others such as Quitkin, et al. (1976) have concluded that their data suggest a right sided lateralization, and still others contend that their studies indicate that the deficits are not lateralized at all.

According to Silverstein and colleagues (1991), Kleist was the first to hypothesize that the brain damage in schizophrenia is lateralized. He asserted that those patients with what he called "confusional" schizophrenia had left temporal damage. He thought those with paranoid schizophrenia had damage localized in the brain stem. Davison and Bagley (1969) evaluated reports of 150 cases of schizophreniform psychosis in terms of the locations of the lesions and found the presence of schizophrenic symptoms to be positively correlated with left sided lesions. They did not find a similar relationship between symptoms and right
sided lesions. In 1976, Flor-Henry was the first to confirm the presence of lateralized left frontal deficits in schizophrenics and right sided deficits in persons with affective disorders using neuropsychological testing. Shortly thereafter, researchers Gruzelier and Hammond (1976) also found evidence for left sided impairment when they administered intelligence tests to schizophrenics and offspring of schizophrenic parents. In a 1978 study done by Schweitzer, et al. lateral eye movements (LEMs) were used as a measure of activation in the contralateral frontal lobes. These researchers compared the number of LEMs in 29 schizophrenics and 31 normals while they experienced four types of material: verbal nonemotional, verbal emotional, spatial nonemotional, and spatial emotional. The resultant data indicate that the schizophrenics initiated thought in their left hemisphere significantly more often than the normal subjects with both types of verbal stimuli and the spatial emotional material. These authors conclude that the "inappropriate" initiation of thought on spatial emotional material, and the general increase in activity, in the left hemisphere are indicative of a left hemisphere locus of damage in schizophrenia. Taylor and colleagues (1979) wrote that they had findings consistent with lateralization to the left on an aphasia test given to schizophrenic subjects. Two more recent studies found evidence of left hemisphere dysfunction in schizophrenia utilizing auditory and visual
tasks. Galderisi, et al. (1994) recorded event related potentials (ERPs), reaction times, errors, and omissions in 18 schizophrenics and 23 controls while they performed a visual detection task. Consonant pairs were tachistoscopically presented to the left or right visual field. In comparison to the controls, the schizophrenic subjects had smaller ERP components and lengthier reaction times for right visual field stimuli. They also seemed to process pairs presented to their left visual field more efficiently. The authors contend that these differences imply left hemisphere dysfunction in the schizophrenic patients. Eleven of these patients were re-tested after 28 days on haloperidol. This resulted in reversals of some of the effects just described. Karny and Nachson (1995) attempted to determine whether cerebral deficits in schizophrenia are related to left hemisphere dysfunction or to impaired interhemispheric transfer by comparing 24 paranoid schizophrenics, 21 non-paranoid schizophrenics, and 18 controls on two auditory lateral tasks. One task required subjects to identify dichotically delivered tone sequences and the other task was similar but consisted of dichotically presented digit sets. The paranoid subjects demonstrated a large and significant right ear advantage in comparison to the other two groups. The authors purport that this finding is indicative of left hemisphere dysfunction.
Among the few proponents of mixed or no lateralization in schizophrenia are Frazier, et al. who in 1989 evaluated the neuropsychological functioning of 52 schizophrenic and 39 major depressive subjects using the four lateralization scales of the Luria-Nebraska Neuropsychological Battery. The results indicated that gender influenced performance on bilateral complex cognitive-perceptual tasks. Females were significantly more compromised on these tasks. Schizophrenics taking neuroleptics evidenced a larger degree of perceptual-cognitive impairment. The data do not support a left or right hemisphere lateralization of schizophrenic dysfunction. Curtis and Gurling (1990) found no consistent dysfunction of cerebral lateralization in schizophrenics when compared to normals regarding regional cerebral blood flow during cognitive tasks. The between group differences that were found were not restricted to one hemisphere or one brain area. Furlong, et al. (1990) also failed to find differences between psychotics and normals when they used somatosensory evoked potentials to assess lateralization. In 1982, Walker and McGuire, after reviewing the literature on intra- and inter-hemispheric functioning in schizophrenia as evaluated via monotic and dichotic listening, hemiretinal presentation, and diphatic stimulation, conclude that there is insufficient support of the idea that schizophrenia is related to either dysfunction in interhemispheric transfer or to abnormal functional lateralization. These authors
also state that the impairments shown by schizophrenics on lateral information processing tests are inconsistent with what models of left hemisphere dysfunction predict. Walker and McGuire propose that left hemisphere overactivation and the resultant temporal anomalies in processing sensory information to the right sensory field are the critical variables, not lateralization. Wale and Carr (1988) also refute the lateralization hypothesis. These authors believe that schizophrenics differ from normals in that they evidence dysfunctions in information processing and attentional disturbance.

While various factors such as age at disease onset, severity of illness and medication dosage have been considered as contributing factors in the lateralization of schizophrenia, the one to be considered here has not been widely studied and involves the concept of positive and negative symptoms in schizophrenia. The idea of positive and negative symptoms and therefore, thought disorders, appears to have originated in the field of neurology around the middle of the 19th century. Since the late 1970's there has been a renewed interest in the positive negative symptom dichotomy (Walker & Lewine, 1988). Typically, positive symptoms are identified as those that are excesses in thought or behavior such as hallucinations or pressured speech. Negative symptoms usually represent cognitive or behavioral deficits such as emotional withdrawal or
impoverished speech (Walker & Lewine, 1988). A positive correlation has been consistently found between the presence of negative symptoms and poor premorbid function (Walker & Lewine, 1988; Pogue-Geile & Zubin, 1988). Researchers have also consistently found a lack of relationship between gender and the presence of negative symptoms. Positive and negative symptoms do not tend to co-exist in equal numbers in the same person, typically making the diagnosis of a positive or negative disorder to a particular patient possible. (Pogue-Geile & Zubin, 1988).

Crow (1980) contends that there are two distinct syndromes in Schizophrenia— one consisting of positive, florid symptoms and the other of negative symptoms. He also asserts that each of these syndromes is caused by separate and independent processes, but do not constitute separate diseases. The positive syndrome is said to involve defective dopamine transmission while the negative syndrome is said to be due to structural anomalies in the brain and to positively correlate with cognitive deficits. Crow and others (e.g., Cornblatt, et al., 1985) have found that positive and negative symptoms often co-exist in the same person either simultaneously or at different times during the course of the disorder.

Cornblatt, et al, (1985) attempted to explore the relationship(s) between attentional and processing deficits and positive and negative symptomatology within rather than
between schizophrenic subjects. They compared the performances of schizophrenic patients, depressed patients, and controls on tasks measuring distractibility and information processing while subjects were experiencing information overload. These authors found that a diminished capacity to process information was specific to the schizophrenic subjects. Moreover, in support of Crow's hypothesis, they found that in the schizophrenic subjects, positive symptoms were related to distractibility while negative symptoms were related to the more complex cognitive function of processing capacity (Cornblatt, et al, 1985).

Researchers Pogue-Geile and Zubin (1988) focused their review of the literature in part on negative symptoms and the associated cognitive deficits and biological variables. Regarding cognitive deficits, these authors concluded the literature generally consists of mixed results but that tasks involving "speed and effortful processing" such as the Continuous Performance Task (CPT) appear to be consistently related to negative symptoms. They suggest that further delineation of negative symptoms is needed in order to determine their relationships to cognitive variables (Pogue-Geile & Zubin, 1988).

Using Mental Status Exams (MSE) as measures of cognitive functions, Owens and Johnstone (1980) and Andreasen and Olsen (1982) found that schizophrenic patients with mostly negative symptomatology obtained lower MSE scores than
schizophrenic patients with mostly positive symptoms. Opler and colleagues (1984) also concluded that cognitive deficits were positively correlated with negative symptoms. Using a series of neuropsychological tasks, they found significant correlations between high negative symptom scores and impaired perceptuomotor performance, low vocabulary scores, and comparatively immature responses on the Color-Form Reference and Representation tasks.

Contrary to Opler's findings, Bilder, et al., (1985) found relationships between neuropsychological deficits and both positive and negative symptoms. They found significant correlations between factor scores of symptom ratings and composite scores of neuropsychological tasks. A factor consisting of positive thought disorder, alogia, attentional impairment, and bizarre behaviors was most highly correlated with poor neuropsychological performance on language and memory tasks and on the Wechsler subtests. The factor made up of negative symptoms was not related to test performance. Likewise, a third factor consisting of positive symptoms was also unrelated to test performance (Bilder, et al, 1985).

Neuchterlein and Dawson (1986) utilized a forced choice span of apprehension task and two different versions of the CPT to detect relationships between positive and negative symptoms in neuropsychological performance in schizophrenic patients. They found that high ratings on "anergia" i.e., certain negative symptoms, were correlated with poor
performance on all three of the tasks. Further analyses revealed that slowed motor function, emotional withdrawal, and disorientation (all negative symptoms) were responsible for most of the covariance with neuropsychological performance (Neuchterlein & Dawson, 1986).

In terms of biological factors, Pogue-Geile and Zubin (1988) reviewed the literature on structural brain anomalies and neurochemical variables. While a few studies have found correlations between negative symptoms and CT scan detected abnormalities such as ventricular enlargement (e.g., Pearlson, et al., 1969), most CT studies have not found a significant and consistent correlation. In view of these results and those of post-mortem studies that have found significant reductions in "peptide concentrations in the hippocampus and amygdala" in patients with negative symptoms, Crow changed his hypothesis in 1985. He now asserts that the pathology responsible for negative symptoms is localized in the temporal lobes. Others such as Seidman (1983) and Weinberger (1987) believe structural anomalies related to negative symptoms are located in the frontal lobes.

Neurochemically, Crow (1980) postulated that negative symptoms are not related to defective dopamine transmission and therefore should not be effected by neuroleptic drugs or dopamine agonists. This hypothesis is not well supported by the literature. While research by Johnstone, et al. (1978)
and Angrist, et al. (1980) found that medications did not significantly impact negative symptoms, Goldberg (1985) and others have found that can ameliorate such symptoms, and Marder, et al. (1984) and other authors contend that their research indicates that these medications make symptoms worse.

Green and Walker (1985) tested the hypothesis that positive and negative symptoms are related to different types of information processing deficits by administering a neuropsychological battery and the SANS and SAPS to schizophrenic subjects. They found support for their hypothesis in that the presence of positive symptoms was correlated with poor performance on tasks that measure short term verbal memory. Negative symptoms were associated with poor performance on visual-motor tasks. Using a backward visual masking task, these authors found negative symptoms to be positively correlated with performance suggesting that subjects with negative symptoms process visual information more slowly. Walker and Harvey (1986) and Olio and colleagues (1987) also found evidence of relationships between positive and negative symptoms and types of information processing.

Walker and Harvey (1986) administered an auditory digit span task to schizophrenic subjects with mostly positive symptoms. These researchers found attentional and auditory information processing skills to be compromised in subjects
with positive symptoms. Consistent with these results, Ollo, et al., (1987) found that patients with mostly negative symptoms performed better on a short term auditory memory task than did patients with mostly positive symptoms. Regarding lateralization and its relationship to positive and negative symptoms, little research has been done. However, in 1991 Silverstein, et al. examined the relationships between positive and negative symptoms and lateralization measures form the HRNB and WAIS-R. They tested 59 subjects with schizophrenic, schizoaffective, and manic disorders and psychotic patients. The authors performed discriminant analyses on left and right hemisphere tasks for positive and negative thought disorder. The data indicated that there was a positive correlation between positive thought disorder and left hemisphere functions. They also assert that both left and right hemisphere task performances were related to negative thought disorder. While the low number of subjects and apparent within group heterogeneity make the results of this study tenable, its fundamental question about the relationships between positive and negative symptoms and lateralization is an important one that will be addressed in the current study.

Substance Abuse and Neuropsychological Performance

Because the relevant research and literature typically explore and discuss the neuropsychological effects of alcohol use and that of other drugs separately, the same
will be done here. Until about ten years ago, studies designed to identify neuropsychological correlates of alcoholism tended to focus on subjects who were either currently intoxicated (to examine acute effects) or those who had the chronic alcohol related disorders stemming from years of heavy drinking--Korsakoff's syndrome or alcoholic dementia (Ryan and Butters, 1986). But because subsequent clinical and research data indicate that these two groups make up only a very small percentage of alcoholics, more recent research has focused on those alcoholics who have fairly long histories of heavy drinking but who are not obviously impaired as measured by a Mental Status Examination and who constitute the majority of the alcoholic population.

Unlike in the study of individuals with Korsakoff's or alcohol induced dementia, with the larger group of apparently "intact" alcoholics it is much more difficult to definitively identify neuropsychological correlates of their drinking. To date, the myriad of studies attempting to characterize the effects of alcoholism in neuropsychological function, yield highly varied and inconsistent results. For example, a study conducted by Solomon and Malloy (1992) determined that there is no relationship between chronic, excessive use of alcohol and the presence of neuropsychological deficits, while one done by Svanum and Schladenhauffen in 1986 found that chronic, excessive
alcohol consumption was positively correlated with significant impairment on HRNB subtests. This disparity can be seen throughout the literature and is most likely due to two primary reasons: (1) failure of researchers to control relevant subject variables such as level of education, socio-economic status, age, history of head injury, etc., that may artificially inflate or minimize significant differences between subject groups and (2) the unavailability of instruments able to detect the subtle and perhaps, higher level cognitive changes that result from heavy drinking.

Of the researchers who have found a positive correlation between alcoholism and cognitive impairment, some such as Miller and Orr (1980) and Goldstein and Shelly (1982), have provided research data that indicates a relationship between excessive alcohol abuse and global neuropsychological dysfunction, while others have identified specific impairments associated with alcoholism. Results of several studies indicate that alcoholics perform poorly on tasks requiring abstraction and concept formation skills. For instance, Fitzhugh, et al (1960) found that even though hospitalized alcoholics obtained average or better IQ scores on the Wechsler-Bellevue Scale, they also exhibited significant deficits on the Category Test which is thought to measure abstraction and adaptive skills. Normal controls performed at the superior level. These results were
replicated by Fitzhugh, Fitzhugh, and Reitan in 1962 when they again found the alcoholics to demonstrate adequate IQ scores while doing quite poorly, in fact, worse than brain damaged subjects, on several of the Halstead-Reitan subtests.

In a 1980 study, Miller and Orr examined differences in neuropsychological performances between alcoholic patients in a Veterans Administration (VA) hospital, psychiatric, and brain damaged subjects. The average scores for the alcoholic group fell at levels intermediate to the other two groups. Both the brain damaged and alcoholic patients were significantly more impaired than the psychiatric subjects on these components of the HRNB: the Category Test, the Tactual Performance Test, Part B of the TMT, and Block Design.

These two groups were more impaired on non-verbal tasks than they were on verbal measures. As in the literature on psychotic disorders, this and most other related studies have attempted to isolate the variables of substance abuse and cerebral trauma by studying individuals with only one of these conditions. But because the two frequently co-exist in the same person, it is important to gather data on individuals who have a substance disorder and who have sustained a cerebral trauma.

Hochla, et al. (1982) compared the Brain Age Quotients (BAQ) of recently detoxified alcoholics, recovered alcoholics, and nonalcoholic controls. All subjects were
female. The BAQ is an age adjusted measure of brain dysfunction and consists of the WAIS Block Design and Digit Symbol subtests and the TPT Time and Location, Category, and TMT subtests of the HRNB (Reitan and Davison, 1974). The mean BAQ's of the controls were significantly higher than those of the two alcoholic groups. Consistent with the findings of the Miller and Orr study (1980), the alcoholic subjects (recently detoxified) were significantly more impaired than controls on the Category Test, the TPT-Time test, and the WAIS Block Design and Digit Symbol subtests. The recovered alcoholics had a performance similar to that of the alcoholics on the two WAIS subtests, and one similar to the controls on the Category test suggesting that cessation of alcohol abuse may result in recovery of some functions.

As with the research on alcohol use and neuropsychological effects, the findings of studies attempting to delineate neuropsychological sequelae of drug abuse are also inconsistent. In a 1981 review paper, Parsons and Farr outlined the results of 22 such studies and concluded that the findings are indefinite. That is, some researchers found a positive correlation between drug use and the presence of cognitive deficits while others found no evidence for this type of relationship (Parsons and Farr, 1981).
For instance, a study conducted by Grant and colleagues in 1976 compared 22 male polydrug users who were abstinent for an average of two months to a group of medical patients and a group of neurologically impaired subjects. They found that approximately half of the 22 polydrug users evidenced mild, generalized cerebral impairment. They were unable to identify a relationship between the use of any particular drug and neuropsychological deficits. Thus, the results of this study are also inconclusive. It can only be deduced that some polydrug users experience cognitive deficits. A later, more well controlled study done by Grant, et al in 1978 compared 151 polydrug users to cognitive impairment rates of psychiatric patients and non-patients but yielded only slightly more definitive results. Only 37% of their polydrug user sample evidenced neuropsychological deficits (an even lower rate than in their 1976 study) but a positive relationship was found between the use of CNS depressants and opiates and cognitive impairment. However, this correlation has not been consistently found by other researchers. Thus, this body of research also suffers from the methodological flaws seen in the work examining psychosis and alcohol and their impacts on neuropsychological functioning.

Substance Abuse and Lateralization

What little research has been done on the interaction of substance abuse and hemispheric lateralization has been done
on alcohol use. Three relevant studies were found in the literature. Ellenberg, et al. (1980) used three temporally spaced administrations of verbal and visuospatial tasks to assess the "recoverability" of chronic alcoholics. The tasks were believed to reliably discriminate one sided cerebral damage. Both visuospatial and verbal impairments and subsequent recoveries were noted. These authors concluded that their data do not support the presence of a right sided lateralization in alcoholism. A study done by Fabian, et al. (1984), however, did evidence right sided lateralization in alcoholics but these authors assert that this result is confined to male alcoholics. Again, visuospatial and verbal tasks were used. Female alcoholics were not impaired on either type of test while males were impaired on visuospatial tasks and had a greater performance discrepancy between the two types of tasks. These researchers believe this is evidence of right lateralization in male alcoholics. Drake, et al. (1990) also examined the relationships between gender and laterality and alcoholism. Consistent with the study just described, these authors found that male alcoholics were impaired on visuospatial tasks. Unlike the Fabian study, they also found their performances to be compromised on verbal tasks. Male alcoholics also exhibited better right ear function on a dichotic listening task and impaired left ear function when music was presented dichotically. These researchers
conclude that their work supports the right lateralization of alcoholism in male alcoholics but not in their female counterparts.

The current study attempts to address the above described methodological difficulties by applying the GNDS, LNDS, and RNDS to four groups of subjects. The subject groups are: (1) individuals with psychotic disorders who have sustained cerebral trauma, (2) subjects with psychotic disorders without a history of cerebral trauma, (3) individuals with substance use disorders with a history of cerebral trauma, and (4) subjects with substance use disorders without cerebral trauma. The psychotic and substance abuse disorder criterion are those used in the DSM-III-R and can be found in the appendices of this manuscript. This method will address the first difficulty of the failure of researchers to control relevant subject variables such as level of education, socio-economic status, history of cerebral trauma, etc., by using subjects with similar educational and SES backgrounds and by manipulating history of cerebral trauma as one of the independent variables. This will not only result in a more homogeneous group and minimize the possibility of confounding variables, but it will also provide systematically acquired information about an understudied group of subjects—those who have both a disorder (psychotic or substance abuse) as well as a history of cerebral trauma. This design also provides a
comparison group of subjects without a history of cerebral trauma for each disorder. The second design flaw of the unavailability of instruments able to detect the subtle and perhaps, higher level cognitive changes that result from substance abuse will be addressed by the application of the three deficit scales designed by Reitan and Wolfson (1993). The use of the GNDS will provide a means to accurately categorize patients with normal, mildly impaired, moderately impaired, and severely impaired neuropsychological functioning as well as provide a measure of subtle, higher level cognitive processes and a general Index of function. The LNDS and RNDS will allow for comparisons of abilities of both sides of the body as well as of intraindividual functioning.

It is hypothesized that the subjects with psychotic disorders and cerebral trauma will yield GNDS scores similar to those found with patients with diffuse damage along with similar mean LNDS and RNDS scores. It is also hypothesized that the individuals with substance use disorders with cerebral trauma will obtain GNDS profiles similar to those seen in persons with diffuse damage and a nonsignificant difference between the LNDS and GNDS. Finally, it is predicted that subjects with substance use disorders without cerebral trauma will yield GNDS, LNDS, and RNDS scores similar to those found in patients with right cerebral trauma.
CHAPTER II

METHOD

Subjects

The Investigator reviewed 562 patient files in the Neuropsychology data pool at a large state hospital to determine which patients had received a complete HRNB. She then reviewed the files with complete HRNB's to identify those that met the inclusion criteria. To be included in the study a subject must have received a diagnosis of either a psychotic or a substance use disorder (not both) based on DSM-III-R criteria by a licensed psychiatrist. Once a pool of these two types of subjects had been found, they were further divided into groups of individuals who had sustained a cerebral trauma, as verified by the staff neuropsychologist, and those who had not. Head injured subjects were at least six months post-trauma. Exclusion criteria were histories of ECT treatments, seizures or a diagnosis of a learning disability. A positive/negative symptom count was done while reviewing each of the psychotic subjects' charts.

The demographic and Halstead-Reitan Neuropsychological Test Battery data of sixty adult, male (n=40) and female (n=20) psychiatric in-patients was collected and
analyzed. The data was assigned numerical codes in order to insure subject confidentiality.

Subject Demographics

Of the substance abuse patients without head trauma, 9 were Caucasian, 4 were African American, and 2 were Hispanic. Three of these patients had completed the 10th grade, 6 had completed highschool, 3 had at least 1 year of college, the remaining 3 had fewer than 10 years of schooling. The average age and length of substance abuse history at time of admission were 36 years old and 14 years respectively. All of these subjects abused alcohol and at least one other drug. All but two of these patients were receiving only vitamin therapy at the time of testing.

Regarding the substance abuse patients with cerebral trauma, 12 were Caucasian and 3 were African American. One patient had completed the 10th grade, 9 had completed highschool, one had a college degree, and 2 had less than 10 years of education. The average age and length of substance abuse history at time of admission were 36 years old and 17 years respectively. All of these subjects abused alcohol and at least one other drug. Nine of these subjects were receiving only vitamin therapy at the time of testing.

Of the psychotic patients without head injury, 10 were Caucasian, 3 were African American, and 2 were Jewish. Four of these subjects had completed the 10th grade, 6 had highschool diplomas, 2 at least one year of college and one
had a college degree. One person had less than 10 years of schooling. The average age and length of disorder at time of admission were 41 years old and 18 years respectively. Thirteen of these subjects were receiving an anti-psychotic drug at the time of testing.

Nine of the psychotic patients with head injury were Caucasian, and 6 were African American. Five of these subjects had completed the 11th grade, 8 had highschool diplomas, one had a college degree, and one had less than 10 years of schooling. The average age and length of disorder history at time of admission were 33 years old and 12 years respectively. Fourteen of these patients were receiving an anti-psychotic medication at the time of testing.

Materials

The Halstead-Reitan Neuropsychological Battery was utilized to obtain the General, Left, and Right Neuropsychological Deficit Scales as described above. Thorough reviews of patient charts yielded demographic and historical data used to determine if subjects met inclusion criteria.

The Halstead-Reitan Neuropsychological Battery consists of a variety of measures derived from several different sources: The Wechsler Adult Intelligence Scale (WAIS) is an IQ test made up of 11 subtests tapping verbal and performance skills. The HRNB uses it to obtain "important information about the comparative status and specialized
functions of the left and right cerebral hemispheres" (Reitan, 1955b). Data from the WAIS can also be used with other test results to help locate a lesion. The Lateral Dominance Examination requires the client to perform a number of tasks requiring the use of one hand or one foot. The object is to determine which side, left or right, is the dominant (more skilled) or preferred for the individual. Dominance must be determined in order to correctly administer other tests in the battery. The Reitan-Indiana Aphasia Screening Test (AST) contains the following tasks: identify common objects; spell words; name single numbers and letters; read, write, pronounce, and comprehend spoken English; name body parts; perform simple math; distinguish between right and left; and reproduce simple shapes on paper with pencil. The AST yields an extensive inventory of aphasic and related deficiencies. The performances on each of the AST's tests can provide information about function in the sensory modality particular to that task. The design of the AST also helps the evaluator to determine, on some items, whether a deficit is expressive or receptive in nature. Deficits on the AST provide important information that can localize the area of dysfunction to the left or right hemisphere (Reitan, 1984). The Finger Tapping Test (FTT) uses a manual tapper to obtain a numerical measure of finger-tapping speed. The subject is required to use the Index finger of his or her dominant hand to tap as many
times as he or she can in each of five, 10 second trials. He or she then does the same with the non-dominant hand. A difference of more than 10% between the two hands suggests deterioration or deficiency in the contralateral cerebral hemisphere. The Grip Strength test consists of the use of a dynamometer to measure the subject's grip strength in each hand. The client is required to extend his or her arm while pointing the dynamometer at the floor and to grip the instrument as hard as possible. He or she does this twice for each hand. As with the FTT, results of this test are compared to determine if there is a significant difference (greater than 10%) in the grip strength between the two hands. Such a disparity may provide information regarding the biological condition of the contralateral hemisphere (Reitan & Wolfson, 1993). The Sensory-perceptual Examination is comprised of four sub-tests: Tests for Perception of Bilateral Sensory Stimulation, Tactile Finger Recognition, Finger-tip Number Writing Perception and the Tactile Form Recognition Test. The Tests for Perception of Bilateral Sensory Stimulation are done in the tactile, visual, and auditory modalities and are conducted only after it has been determined that the subject is able to perceive unilateral stimulation on each side. In evaluating tactile function, each of the client's hands is touched separately to test for ability to perceive unilateral stimuli. Then touch on one hand is interspersed with simultaneous
stimulation of both hands. A person who is unimpaired should be able to indicate when he or she is experiencing touch on the right hand, the left hand and on both hands at once. Contralateral face-hand stimulation patterns are also part of this test. Deficits on this exam can provide clues regarding lateralization of the lesion. The auditory evaluation involves the presentation of a sound created by the Examiner rubbing his or her thumb and Index fingers together next to the subject's ear(s). When assessing the ability to detect visual stimulation, the client is instructed to look at the Investigator's nose while the Investigator produces subtle movements with his or her fingers in the outer boundaries of the visual field. The Tactile Finger Recognition test requires the subject, with eyes closed, to indicate which finger has just been stimulated via light touch by the Examiner. Clients with deficits on this exam may have a parietal lobe lesion contralateral to the hand with the defective performance and/or a lesion in the posterior cerebral region (Reitan & Wolfson, 1993). The Finger-tip Number Writing Perception task involves the client having to identify numbers written on each finger-tip on each hand while his or her eyes are closed. The numbers written are 2, 4, 5, and 6 and are presented in a standard order during four trials on each hand. Errors on this exam have been negatively correlated with IQ (Fitzhugh, Fitzhugh, & Reitan, 1962). Results of
this test are analyzed to determine if there is a significant difference in performance between the two sides of the body. When one hand is deficient, contralateral parietal lobe dysfunction is apparent. In the Tactile Form Recognition Test the client is required to identify flat, plastic objects in the shapes of a cross, square, triangle, and circle as they are placed in his or her hand. The objects are held outside of the subject's field of vision. While the client feels the object in his or her hand, he or she points to its match in the group of four corresponding shapes glued on a board in front of him or her. Subject response time for each trial is recorded. The total time required for each hand as well as the number of errors for each hand are recorded as separate scores. The Rhythm Test assesses the client's ability to differentiate between pairs of rhythmic sounds. The sounds are standardized and presented by tape recorder. After the presentation of each pair, the subject writes "S" if the two sounds seemed similar and "D" if they sounded different. Successful completion of this task requires awareness of nonverbal auditory stimuli, continuous attention, and the ability to detect and distinguish different rhythmic sequences. The Rhythm Test appears to be an Index of general adequacy of cerebral functioning and not of lateralization. The Speech-sounds Perception Test (SSPT) is comprised of 60 nonsense words all containing the ee sound, presented by tape
recorder. A nonsense word is spoken and the subject must underline the printed version on the answer sheet. This task requires sustained attention, the ability to perceive an unfamiliar auditory stimulus, and the skill of matching the perception with its printed counterpart. Poor performance on this task is most often due to an inability to pay close and continuous attention. Therefore, this test is a good measure of the first level of central processing (Reitan & Wolfson, 1993). The Trail Making Test (TMT) has two parts, A and B. Part A is a sheet of white paper with 25 circles numbered 1-25 on it. The subject is required to draw a line connecting the circles in sequential order as quickly as possible. Part B is a sheet of white paper with 25 circles on it. Thirteen of the circles are numbered 1-13, and twelve are lettered A-L. Here, the subject must draw a line connecting the circles in order while alternating between number and letter. The score for each part is the number of seconds it takes the person to complete the task. This test measures the abilities to quickly recognize the symbolic significance of numbers and letters, to scan the page to find the next symbol in the sequence, cognitive flexibility in combining the numerical and alphabetical series and to work under time pressure. The TMT is considered a good measure of general brain functions (Reitan, 1958).
The Tactual Performance Test (TPT) consists of a formboard with various spaces of different shapes and blocks that fit into the spaces. The subject is not shown the board or the blocks at anytime. He or she must first fit the blocks into the spaces while blindfolded, using his or her dominant hand. The second part of the test requires the person to do the same task using only the non-dominant hand. Next, he or she fits the blocks into the spaces using both hands. After the third trial, the subject is instructed to remove the blindfold and in the absence of the board and blocks, produce a drawing of the formboard and the blocks in their appropriate spaces. The scores derived from this test are the time required to complete each trial (so that a comparison between the performances of the two hands can be made), the total time needed to complete all three trials and a Memory and a Localization score from the drawing task. The Memory score consists of the number of shapes the subject remembers accurately and the Localization score is the number of blocks that the person is able to identify by both their form and their location on the board. According to Reitan and Wolfson (1993), successful performance of the first three tasks "depends upon tactile form discrimination, kinesthesis, coordination of movement of the upper extremities, manual dexterity, and an understanding of the relationship between the spatial configuration of the shapes and their location on the board". The drawing task requires
both memory of the shapes and their location as well as the ability to reproduce through visual means, stimuli experienced only tactually.

The Category Test consists of a series of slides with symbols or shapes on them. They are shown to the subject using a slide projecting machine. The subject is told to guess the principle underlying the pattern of the symbols or shapes and to then choose one of four responses by pulling a corresponding lever, based on the principle used. The machine makes a sound to indicate whether the choice was correct or incorrect after each response. The Category Test has seven subtests, the first six are as just described and get progressively more difficult. The seventh task taps the subject's memory by showing slides he or she has already seen and requiring him or her to remember the principle and correct answer for that item. Successful performance on the Category Test requires abstraction, reasoning, analytical skills, the ability to use feedback to alter or maintain response pattern, and concept formation.

Procedure

This study is using archival data consisting of full Halstead-Reitan Neuropsychological Batteries and demographic and historical data of in-patients of a 400 bed state hospital. The HRNB was administered to each subject by trained examiners in response to a referral question asked by the unit psychiatrist or psychologist. The testing took
place in a quiet room remote from other patients and staff. The room contained minimal stimuli and was furnished with a table and two chairs. The patients were given adequate opportunities to take a break or discontinue testing if they were fatigued. Multifactorial analyses of variance will be conducted on the GNDS and its four subscales, the LNDS and RNDS. Exploratory analyses will be done on the other variables.
CHAPTER III

RESULTS

Groups were compared by performing a 2 x 2 MANOVA using diagnosis (psychotic vs. substance abuse) and head injury as independent variables. Dependent variables were scores on the GNDS and its four subscales the LNDS, RNDS, and the Impairment Index (Table 1, Appendix B). Results indicated no significant F for main effects of diagnosis or head injury on any of the scales or subscales, nor on the Impairment Index (Table 2, Appendix B). There was one significant interaction that indicates subjects who were psychotic and had head injuries performed significantly worse on factors comprising the GNDS subscale of Right/Left differences than did patients in the other three diagnostic groups (df = 1,56; F = 8.81; p = .004).

Table 1 (Appendix B) contains the mean GNDS and subscales, LNDS, and RNDS and Impairment Index scores for each of the four patient groups. As can be seen from Table 1, patients with psychotic disorders without head injuries had a mean and standard deviation on the GNDS of 37.13 (12.77) which is above the established impairment cut-off of 26. Mean Level of Performance score was 24.33 (9.72). On the other subscales, the average Pathognomic Signs score was
1.07 (2.09), Patterns average was 1.93 (1.71), Right/Left differences mean was 9.80 (3.08). The mean LNDS was 6.20 (3.05) and the mean RNDS score was 7.33 (4.87). Reitan and Wolfson assert that a difference of 7 or more points between these two scales indicates lateralization to the side with the higher score. Thus, there was no evidence of laterality in this group. The average score on the Impairment Index for this diagnostic category was .69 (.32).

Psychotic subjects with head injuries had a mean GNDS score of 39.40 (11.60). Mean Level of Performance score was 26.73 (9.08). Pathognomic Signs average score was 2.60 (2.60). Mean Patterns score was 1.33 (1.35). The average Right/Left differences score for this group was 8.73 (2.69). On the LNDS and RNDS they had the same means and standard deviations of 6.87 (3.76). Mean Impairment Index was .75 (.28).

Substance abuse subjects without head injuries had an average GNDS of 35.67 (10.30). Mean Level of Performance score was 21.47 (8.43). Pathognomic Signs mean was 2.53 (2.97). Patterns average score was 1.80 (1.82). Right/Left differences mean score for this group was 7.67 (1.88). LNDS and RNDS means were 7.13 (4.31) and 4.87 (2.20) respectively. The difference between these two means is 2.13, and therefore, not indicative of the lateralization predicted by the third hypothesis. The average Impairment Index score for this group was .54 (.28).
Substance abuse patients with head injuries had an average GNDS score of 39.67 (13.46). Mean Level of Performance score was 24.67 (9.93). Pathognomic Signs average score of was 2.87 (3.52). Mean Patterns score was 1.47 (1.41). The average Right/Left differences score for this group was 10.67 (2.82) points. On the LNDS, these subjects had a mean of 8.40 (4.91) while their average score on the RNDS was 6.93 (5.15). Mean Impairment Index was .64 (.28).

The means and standard deviations of the Halstead-Reitan battery which contribute to the GNDS score are provided in Table 3. WAIS Full scale, Verbal, and Performance IQs were within the normal range across all groups. Since a score of 46 or more is the impairment cut-off for the Category Test, data in Table 3 indicates that subjects across all four groups were impaired. Fifteen minutes is the impairment cutoff for Tactual Performance Test total time. All subjects in each group were significantly impaired on this task. Likewise, with impairment cut-offs of 6 or less on TPT Memory and 5 or less on TPT Localization, all subjects across all groups were again significantly impaired. Psychotic, head injured subjects were the only impaired group when performing Tapping with the dominant hand which has a cut-off of 49 or less. This group was also the only one impaired on Tapping using the non-dominant hand which has a cut-off of 44 or
less. Only the head injured subjects in each diagnostic
group were impaired on Trails A where a score of 40 or more
seconds indicates impairment. Trails B has an impairment
cut-off of 86 or more seconds. Subjects across all groups
were impaired on Trails B. Eleven or more errors indicates
impairment on the Speech Sounds Perception Test. Subjects
across all four groups were impaired on this task. All four
group means were below the impairment Seashore Rhythm cut-
off of 24 or less. An Impairment Index of .50 or higher
indicates significant impairment and was obtained across all
groups.

Table 4 (Appendix B) contains the percentages of
subjects at various GNDS cut-offs for each diagnostic group.
This information is useful in that it indicates how many
patients in each group had scores above the established
impairment cut-off of 26 on the GNDS and also allows for
comparison of subject performance on the LNDS and RNDS.
Reitan and Wolfson do not provide cut-offs for the LNDS and
RNDS scales but do assert that a significant difference (of
7 or more points) between the RNDS and LNDS suggests
laterality of impairment to the side with the higher score.
No such difference was found for any of the four groups
(Table 1, Appendix B).

In the psychotic non-head injured group, the GNDS
scores ranged from 15 to 56 points. Twelve of these
subjects (80%) had scores at or above 26 points (Table 4,
Appendix B). Their LNDS scores ranged from 1 to 12. This group's RNDS scores ranged from 1 to 19.

Among the psychotic, head injured subjects, the GNDS scores ranged from 23 to 57 points. Fourteen of these patients (93%) had scores at or above the GNDS impairment cut-off (Table 4, Appendix B). LNDS scores ranged from 0 to 13 while RNDS scores fell between 0 and 20 points.

Substance abuse, non-head injured GNDS scores ranged from 16 to 58 with 13 (87%) of the subjects scoring at or above 26 points (Table 4, Appendix B). On the LNDS these patients had scores ranging from 2 to 10 points.

GNDS scores of the substance abuse, head injured subjects ranged from 20 to 69. Twelve (73%) patient scores were at or above the 26 point cut-off (Table 4, Appendix B). LNDS scores for this group were between 0 and 20. The RNDS scores ranged from 0 to 17.

Exploratory analyses included Pearson Product Moment correlations among all variables. Correlations were generally as would be expected. Correlations of the GNDS and subscales, the LNDS, RNDS and the Impairment Index for each of the four groups were generally high and significant (Table 5, Appendix B).

Regarding the total sample of 60 subjects, all of the correlations between the GNDS and the Halstead-Retain subtests were significant. The WAIS Full scale correlated -.37, Verbal IQ, -.30 and Performance IQ -.40. Category
Test score covaried with GNDS at .74. TPT Total, Memory, and Localization correlations were .51, -.66, and -.42 respectively. Tapping dominant and non-dominant correlations were -.47 and -.55. Speech Sounds Perception Test and Seashore Rhythm Test scores covaried with GNDS at .52 and .48. Trails A and B had covariances of .50 and .67 with GNDS. Impairment Index and GNDS correlated at .76.
CHAPTER IV

DISCUSSION

Perhaps the most surprising finding of this study is the lack of main effects or significant differences among the four groups. This result may be due to a high level of severity across all subjects in the study. That is, it appears that although these patients did not carry the same diagnosis, they all had about the same severity of neuropsychological impairment. The fact that at least 80% of all subjects in each group had GNDS scores equal to or greater than the established impairment cut-off of 26 points supports this hypothesis. These results also suggest that GNDS is not only able to detect the cognitive impairment present in cerebral trauma patients but can also discern the presence of impairment in individuals with psychotic or substance abuse disorders. This supports the conclusion that the GNDS can be used with a much larger and more varied population than its authors have been able to verify to this point. The GNDS could prove especially useful with substance abuse subjects for whom, heretofore, there was no single sufficiently sensitive, standardized method for detecting brain impairment, with the possible exception of the Impairment Index. It seems that the GNDS can reliably
determine whether or not a patient is impaired across a wide variety of sources of cognitive impairment. Inspection of Table 4 indicates that, depending on group membership, from 80 to 93 percent of all of the subjects in the current study had scores at or above the established impairment cut-off. When this data is compared to national norms, this statistic validates the use of a score of 26 as the impairment cut-off. This supports the use of 26 as the optimal cut-off across all groups in this study. It should be noted that only 10% of unimpaired subjects have a score this high. Tables 6 and 7 provide subjects' percentile rank (Table 6) and level of impairment (Table 7) on the GNDS.

Of course, the most important weakness of the current study is the lack of a control group which necessitates our reliance on published norms for control comparisons. This extension of the use of the GNDS and this cut-off further strengthens the utility and generalizability of this Index. Although the GNDS has proven its value in detecting brain impairment, because the same score appears to be a valid cut-off for all patients, this seems to preclude its use to differentiate between diagnostic groups.

Apparently, in their efforts to develop a more global measure, Reitan and Wolfson have been very successful with patient populations assessed to date, including those in the current study. The GNDS then, does seem to be sensitive to the presence of significant impairment but not to the subtle
differences between diagnostic groups that would allow for differential diagnosing with the GNDS. Differentiation among patient groups must still be accomplished by clinical analysis of profiles on specific tests themselves as has historically been standard practice.

Another curious finding in the current study was the fact that head injured subjects did not yield significantly more impaired scores than those patients without head injuries. It is reasonable to expect that individuals with either a psychotic or substance abuse disorder as well as a head injury would be more neuropsychologically compromised than persons with just a psychotic or substance abuse disorder. Table 1 (Appendix B) indicates that this was not the case with this sample. This result may be due to the aforementioned insensitivity of the GNDS or it may be due to the approximately equivalent level of impairment across all groups discussed earlier. That is, it could be that the GNDS is not able to detect differences of the magnitude one would see when comparing significantly impaired groups with and without head injury or it may be that these particular subjects were all about equally impaired.

Two of the three stated hypotheses of the current study were supported by the results. Subjects with psychotic disorders and head injuries did yield GNDS, LNDS, and RNDS scores similar to those of patients with diffuse damage, but so did all of the other subjects. Similarly, support could
also be found for the second hypothesis which predicted that patients with substance abuse disorders and head injuries would obtain GNDS, LNDS, and RNDS scores similar to subjects with diffuse damage. This deficit scale profile was present in our substance abuse with head injury sample, but was also evidenced in each of the other three groups.

The current study did not yield data in support of the third hypothesis which stated that subjects with substance abuse disorders only, will have deficit scale profiles similar to patients with right cerebral trauma. However, the mean difference between the LNDS and RNDS was largest for this group and was in the predicted direction. Perhaps with a sample size of only 15 power was not sufficient to detect the variance.

While many of the post-hoc exploratory analyses yielded numerous significant correlation coefficients, not all of them warrant consideration here. Many of the findings were inconsistent or in the case of individual groups, were associated with too small a number of subjects, thus, making extrapolation and meaningful use of the information more difficult. Due to the small number of subjects involved, it is also difficult to know how much confidence one should place in the correlations. Also, since some of the correlations are between tests that have many factors in common, e.g., the GNDS and Level of Performance, the magnitude of these correlations were inflated and the
significances, artifactual. However, one result in the specific pattern of correlations is of interest. This pattern consisted of large and significant positive correlations between the GNDS and the Impairment Index, Level of Performance score, and the Category Test score in the two psychotic groups. Although these relationships also existed for the substance abuse groups, the magnitudes of the correlations of two of the factors—the Impairment Index and Category Test score were much smaller for the substance abuse groups. If this pattern remains or a different pattern emerges when larger sample sizes are used, it may be useful as a marker to aid in predictive, diagnostic, and treatment techniques for both patient populations. Detection of this and other patterns may add the dimension needed in the GNDS in order to make it possible to use the scales to differentiate between the neuropsychological profiles of various patient populations. Future research should be directed at replicating this type of study so that the validity and relevance of such findings can be discerned and hopefully lead to their use with other populations as well. To maximize the value of these replications, researchers should (1) use larger samples, (2) apply the scales to other diagnostic categories, and (3) add other neuropsychological measures to the experimental battery to determine the correlations between these and the GNDS.
In conclusion, the current study has successfully expanded the data available on the GNDS, showing psychotic and substance abuse patients to score poorly and in the impaired range. It has done this with populations for which there was not any previous GNDS data available and therefore, has supported the scale's utility as a measure of impairment across a variety of populations. Although subjects in different diagnostic groups did not differ from one another, they all scored higher than normals compared to published norms.
APPENDIX A

DSM-III-R CRITERIA FOR PSYCHOTIC AND
SUBSTANCE ABUSE DISORDERS
DSM-III-R Criteria for Psychotic and Substance Abuse Disorders

The third, revised edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-III-R) lists the following criteria for the diagnosis of Schizophrenia:

A. Presence of characteristic psychotic symptoms in the active phase: either (1), (2), or (3) for at least one week (unless the symptoms are successfully treated):

(1) two of the following:
   (a) delusions
   (b) prominent hallucinations (throughout the day for several days or several times a week for several weeks, each hallucinatory experience not being limited to a few brief moments)
   (c) incoherence or marked loosening of associations
   (d) catatonic behavior
   (e) flat or grossly inappropriate affect

(2) bizarre delusions (i.e., involving a phenomenon that the person's culture would regard as totally implausible, e.g., thought broadcasting, being controlled by a dead person)
(3) prominent hallucinations [as defined in (1)(b) above] of a voice with content having no apparent relation to depression or elation, or a voice keeping up a running commentary on the person's behavior or thoughts, or two or more voices conversing with each other

B. During the course of the disturbance, functioning in such areas as work, social relations, and self-care is markedly below the highest level achieved before onset of the disturbance (or, when the onset is in childhood or adolescence, failure to achieve expected level of social development).

C. Schizoaffective Disorder and Mood Disorder with Psychotic Features have been ruled out, i.e., if a Major Depressive or Manic Syndrome has ever been present during an active phase of the disturbance, the total duration of all episodes of a mood syndrome has been brief relative to the total duration of the active and residual phases of the disturbance.

D. Continuous signs of the disturbance for at least six months. The six month period must include an active phase (of at least one week, or less if symptoms have been successfully treated) during which there were psychotic symptoms characteristic
of Schizophrenia (symptoms in A), with or without a prodromal or residual phase, as defined below.

Prodromal phase: A clear deterioration in functioning before the active phase of the disturbance that is not due to a disturbance in mood or to a Psychoactive Substance Use Disorder and that involves at least two of the symptoms listed below.

Residual phase: Following the active phase of the disturbance, persistence of at least two of the symptoms noted below, these not being due to a disturbance in mood or to a Psychoactive Substance Use Disorder.

Prodromal or Residual Symptoms:

(1) marked social isolation or withdrawal
(2) marked impairment in role functioning as wage-earner, student, or homemaker
(3) markedly peculiar behavior (e.g., collecting garbage, talking to self in public, hoarding food)
(4) marked impairment in personal hygiene and grooming
(5) blunted or inappropriate affect
(6) digressive, vague, overelaborate, or circumstantial speech, or poverty of speech, or poverty of content of speech
(7) odd beliefs or magical thinking, influencing behavior and inconsistent with cultural norms, e.g., superstitiousness, belief in clairvoyance, telepathy, "sixth sense", "others can feel my feelings," overvalued ideas, ideas of reference

(8) unusual perceptual experiences, e.g., recurrent illusions, sensing the presence of a force or person not actually present

(9) marked lack of initiative, interests, or energy

Examples: Six months of prodromal symptoms with one week of symptoms from A; no prodromal symptoms with six months of symptoms from A; no prodromal symptoms with one of symptoms from A and six months of residual symptoms.

E. It cannot be established that an organic factor initiated and maintained the disturbance.

F. If there is a history of Autistic Disorder, the additional diagnosis of Schizophrenia is made only if prominent delusions or hallucinations are also present.

The DSM-III-R criteria for Schizophreniform Disorder are:

A. Meets criteria A and C of Schizophrenia
B. An episode of the disturbance (including prodromal, active, and residual phases) lasts less than six months. (When the diagnosis must be made without waiting for recovery, it should be qualified as "provisional.")

C. Does not meet the criteria for Brief Reactive Psychosis, and it cannot be established that an organic factor initiated and maintained the disturbance.

The following are the DSM-III-R diagnostic criteria for Schizoaffective Disorder:

A. A disturbance during which, at some time, there is either a Major Depressive or a Manic Syndrome concurrent with symptoms that meet the A criterion of Schizophrenia.

B. During an episode of the disturbance, there have been delusions or hallucinations for at least two weeks, but no prominent mood symptoms.

C. Schizophrenia has been ruled out, i.e., the duration of all episodes of a mood syndrome has not been brief relative to the total duration of the psychotic disturbance.

D. It cannot be established that an organic factor initiated and maintained the disturbance.
The DSM-III-R lists the following as criteria for
Induced Psychotic Disorder:

A. A delusion develops (in a second person) in the context of a close relationship with another person, or persons, with an already established delusion (the primary case).

B. The delusion in the second person is similar in content to that in the primary case.

C. Immediately before onset of the induced delusion, the second person did not have a psychotic disorder or the prodromal symptoms of Schizophrenia.

The DSM-III-R definition of Psychotic Disorders Not Otherwise Specified (Atypical Psychosis) is: Disorders in which there are psychotic symptoms (delusions, hallucinations, incoherence, marked loosening of associations, catatonic excitement or stupor, or grossly disorganized behavior) that do not meet the criteria for any other nonorganic psychotic disorder. This category should also be used for psychoses about which there is inadequate information to make a specific diagnosis. This diagnosis is made only when it cannot be established that an organic factor initiated and maintained the disturbance.
The DSM-III-R provides these criteria for Psychoactive Substance Abuse Disorder:

A. A maladaptive pattern of psychoactive substance use indicated by at least one of the following:
   (1) continued use despite knowledge of having a persistent or recurrent social, occupational, psychological, or physical problem that is caused or exacerbated by use of the psychoactive substance
   (2) recurrent use in situations in which use is physically hazardous (e.g., driving while intoxicated)

B. Some symptoms of the disturbance have persisted for at least one month, or have occurred repeatedly over a longer period of time.

C. Never met the criteria for Psychoactive Substance Dependence for this substance.
APPENDIX B

TABLES
Table 1

Comparative Performance Means and Standard Deviations on the GNDS and Subscales, LNDS, RNDS, and Impairment Index for Subjects with Psychotic and Substance Abuse Disorders With and Without Head Injuries

<table>
<thead>
<tr>
<th></th>
<th>M Level of Perf.</th>
<th>M Signs</th>
<th>M Patterns</th>
<th>M Rt/Lft Diff.</th>
<th>M GNDS</th>
<th>M LNDS</th>
<th>M RNDS</th>
<th>M Imp. Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psychotic Disorder</td>
<td>24.33 (9.72)</td>
<td>1.07 (2.09)</td>
<td>1.93 (1.71)</td>
<td>9.80 (3.08)</td>
<td>37.13 (12.77)</td>
<td>6.20 (3.05)</td>
<td>7.33 (4.87)</td>
<td>.69 (.32)</td>
</tr>
<tr>
<td>Psychotic with Head Injury</td>
<td>26.73 (9.08)</td>
<td>2.60 (2.60)</td>
<td>1.35 (1.35)</td>
<td>8.73 (2.69)</td>
<td>39.40 (11.60)</td>
<td>6.87 (3.76)</td>
<td>6.87 (3.76)</td>
<td>.75 (.28)</td>
</tr>
<tr>
<td>Substance Abuse Disorder</td>
<td>21.47 (8.43)</td>
<td>2.53 (2.97)</td>
<td>1.80 (1.82)</td>
<td>7.67 (1.88)</td>
<td>35.67 (10.30)</td>
<td>7.13 (4.31)</td>
<td>4.87 (2.20)</td>
<td>.54 (.28)</td>
</tr>
<tr>
<td>Substance Abuse With Head Injury</td>
<td>26.67 (9.93)</td>
<td>2.87 (3.52)</td>
<td>1.47 (1.41)</td>
<td>10.67 (2.82)</td>
<td>39.67 (13.46)</td>
<td>8.40 (4.91)</td>
<td>6.93 (5.15)</td>
<td>.64 (.28)</td>
</tr>
</tbody>
</table>
Table 2

Analysis of Variance of Summary Indices of Impairment

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>GNDS</td>
<td>1,56</td>
<td>.04</td>
<td>.85</td>
</tr>
<tr>
<td>DX</td>
<td>1,56</td>
<td>1.01</td>
<td>.32</td>
</tr>
<tr>
<td>HI</td>
<td>1,56</td>
<td>.08</td>
<td>.78</td>
</tr>
<tr>
<td>Interaction</td>
<td>1,56</td>
<td>.08</td>
<td>.78</td>
</tr>
<tr>
<td>Level of Perf.</td>
<td>1,56</td>
<td>1.05</td>
<td>.31</td>
</tr>
<tr>
<td>DX</td>
<td>1,56</td>
<td>1.36</td>
<td>.25</td>
</tr>
<tr>
<td>HI</td>
<td>1,56</td>
<td>.03</td>
<td>.87</td>
</tr>
<tr>
<td>Interaction</td>
<td>1,56</td>
<td>.03</td>
<td>.87</td>
</tr>
<tr>
<td>Path. Signs</td>
<td>1,56</td>
<td>1.40</td>
<td>.24</td>
</tr>
<tr>
<td>DX</td>
<td>1,56</td>
<td>1.63</td>
<td>.21</td>
</tr>
<tr>
<td>HI</td>
<td>1,56</td>
<td>.67</td>
<td>.42</td>
</tr>
<tr>
<td>Interaction</td>
<td>1,56</td>
<td>.67</td>
<td>.42</td>
</tr>
<tr>
<td>Patterns</td>
<td>1,56</td>
<td>.00</td>
<td>1.00</td>
</tr>
<tr>
<td>DX</td>
<td>1,56</td>
<td>1.30</td>
<td>.26</td>
</tr>
<tr>
<td>HI</td>
<td>1,56</td>
<td>.11</td>
<td>.75</td>
</tr>
<tr>
<td>Interaction</td>
<td>1,56</td>
<td>.11</td>
<td>.75</td>
</tr>
<tr>
<td>R/L Differences</td>
<td>1,56</td>
<td>.02</td>
<td>.88</td>
</tr>
<tr>
<td>DX</td>
<td>1,56</td>
<td>1.99</td>
<td>.16</td>
</tr>
<tr>
<td>HI</td>
<td>1,56</td>
<td>8.81</td>
<td>.00</td>
</tr>
<tr>
<td>Interaction</td>
<td>1,56</td>
<td>8.81</td>
<td>.00</td>
</tr>
<tr>
<td>LNDS</td>
<td>1,56</td>
<td>1.38</td>
<td>.25</td>
</tr>
<tr>
<td>DX</td>
<td>1,56</td>
<td>.85</td>
<td>.36</td>
</tr>
<tr>
<td>HI</td>
<td>1,56</td>
<td>.08</td>
<td>.78</td>
</tr>
<tr>
<td>Interaction</td>
<td>1,56</td>
<td>.08</td>
<td>.78</td>
</tr>
<tr>
<td>RNDS</td>
<td>1,56</td>
<td>1.04</td>
<td>.31</td>
</tr>
<tr>
<td>DX</td>
<td>1,56</td>
<td>.46</td>
<td>.50</td>
</tr>
<tr>
<td>HI</td>
<td>1,56</td>
<td>1.16</td>
<td>.29</td>
</tr>
<tr>
<td>Interaction</td>
<td>1,56</td>
<td>1.16</td>
<td>.29</td>
</tr>
<tr>
<td>Imp. Index</td>
<td>1,56</td>
<td>3.00</td>
<td>.09</td>
</tr>
<tr>
<td>DX</td>
<td>1,56</td>
<td>1.04</td>
<td>.31</td>
</tr>
<tr>
<td>HI</td>
<td>1,56</td>
<td>.10</td>
<td>.76</td>
</tr>
<tr>
<td>Interaction</td>
<td>1,56</td>
<td>.10</td>
<td>.76</td>
</tr>
</tbody>
</table>
Table 3

Means and Standard Deviations of Halstead Subtests by Group

<table>
<thead>
<tr>
<th></th>
<th>Psychotic</th>
<th>Psychotic with Head Injury</th>
<th>Substance Abuse</th>
<th>Substance Abuse with Head Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WAIS-R</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FSIQ</td>
<td>92.93 (14.84)</td>
<td>86.33 (14.23)</td>
<td>90.13 (14.23)</td>
<td>92.27 (15.01)</td>
</tr>
<tr>
<td>VIQ</td>
<td>93.73 (16.71)</td>
<td>85.80 (13.27)</td>
<td>86.60 (14.73)</td>
<td>91.33 (13.66)</td>
</tr>
<tr>
<td>PIQ</td>
<td>92.80 (14.98)</td>
<td>88.87 (14.16)</td>
<td>92.93 (14.37)</td>
<td>94.67 (16.60)</td>
</tr>
<tr>
<td><strong>Category Test</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>76.93 (32.12)</td>
<td>74.00 (28.91)</td>
<td>68.93 (32.40)</td>
<td>76.00 (34.40)</td>
</tr>
<tr>
<td><strong>Tactual Performance Test</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>25.43 (13.60)</td>
<td>23.48 (13.24)</td>
<td>25.00 (9.86)</td>
<td>24.71 (9.12)</td>
</tr>
<tr>
<td>Memory</td>
<td>5.40 (2.38)</td>
<td>5.27 (3.04)</td>
<td>5.73 (2.31)</td>
<td>6.13 (1.96)</td>
</tr>
<tr>
<td>Localization</td>
<td>1.00 (1.07)</td>
<td>3.07 (3.06)</td>
<td>2.47 (1.92)</td>
<td>2.47 (2.62)</td>
</tr>
<tr>
<td><strong>Tapping</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dominant</td>
<td>49.87 (9.81)</td>
<td>45.60 (7.50)</td>
<td>53.40 (7.72)</td>
<td>54.13 (9.94)</td>
</tr>
<tr>
<td>Non-dominant</td>
<td>48.87 (8.49)</td>
<td>43.27 (10.62)</td>
<td>50.32 (7.79)</td>
<td>50.00 (9.28)</td>
</tr>
<tr>
<td><strong>Trails A</strong></td>
<td>38.13 (17.03)</td>
<td>61.26 (65.15)</td>
<td>37.53 (13.83)</td>
<td>44.53 (29.87)</td>
</tr>
<tr>
<td>Trails B</td>
<td>106.60 (57.72)</td>
<td>143.20 (81.70)</td>
<td>122.00 (63.90)</td>
<td>126.67 (91.38)</td>
</tr>
<tr>
<td><strong>Speech Sounds</strong></td>
<td>11.33 (5.90)</td>
<td>17.27 (16.26)</td>
<td>13.13 (8.41)</td>
<td>12.00 (7.28)</td>
</tr>
<tr>
<td>Seashore Rhythm</td>
<td>21.27 (5.42)</td>
<td>20.60 (4.01)</td>
<td>21.60 (6.25)</td>
<td>22.87 (4.53)</td>
</tr>
<tr>
<td><strong>Impairment Index</strong></td>
<td>.69 (.32)</td>
<td>.75 (.28)</td>
<td>.54 (.28)</td>
<td>.64 (.28)</td>
</tr>
</tbody>
</table>
Table 4

Accuracy of Classification of Psychotic and Substance Abuse Disorders With and Without Head Injuries at Various Cut-off Scores for the General Neuropsychological Deficit Scale

<table>
<thead>
<tr>
<th>Cut-Off Score</th>
<th>Psychotics</th>
<th>Psychotics with Head Injury</th>
<th>Substance Abuse</th>
<th>Substance Abuse Without Head Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>34+</td>
<td>53%</td>
<td>60%</td>
<td>60%</td>
<td>67%</td>
</tr>
<tr>
<td>34-</td>
<td>47%</td>
<td>40%</td>
<td>40%</td>
<td>33%</td>
</tr>
<tr>
<td>33+</td>
<td>60%</td>
<td>67%</td>
<td>60%</td>
<td>80%</td>
</tr>
<tr>
<td>32-</td>
<td>40%</td>
<td>33%</td>
<td>40%</td>
<td>20%</td>
</tr>
<tr>
<td>26+</td>
<td>80%</td>
<td>93%</td>
<td>87%</td>
<td>80%</td>
</tr>
<tr>
<td>25-</td>
<td>20%</td>
<td>7%</td>
<td>13%</td>
<td>20%</td>
</tr>
<tr>
<td>13+</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>12-</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>
Table 5

**Correlations between GNDS and Halstead Subtests**

<table>
<thead>
<tr>
<th>Category</th>
<th>Total Sample</th>
<th>Psychotic</th>
<th>Psychotic with Head Injury</th>
<th>Substance Abuse</th>
<th>Substance Abuse with Head Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WAIS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FSIQ</td>
<td>-.37*</td>
<td>-.09</td>
<td>-.34</td>
<td>-.50</td>
<td>-.57*</td>
</tr>
<tr>
<td>VIQ</td>
<td>-.30*</td>
<td>-.02</td>
<td>-.20</td>
<td>-.55*</td>
<td>-.55*</td>
</tr>
<tr>
<td>PIQ</td>
<td>-.40*</td>
<td>-.21</td>
<td>-.51</td>
<td>-.34</td>
<td>-.54*</td>
</tr>
<tr>
<td><strong>Category Test</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>.74*</td>
<td>.87*</td>
<td>.82*</td>
<td>.59*</td>
<td>.68*</td>
</tr>
<tr>
<td><strong>Tactual Perf. Test</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>.51*</td>
<td>.54*</td>
<td>.73*</td>
<td>.39</td>
<td>.39</td>
</tr>
<tr>
<td>Memory</td>
<td>-.66*</td>
<td>-.80*</td>
<td>-.92*</td>
<td>-.39</td>
<td>-.53*</td>
</tr>
<tr>
<td>Localiz.</td>
<td>.42*</td>
<td>-.61*</td>
<td>-.62*</td>
<td>-.08</td>
<td>-.56*</td>
</tr>
<tr>
<td><strong>Tapping</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dominant</td>
<td>-.47*</td>
<td>-.71*</td>
<td>-.49</td>
<td>-.46</td>
<td>-.31</td>
</tr>
<tr>
<td>Nondominant</td>
<td>-.55*</td>
<td>-.71*</td>
<td>-.61*</td>
<td>-.37*</td>
<td>-.55*</td>
</tr>
<tr>
<td>Trails A</td>
<td>.50*</td>
<td>.45*</td>
<td>.55*</td>
<td>.58*</td>
<td>.76*</td>
</tr>
<tr>
<td>Trails B</td>
<td>.67*</td>
<td>.45*</td>
<td>.80*</td>
<td>.75*</td>
<td>.70*</td>
</tr>
<tr>
<td>Speech Sounds</td>
<td>.52*</td>
<td>.39</td>
<td>.48</td>
<td>.77*</td>
<td>-.31</td>
</tr>
<tr>
<td><strong>Seashore</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rythm</td>
<td>-.48*</td>
<td>-.59*</td>
<td>-.33</td>
<td>-.45</td>
<td>-.63*</td>
</tr>
<tr>
<td>Imp. Index</td>
<td>.76*</td>
<td>.89*</td>
<td>.92*</td>
<td>.56</td>
<td>.68*</td>
</tr>
</tbody>
</table>

*significant
Table 6

Distributions of Scores on the GNDS of Psychotic and Substance Abuse Patients With and Without Head Injuries

<table>
<thead>
<tr>
<th>Percentile</th>
<th>Psychotic (N = 15)</th>
<th>Psychotic with Head Injury (N = 15)</th>
<th>Substance Abuse (N = 15)</th>
<th>Substance Abuse with Head Injury (N = 15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>95</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>90</td>
<td>53.60</td>
<td>55.20</td>
<td>52.00</td>
<td>60.60</td>
</tr>
<tr>
<td>85</td>
<td>52.00</td>
<td>53.60</td>
<td>46.00</td>
<td>53.40</td>
</tr>
<tr>
<td>80</td>
<td>51.00</td>
<td>52.40</td>
<td>43.00</td>
<td>50.40</td>
</tr>
<tr>
<td>75</td>
<td>47.00</td>
<td>50.00</td>
<td>43.00</td>
<td>48.00</td>
</tr>
<tr>
<td>70</td>
<td>46.20</td>
<td>48.40</td>
<td>40.60</td>
<td>47.20</td>
</tr>
<tr>
<td>65</td>
<td>46.00</td>
<td>47.40</td>
<td>38.20</td>
<td>47.00</td>
</tr>
<tr>
<td>60</td>
<td>43.60</td>
<td>45.00</td>
<td>37.00</td>
<td>43.40</td>
</tr>
<tr>
<td>55</td>
<td>40.00</td>
<td>41.60</td>
<td>36.80</td>
<td>38.00</td>
</tr>
<tr>
<td>50</td>
<td>40.00</td>
<td>40.00</td>
<td>36.00</td>
<td>38.00</td>
</tr>
<tr>
<td>45</td>
<td>34.40</td>
<td>36.00</td>
<td>36.00</td>
<td>36.40</td>
</tr>
<tr>
<td>40</td>
<td>35.60</td>
<td>33.80</td>
<td>33.00</td>
<td>35.40</td>
</tr>
<tr>
<td>35</td>
<td>29.60</td>
<td>31.40</td>
<td>30.60</td>
<td>34.60</td>
</tr>
<tr>
<td>30</td>
<td>29.00</td>
<td>28.60</td>
<td>29.80</td>
<td>33.80</td>
</tr>
<tr>
<td>25</td>
<td>29.00</td>
<td>27.00</td>
<td>29.00</td>
<td>33.00</td>
</tr>
<tr>
<td>20</td>
<td>23.40</td>
<td>27.00</td>
<td>30.60</td>
<td>25.80</td>
</tr>
<tr>
<td>15</td>
<td>20.80</td>
<td>26.40</td>
<td>25.00</td>
<td>21.60</td>
</tr>
<tr>
<td>10</td>
<td>18.00</td>
<td>24.80</td>
<td>20.20</td>
<td>20.00</td>
</tr>
<tr>
<td>5</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
</tbody>
</table>
### Table 7
Numbers of Subjects Falling into Each GNDS Impairment Category

<table>
<thead>
<tr>
<th>GNDS Score</th>
<th>Psychotic</th>
<th>Psychotic with Head Injury</th>
<th>Substance Abuse</th>
<th>Substance Abuse with Head Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>68 or more</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>1 (7%)</td>
</tr>
<tr>
<td>Severe Impairment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>41-67</td>
<td>6 (40%)</td>
<td>7 (47%)</td>
<td>4 (27%)</td>
<td>5 (33%)</td>
</tr>
<tr>
<td>Moderate Impairment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26-40</td>
<td>6 (40%)</td>
<td>7 (47%)</td>
<td>9 (60%)</td>
<td>6 (40%)</td>
</tr>
<tr>
<td>Mild Impairment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-25</td>
<td>3 (20%)</td>
<td>1 (6%)</td>
<td>2 (13%)</td>
<td>3 (20%)</td>
</tr>
<tr>
<td>Normal Range</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
REFERENCES


schizophrenic inpatients. *Journal of Nervous and Mental Disease, 172,* 317-325.


