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Category Test and WAIS Scores: Sex and Age Inter-Relationships

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Dissertation
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CATEGORY TEST AND WAIS SCORES:
SEX AND AGE INTER-RELATIONSHIPS

by

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Submitted to the Faculty of

The College of William and Mary
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Dedication

I wish to dedicate this manuscript to my parents, whose unconditional and unswerving love and support made this mid-life trek through academia possible.

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attributable to the help, support, and cooperation of
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ABSTRACT

CATEGORY TEST AND WAIS SCORES:

SEX AND AGE INTER-RELATIONSHIPS

Julia Ann Shelton

Virginia Consortium for Professional Psychology, 1987

Chairman: John David Ball, Ph.D., EVMS

The current study investigated sex and age differences
on the WAIS and Category Test in a sample of 218 persons,
half male and half female, between the ages of 16 and 39.
The sample was composed of well educated diabetics without
neurological symptomotology and of above average
intelligence.

Three types of statistical analyses were performed. The
first of these were factor analyses of structural
composition of WAIS and Category tests as influenced by sex.
Results suggested that males and females exhibit different
patterns of performance. The second analyses were
regression analyses to predict Category Test performance
from WAIS scores and age, as influenced by sex. Findings
were that for males, verbal subtests and age more strongly
predicted Category Test performance, while for females the
Block Design subtest was the strongest predictor. The third
analyses examined classification accuracy of good and bad

performance on the Category Test for males and females
utilizing discriminant function analyses. Good performance
could not be predicted for either males or females, and poor
performance was best predicted for females by Block Design.

The major findings of this study were: (1) differences
in Category Test performance and underlying cognitive
strategies for males and females, and (2) unique variance
contributions from the Category Test in factor analyses.
Males appear to rely on well learned cognitive skills most
in their Category Test performance, while for females this
task is more closely related to novel spatial problem
solving. There is support here for the inclusion of the
Category Test in a comprehensive neuropsychological test
battery as a measure of abilities not tapped by traditional
intellectual instruments. Future research should attend to
sex and age differences in establishing normative data.

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Introduction

Statement of Purpose

The importance of attending to the composition of the normative standardization sample of a test or procedure when interpreting results is undisputed (Anastasi, 1970). However, in the relatively new field of neuropsychology, many test norms are based on the performance of institutionalized and other non-representative population samples (Klove, 1974, Fromm-Auch & Yeudall, 1983). Too few studies of neuropsychological assessment instruments provide normative data from non-psychiatric, non-neurologically impaired adult samples, and even fewer provide information regarding sex and handedness differences. The Halstead-Reitan Neuropsychological Battery and Allied Procedures is the most widely utilized neuropsychological test battery in this country (Kolb & Whishaw, 1980, Lezak, 1983); yet much of the normative data for the Halstead-Reitan is based on control groups which include a large percentage of males, psychiatric patients, medical patients, and other dysfunctional groups (Klove, 1974, Fromm-Auch & Yeudall, 1983).

The Halstead-Reitan is typically administered in conjunction with the Wechsler Intelligence Scales (WAIS or

WAIS-R). These scales are normed on large, heterogeneous, normal population samples with equal sex distribution and include age-corrected scoring (Wechsler, 1955, 1981). However, there have been few studies which examine the relationship between the Wechsler scale performance, other Halstead-Reitan measures and important demographic variables such as age, handedness, and gender. Although it is generally accepted that the demographic variables of age, education, and sex of subjects are important and bear on neuropsychological test results (Parsons & Prigatano, 1978), we know little about how age, handedness, and sex affect cognitive performance on the Halstead-Reitan tests.

This study will examine WAIS and the Halstead Reitan Category Test performance of a sample of 218 male and female, well educated, non-psychiatric, high-functioning diabetics who perform at the high end of the normal curve cognitively. These subjects have no known neurological impairments and have been carefully screened to assure that they are neurologically and psychiatrically normal (See Appendix A). Particular emphasis will be placed on an analysis of level and pattern of performance differences as reflected by test scores on these two instruments due to sex and age.

<u>Theoretical Overview</u>

<u>Control Subjects</u>

The development of normative data has lagged behind

other advances in neuropsychological research. Reynolds (1982) lists several advantages which would accrue from the presence of good normative data, including the following: enhanced communication between researchers; more objective training of clinical neuropsychologists; and objective clinical anecdotal data and evaluation of clinical insight. He is uneasy with heavy reliance on clinical judgment and takes issue with Reitan's reported comment that to become a good clinical neuropsychologist one should "work in the field for 30 years". Reynolds feels that basing judgments on well researched normative data is more professional (and replicable) than reliance on clinical experience. Reynolds, in his extensive 1982 review of many neuropsychological tests, lamented the paucity of good normative reference samples. He noted that we do not know enough about how normal individuals respond to most neuropsychological tests to make the types of inferences commonly found in assessment evaluations.

Fromm-Auch and Yeudall (1983) conducted one of the few neuropsychological research studies using the Halstead-Reitan battery on a neurologically intact, nonpsychiatric population of both males and females. They made the point that inclusion of psychiatric patients as control groups in validation studies is common and noted that although utilization of such patients is based on the assumption that they display functional rather than organic disorders, there

is a growing body of evidence for central nervous system abnormality in the major psychiatric psychoses (Heaton, Baade, & Johnson, 1978, Flor-Henry, Fromm-Auch, & Schopflocker, 1983, Snow, 1981). Thus, many standard cut-off scores for neuropsychological tests which have been derived or validated from research utilizing psychiatric controls may be excessively conservative, producing a high rate of false negatives. Heaton, Baade, and Johnson (1978) note that the Halstead Reitan is able to correctly identify documented brain damage in from 53 to 83 percent of psychiatric patients, and Donnelly (1984) actually found the WAIS a more accurate predictor of neuropsychological dysfunction than the Halstead-Reitan battery for psychotic groups. Donnelly quoted Wittenborn (1972) to substantiate his conviction that assessment procedures should be considered invalid when applied to an inappropriate sample (psychotic rather than neurologically impaired groups). In addition to problems emanating from utilization of neuropsychiatric patients as controls, there are other issues regarding control subjects which will be discussed herein. In most of the literature relating to validation of neuropsychological assessment instruments, including the Halstead-Reitan battery, moderating variables such as age, sex, and handedness of tested subjects are often ignored as is level of cognitive functioning, and may confound results (Anthony, Heaton, & Lehman, 1980).

Halstead-Reitan Studies

The Halstead-Reitan Neuropsychological Battery and Allied Procedures (HRB) is a well known battery which aims to discriminate brain-damaged individuals from "normals" and to describe the behavioral skills and deficits of these patients in detail (Reitan, 1974). Most validity studies for the HRB have utilized a wide range of control subjects, with exclusionary criteria including those with "freedom from any known injury which might have resulted in brain damage" (Aftanas & Royce, 1969), psychiatric in-patients referred for neuropsychological testing to evaluate a possible organic component (Prigatano & Parsons, 1976), "medical and nonschizophrenic psychiatric patients" (Kane, Parsons, & Goldstein, 1985), persons "without evidence of past or present brain damage or disease" (Reitan, 1956), and patients receiving treatment for alcoholism (Hesselbrock, Weidenman, & Reed, 1985). Halstead's original validation sample (Halstead & Settlage, 1943) utilized ten control subjects, "heterogeneous as to age, sex, education, socioeconomic status . . . in good general health . . . selected primarily from the standpoint of availability". Reitan's series of studies in the '50's (1955), upon which the validation of the Halstead Reitan is based, utilized the following subjects for "patients without brain damage": 13 paraplegics; 17 depressed inpatients; six acute anxiety state patients; two persons with obsessive-compulsive

neurosis; and 12 "normals". He matched these 50 controls with the brain damaged group on age, education and sex (15 females each group), but did not examine either age or possible sex differences.

Other studies present similar loose criteria for "normality", and, as stated above, evidence is accumulating that the line between "organic" and "functional" disorders is indeed blurred, and possibly nonexistent. Drudge, Williams, Kessler and Gomes (1984) utilized persons with psychogenic symptoms referred for psychological assessment as normals, and noted that although this was not a normal control group per se, it was justifiable because of similarity to comparison groups used in other studies of Halstead-Reitan tests. Even the Russell-Neuringer-Goldstein Key Approach (1970) was normed on psychiatric patients for whom brain damage had been suspected but ruled out, as controls. Vega and Parsons (1967) noted in their well known study validating the Halstead-Reitan, that their control sample consisted of sick, malfunctioning, poor, rural persons. Two of the few studies which utilized a normal (but small) sample were conducted by Matarazzo, Wiens, Matarazzo, and Manaugh (1973) and Matarazzo, Wiens, Matarazzo, and Goldstein (1974). However, this sample was all male. This sample also represented the high end of the normal curve in cognitive performance and was somewhat non-representative in this regard.

Wechsler Adult Intelligence Scales

The Wechsler Adult Intelligence Scale (WAIS) and Wechsler Adult Intelligence Scale - Revised (WAIS-R) are the most frequently utilized individually administered instruments for assessing adult intelligence in the United States (Lezak, 1983). Normative data for the WAIS are based on a heterogeneous sample of 850 males and 850 females (Wechsler, 1958). Distribution of scores for this population approximates the normal curve, and the sample is considered to be balanced and representative (Matarazzo, 1972). These scales are utilized with a myriad of deviant populations, including schizophrenics, learning-disabled, character disorders, and medical patients, and are almost always included as a part of the HRB (Lezak, 1983).

The WAIS-R is the revised version of the WAIS, and was published in 1981. It incorporates a number of changes in content and revisions in administration and scoring. About 80 percent of the WAIS-R items are retained from the WAIS, either intact or with slight modifications (Wechsler, 1981). Specific changes are listed in the WAIS-R scoring manual, and differences between WAIS and WAIS-R results are explicated below.

Other Psychiatric Diagnostic Procedure Studies

Neuropsychological assessment procedures are not the only neurological diagnostic aids which lack a sophisticated normative base. Electroencephalography has been utilized

since as early as 1905 in the study of the relationship between physical and biological variables and psychiatric functioning (Struve, 1985). Yet, here too there are few studies which examine normal control populations. Chatrian (1976) made the point that even control populations selected with stringent exclusion criteria may exhibit some degree of deviant EEG findings. Unfortunately, most control subjects are selected as "normal" based on self report of good health, while the prevalence of accepted paroxysmal patterns among these so-called normal control subjects ranges from 0 to 22.9 percent (Struve, 1985). It is of course difficult to generalize results of studies utilizing such population samples to other populations.

As can be seen, effects of age, sex, handedness, psychiatric illness, and the level of intellectual functioning, are often ignored in validation studies of neuropsychological assessment instruments. The following is a more detailed review of the literature focusing on the WAIS and the Category Test from the HRB and the role of moderator variables of age, sex, and handedness on WAIS and Category Test scores.

Literature Review

Wechsler Adult Intelligence Scale (WAIS) and Related Scales

Role in neuropsychological assessment. The WAIS or WAIS-R is usually included as a part of both the Halstead-Reitan and Luria Nebraska Neuropsychological batteries.

Several studies suggest that the WAIS is almost as accurate as either the Halstead-Reitan or the Luria Nebraska Neuropsychological batteries for discriminating brain-damaged from non-brain-damaged individuals. For example, Goldstein and Shelly (1984) compared the efficiency of the Halstead-Reitan, Luria Nebraska, and WAIS in discriminating between brain damaged and non-brain damaged subjects, and found that the WAIS predicts to these groups with 65.5 percent accuracy, compared with 77.4 percent correct classifications using the Halstead-Reitan and 79.8 percent correct predictions for the Luria-Nebraska. Russell (1979) found that the WAIS alone could accurately discriminate between normal controls and patients with brain damage, and Simpson and Vega (1971) went even further, proposing that there are specific patterns of WAIS subtest scores which are good predictors of brain damage. As noted above, Donnelly (1984) found the WAIS more accurate than the Halstead-Reitan as a predictor of brain damage for psychotic inpatients. Moses (1985a, 1985b) examined the relationship between the WAIS, the Halstead-Reitan, and Luria-Nebraska batteries, and concluded that the WAIS measures appear to operate as level of performance estimators, thus contributing nonredundant information in addition to the basic batteries. This is congruent with findings of Lehman, Chelune, and Heaton (1979), who studied psychiatric, brain-damaged, and control patients, and found that overall level and non-specific

variability of performance distinguished normals from other groups. Fitzhugh, Fitzhugh, and Reitan (1961) utilized acute, chronic, and static brain damaged groups and a control group to evaluate the accuracy of the Halstead-Reitan in prediction of brain damage, and concluded that the type of brain damage was an important variable. Examination of their results also reveals significantly higher WAIS summary scores for the control group than for all the brain damaged groups. Kane, Parsons, and Goldstein (1985) also compared brain damaged and control samples on neuropsychological test batteries and the WAIS, but again IQ was significantly higher for controls. It is difficult to interpret studies such as these which attempt to assess the accuracy (validity) of neuropsychological batteries but do not control for level of IQ. Zillmer, Fowler, Newman, and Archer (1986) in a study of neuropsychiatric inpatients, found a significant relationship between level of IQ scores and degree of neuropsychological dysfunction. Specifically, IQ summary scores and individual subscales predicted on the average 21 to 41 percent respectively of the variance of the Halstead-Reitan measures. These authors recommend more research with normal samples to examine the relationships between psychometric estimates of cognitive abilities and other variables.

Education effects. Wechsler (1958) stated that the fact . . . "that level of education is correlated with level

of performance on intelligence tests is well established".
The correlation between years of school completed and Full
Scale IQ scores was approximately 0.70 for all age groups of
the original WAIS sample. Finlayson, Johnson, and Reitan
(1977) analyzed the effect of education on both the WAIS and
the Halstead-Reitan battery, and found different patterns of
performance between well-educated and poorly educated
persons; however, education effects did not appear to be as
consistent as brain damage effects. They recommended the
use of methods of inference other than level of performance
when diagnosing brain impairment, noting that education
level especially affects psychometric measures which load
heavily on auditory-verbal language requirements. Heaton,
Grant, and Matthews (1986) found, not surprisingly, that
performance on those WAIS subtests of verbal skills and past
accumulated knowledge are more education related.

Personality factors. Matarazzo (1972), in a historical
overview of changing perceptions regarding the relationship
between WAIS subtest score patterns and differential
psychiatric diagnosis, stated that early "cookbook" patterns
or profiles proved inaccurate and unuseful. He cited early
research which searched for linear relationships between
patterns of WAIS subtest scores and specific personality
diagnoses. However, he noted that more and better research
utilizing well-defined criterion subgroups of patients with
reliable personality disorder and/or psychiatric diagnoses,

chronic as well as acute, may yield useful data showing group differences. One initially promising system for extracting personality assessment information from WAIS subtest scores was the Gittinger Personality Assessment System (Matarazzo, 1972) which utilizes weighted WAIS subtest scores to produce personality profiles. Unfortunately, normative data and information regarding application of weighting systems is not readily available, and little research has been published regarding reliability and validity of the system (Saunders, 1981). Dodrill et al (1986) attempted to utilize WAIS, various personality tests and several neuropsychological test scores, including the Category Test, to predict surgical outcome for epileptics. They found personality variables (Hysteria and Paranoia scales) from the Minnesota Multiphasic Personality Inventory to be the most reliable predictors.

Several studies have attempted to use the Halstead-Reitan and/or the WAIS to discriminate between normals and other types of disorders: Schultz, Elia, Robbins, Streeten, and Blakeman (1986) were unable to discriminate hypertensives from normotensives on the basis of the WAIS alone, but found group differences based on age and education. Goldstein, Shelly, Mascia, and Tarter (1985) conducted a study of the relationships between psychopathology and neuropsychological deficits in chronic alcoholic patients. They administered the Halstead-Reitan

battery, the WAIS, and the MMPI. The only significant difference between subjects with psychotic MMPI profiles and other subjects was poorer performances on WAIS Full Scale (FS) and Verbal (V) IQs, and Arithmetic and Vocabulary subtests. McCue, Shelly, and Goldstein (1986) contrasted normals with learning disabled adults and found patterns of mild neuropsychological deficits among the learning disabled on the Halstead-Reitan and WAIS. Miller and Orr (1980) found that performances on Block Design and Similarities subtests were efficient discriminators between chronic alcoholics and psychiatric subjects, with psychiatric subjects performing significantly better than both alcoholics and brain damaged subjects. Heaton, Nelson, Thompson, Burks, and Franklin (1985) examined cognitive performance of multiple sclerosis patients, and found significantly worse WAIS performance among chronic groups compared to relapsing groups, with both groups distinguishable from normals.

Factor loadings and scale differences. Most of the aforementioned literature utilized the WAIS. However, several studies have used other Wechsler scales including the WAIS-R and the Wechsler Bellevue (W-B). Leckliter, Matarazzo, and Silverstein (1986) reviewed factor analytic studies of the WAIS-R, and found the best fit to be three factors: verbal comprehension, perceptual organization, and memory/freedom from distractibility. This is consonant with

results of factor analyses of the WAIS (Cohen, 1957,

Matarazzo, 1972). Matarazzo (1972) reviewed extensive

factor analysis literature and replicated Cohen and others'

findings of three stable factors termed Verbal

Comprehension, Perceptual Organization, and Memory/Freedom

from Distractibility on the WAIS. More specifically,

Matarazzo found that most factor analyses of the WAIS

produced a four factor solution, with two large definable

factors, one small definable factor, and one small factor

which appeared to vary according to characteristics of the

population sample. More recently, other investigators

(Fowler, Zillmer, & Newman, 1987; Zillmer, Fowler, Newman, &

Archer, 1986) have reported two stable factor patterns: a

Verbal Comprehension and Perceptual Organization Factor, in

low functioning neuropsychiatric patients with average IQ

less than or equal to 84. They suggested that the WAIS has

a well-grounded structure that is little affected by either

neurological or psychiatric dysfunction and provides

empirical reassurance for clinicians who work with such

patients. Finlayson, Johnson, and Reitan (1977) suggested

that level of IQ and/or education results in different

patterns of performance: this might result in different

factors and/or factor loadings. Zimmerman, Whitmyre, and

Fields (1970), in a factorial study of the WAIS on several

subgroups of brain damaged persons, found that factorial

structure differed according to type of brain damage.

Mishra and Brown (1983) compared performance on the WAIS and WAIS-R, and found higher WAIS subtest scores, averaging five to six points higher for PIQ, VIQ, and FSIQ. These findings were substantiated by Rogers and Osborne (1984), who found, in addition, that WAIS - WAIS-R differences were greater for patients in their 20's, 50's, 60's, and 70's than for those in their teens.

V-P discrepancies. Several researchers have attached importance to the V-P discrepancy scores among subjects presumed to be normal. Matarazzo and Herman (1984), using the WAIS-R standardization sample, examined discrepancy scores, and found a normal distribution of discrepancies. They cautioned that base-rate data for the population being studied should be considered before making inferences based on discrepancy scores. Todd, Collidge, and Satz (1977) noted that discrepancy scores vary as a function of IQ level. Johnson and Harley (1980) repeated this caution. Pickering, Johnson, and Stary (1977) went even further, and stated that the discrepancy score is an artifact of the WAIS, not found on other instruments. However, Lin (1979) described sex differences in the distribution of discrepancy scores on the WAIS, and suggested that discrepancy scores may be a function of individual differences on variables such as sex, IQ, or others, and are not an artifact of the test. Inglis, Ruckman, Lawson, MacLean, and Monga (1982) in a study of stroke patients and non-neurologically impaired

controls, examined WAIS discrepancy scores, found different patterns of discrepancy correlated with sex, handedness, brain damage and chronicity. There also appear to be differences between the earlier Wechsler-Bellevue (W-B) scales and the WAIS. Snow, Freedman and Ford (1986) reviewed sex difference literature which utilized the WAIS and W-B with persons with lateralized brain damage. They re-analyzed existing data, and found that the relationship, or pattern of scoring, between sex and discrepancy scores differed on the two instruments. They found a significant correlation between V-P discrepancy scores in the samples which had utilized the W-B, but did not find this relationship in the samples which had used the WAIS. They recommended the use of multiple regression techniques to investigate the possibility that correlational sex difference findings are a function of age, education, and chronicity of cognitive deficit.

Category Test

Description. The Category Test (CT) is one of the 10 tests included in the Halstead-Reitan Neuropsychological Test Battery, and is considered to be the most sensitive test in the battery to the simple presence or absence of brain damage (Reitan, 1955). Halstead (1947; Halstead & Settlage, 1943) initially described this test as loading highest on what he termed a "central integrative field factor", which is analagous to what is often referred to as

"fluid intelligence" or innate ability. This is in contrast to what is generally known as "crystallized intelligence" or acquired factual knowledge. While the test is generally thought to measure complex concept formation, good performance also requires adequate visual memory, visuo-spatial reasoning, and the ability to translate visual stimuli into verbal concepts (Rothke, 1986). There also appears to be a strong attention-concentration component (Whitworth, 1984). The variables in the Luria Nebrasks neuropsychological battery to which CT scores appear most highly correlated are Memory, Visual, and Intelligence (Golden et al, 1981). The current version of the CT consists of seven subtests, in which correct responses are based on various underlying principles of logic. Once the correct principle is found, application of that principle to subsequent items will result in correct answers throughout a particular subtest. Feedback is provided after each response. The underlying principle for the first two subtests is counting, and few persons with unimpaired cortical functioning make mistakes on these two subtests. The third subtest is an oddity task, and the correct principle is the ordinal position of the odd figure (position one, two, three, or four). In the fourth subtest a quadrant framework is presented and the subject is to respond with the quadrant position of the omitted quadrant. In sets five and six, the correct response is the proportion

of the total configuration which is outlined with solid rather than dotted contours. Finally, subtest seven is a recall set with items taken from the first six subtests. Calsyn, O'Leary, and Chaney (1980) found that the first four subtests correlated 0.89 with total score. Despite the variation in types of tasks among the subtests, the sole score utilized in diagnosis in the standard method of interpretation of the Halstead-Reitan battery is the total number of errors.

Halstead (1947) described each subtest as progressing in terms of increasing difficulty of items. However, an item analysis prepared by Simmel and Counts (1957) utilizing normal subjects did not support the notion of increasing difficulty within subtests. For instance, analysis of distribution of correct and incorrect answers on subtest 3 indicated that certain items "pull" incorrect responses throughout the subtest even from persons who previously appeared to have learned the correct principle. Simmel and Counts described the basic assumption of the test as follows: first responses are random, and once the correct principle is learned, responses are correct. However, in actuality, it appears that many correct responses are given by subjects who have not grasped the principle, and many incorrect answers are given by subjects who previously demonstrated knowledge of the relevant principle by long errorless runs.

Simmel and Counts (1957) suggested that there appear to be four classes of factors which co-determine successes and erroneous choices: (1) application to a new set of items of specific previously learned principles, (2) perceptual characteristics of the stimulus configuration, (3) unconscious mental sets induced by several aspects of the total experimental situation, most pronounced of which is the tendency to respond by counting some aspect of the stimulus, and (4) response tendencies. Response tendencies are part of the more or less permanent make-up of the subjects, a function of learning in its widest meaning, with roots in the developmental hierarchy of intellectual operations, in the nature of our language, and in the saliency aspects of frequent, everyday kinds of experiences and actions. These response sets might be evidenced by a tendency to respond to a certain color, shape, or size of stimulus. Such response tendencies are demonstrated in the non-random distribution of errors, and also affect responses which are scored correct. Learning the correct principle involves first and foremost the active rejection of the individual subjects' response tendencies. A response may be rewarded when incidentally correct; that is, when the response is determined by some prominent feature of the stimulus or preceding set which coincided with the essentially correct response. Reward of an incidentally correct response may retard progress toward acquiring the

correct principle. Also, the trial and error nature of this task means that a response may be judged incorrect due to a misapplication of an already attained correct principle, even when the misapplication is as logical as the response which is scored correct.

There are probably important individual differences with respect to response tendencies, with some subject's responses determined more strongly by perceptual characteristics of the stimuli, others affected by past learning of the immediately preceding group, others having difficulty freeing themselves of specific procedures practiced in everyday life, others more influenced by mental sets induced by characteristics of the testing environment (apparatus, response keys), others who have difficulty rejecting dichotomous response tendencies, and others for whom variation of basic stimulus figures may be either disorganizing or stimulating and enhancing performance. These differences may have clinical implications, and explication of them should add diagnostic power to the interpretation of Category Test results.

Bond and Buchtel (1984), in a study comparing the Wisconsin Card Sort Test and the Category Test, noted that there are many unknown potential influences on the magnitude of correlation coefficients, making correlational analysis inadequate for analyzing specific cognitive abilities that underlie performance on many neuropsychological tests. They

also noted that many cognitive capacities are tapped by
successful performance on the Category Test. These include
perception of abstract relevant attributes, ignoring
irrelevant attributes, recognizing matches, forming
hypotheses regarding the matching principle, drawing
inferences based on feedback; remembering the current
hypothesis (i.e. what was learned on previous trials), using
systematic strategies to eliminate erroneous hypotheses,
being able to stay with the correct matching principle until
it is wrong, being able to repeat the previous steps of
hypothesis testing after a change in the correct matching
principle, and possession of sufficient intellectual power
to remember and coordinate various components of the task.
Subjects fail for different reasons, and only a fine grained
analysis will determine which factors are salient for
different individuals.

IQ effects. Simmel and Counts (1957) noted the highly
significant positive correlation of the Category Test (CT)
with tests of intelligence. Perkins (1974) studied
psychiatric outpatients, and found a significant positive
correlation between IQ as measured by the Shipley
Intelligence Scale (Shipley, 1940) and CT scores in a sample
of "nonorganic psychiatric patients". Lansdell and Donnelly
(1977) factor-analyzed WAIS and CT scores of psychiatric and
neurological patients, and found that the CT loaded highest
on the second, visuo-motor factor, on which the Block Design

and Object Assembly subtests load highest. Shore, Shore and
Pihl (1971) administered WAIS and CT to an adult "normal"
sample, calculated correlations between total error and each
subset error score on the CT and each WAIS subtest. They
found subtests 1 and 2 independent of IQ and remaining
subtests highly positively correlated with IQ scores, the
FSIQ being the best predictor of CT performance. They
reported the following correlations between total CT errors
and the three main WAIS factors (Cohen, 1957): verbal
comprehension, 0.84; perceptual organization, 0.72; and
memory/concentration, 1.00. Wiens and Matarazzo (1977)
found the CT score correlated most highly with the Block
Design subtest for a group of normal young men and concluded
that in a normal sample, CT score is not influenced
systematically by increases in FSIQ above 105. Lin and
Rennick (1974) studied correlations between CT and WAIS
performance in two epileptic samples, and found that,
although correlations of CT and individual WAIS subtests
differed somewhat between samples, correlations between CT
scores and FSIQ, VIQ, PIQ, and the most common three factor
scores remained relatively constant. Pendleton and Heaton
(1982) studied a large group of brain damaged and normal
controls, and found that CT correlated highest with FSIQ for
both groups. Logue and Allen (1971) produced a predictor
table based on WAIS FSIQ scores for CT errors using Reitan's
(1955) original sample of 50. They noted that at the high

end of the IQ range WAIS FSIQ scores were poor predictors of

CT errors. Kupke and Lewis (1985) reversed the direction of

prediction, and found that of the major Halstead-Reitan

tests, CT most consistently predicted WAIS IQ scores.

Goldstein and Shelly (1972) also examined the relationship

between Halstead-Reitan tests and the WAIS, and found that

CT performance is related most strongly to the performance

subtests of the WAIS for a large sample of neuropsychiatric

inpatients. Cullum, Steinman, and Bigler (1984) studied

cerebral trauma patients' performance on the WAIS and CT,

and found significant correlations between CT errors and

VIQ, PIQ, and FSIQ, with highest correlations with PIQ.

Fowler, Zillmer, and Newman (1987) found a significant

relationship between PIQ and CT scores in a neuropsychiatric

population. They found that PIQ predicts 26 percent of the

CT score, and found Block Design the best predictor in the

WAIS subtests for CT score.

Education effects. Prigatano and Parsons (1976)

examined age and education effects on performance of

Halstead-Reitan measures by brain damaged, psychiatric, and

medical-surgical patients. Education was unrelated to test

performance for brain damaged subjects, was correlated to

most measures for medical-surgical patients, but correlated

with only one measure in the psychiatric group. Finlayson,

Johnson, and Reitan (1977) examined education effect on

neuropsychological adaptation in brain damaged and control

adults, all under age 50. Brain damage had the most

consistent effect, increasing errors on Halstead-Reitan test

scores (including CT scores). However, education also had

an effect among both brain damaged and control subjects,

with higher education associated with fewer errors on the

CT. The authors noted that their study utilized a sample

with a wider range of education than did the Prigatano and

Parsons (1976) study, which might explain the differences in

findings.

Personality factors. Heaton and Crowley (1981)

conducted an extensive review of the relationship between

neuropsychological assessment and psychiatric disturbance,

and concluded that there is a much stronger relationship

between degree of emotional disturbance and performance on

neuropsychological tests with psychiatric patients than with

neurological patients. However, they cited the relative

weakness of the correlations as an argument against the

possibility of any major emotional impact on

neuropsychological functioning of either type of patient.

This is however in contrast to an earlier study by Perkins

(1974) who investigated the relationship between CT scores

and selected measures of emotional and cognitive variables.

Perkins found no support for the hypothesis that

emotionality and mood state was associated significantly

with performance on the CT in a sample of nonorganic

psychiatric patients, the majority of whom were diagnosed

with Personality Disorders, with no identified
schizophrenics. Wiens and Matarazzo (1977) also found no
relationship between personality scales and Halstead-Reitan
measures in a study of high functioning normal males. On
the other hand, neurological data have been accumulating
which document enlarged ventricles, abnormal patterns of
cerebral metabolism, and signs of primary subcortical
dysfunction in many chronic schizophrenics (Goldstein,
1986). In the Heaton and Crowley study cited above, they
found that chronic schizophrenics appear to score in the
impaired range on neuropsychological tests. O'Donnell,
Kurtz, and Ramanaiah (1983) examined neuropsychological
performance in a sample of brain damaged, learning disabled,
and normal subjects. Interestingly, the CT was one of the
two Halstead-Reitan tests contributing the least to group
discrimination. Yet in a study of alcoholics, psychiatric
patients, and brain damaged persons, (Miller & Orr, 1980),
the CT was the most efficient discriminator between
alcoholics and psychotics, with alcoholics performing
significantly worse.

Sex Differences

The study of sex differences is rife with controversy,
quarrels over definitions of components of intelligence, and
disagreement about the meaningfulness of small but
significant differences. Sherman (1978) pointed out
problems of concept, methodology, design, and statistical

analyses in current studies of sex differences, and suggested that the statistics utilized in many studies were difficult to follow, and did not illustrate clearly the magnitude of differences found between male and female performance. Caplan, MacPherson, and Tobin, in a 1985 review of sex differences in spatial abilities, highlighted problems with both definitions of spatial abilities and the meaningfulness of the magnitude of differences between males and females. They concluded that the major thrust of existing literature has been directed toward answering the question of why males are superior to females. Halpern (1986) answered that, regarding definitional problems, there are basically three different kinds of spatial ability tests, and the most compelling evidence for meaningful sex differences is not the size of sex effects but the fact that when differences are found they almost always favor males. Halpern found strong evidence in the literature for a relationship between sex differentiated cerebral lateralization and cognitive abilities. Hiscock (1986), also replying to the Caplan, MacPherson, and Tobin (1985) article, made the additional point that although sex differences on some spatial tests appear trivial, the magnitude of others is substantial. He noted that both the distribution of scores as well as central tendencies are important, as there appear to be striking sex differences at extreme upper portions of the score distribution on some

tests. Burnett (1986), in his response, noted that 50 years of psychometric research has identified some fairly consistent subfactors of spatial abilities, with sex differences varying in size across subfactors. Burnett further pointed out that a "trivial" difference of one-half a standard deviation in selection criteria for engineering school would mean twice as many men admitted than women! Harris (1979) asserted that the fact of the male's superior spatial ability is not in dispute; only the explanation is. He described the major explanatory models as being sociocultural, genetic, and neurologic, and found the neurologic model of greater lateralization in males to have the broadest degree of support. However, he cautioned that alternative explanations based on preferred modes of cognitive analysis also fit the current data well. He described both structural and functional lateral asymmetries which are known to exist, along with probable sub-cortical differences between males and females. He recommended new questions: what are the different mechanisms of attention, memory, information processing style, that might be engendered by different kinds of brain organization.

Wechsler (1958) noted that determination of sex differences in intelligence depends both upon how one defines intelligence, and on types of tests used to measure it. One can examine standardized test results, look at gross anatomical features, and/or search for differences at

the cellular structure level. At the gross anatomical or structural level of investigation, a great deal of research has been conducted exploring sex differences in cerebral lateralization and asymmetry. However, according to Bryden (1979), there is a scarcity of cerebral lateralization studies on normal subjects, and it is difficult to generalize results from clinical studies of brain functioning among brain damaged subjects to normal subjects. Even when studying normal subjects, different subtest patterns may represent differences in strategy rather than true differences in cerebral organization. Bryden noted that, based on review of the current literature on cerebral asymmetry, adult males do appear more likely than females to show left hemisphere superiority on verbal tasks such as dichotic listening or tachistoscopic word recognition, and there are indications of greater asymmetry in males on tasks involving visuo-spatial processes.

According to Goldberg and Costa's model (1981), differences in neuroanatomical organization of cerebral hemispheres may account for two fundamental distinctions in processing. The right hemisphere may have a greater ability to perform intermodal integration and to process novel stimuli, while the left hemisphere may be more capable of unimodal and motoric processing and storage of compact codes. The right hemisphere appears to have a greater neuronal capacity to deal with informational complexity, and

to process many modes of representation within a single cognitive task, while the left hemisphere is superior in tasks requiring fixation upon a single mode of representation. The right hemisphere may be better able to activate the entire cortex, but there is a gradient of relative hemispheral involvement in a wide range of cognitive processes reflecting the degree of routinization. Harris (1979) has agreed with theories of greater lateralization in males than in females, but noted that the superiority of males in spatial ability tasks appears to be a result of interactions between genetic and environmental factors. He reframed the differences as differences in preferred modes of cognitive analysis, and related these to the different developmental history of males and females. Thus, males and females may be predisposed to use different methods of analysis of spatial problems, with females utilizing linguistic modes more than males, perhaps using language maladaptively to solve spatial problems.

McGlone has written extensively about sex and handedness differences in laterality, as measured by a wide variety of tests (McGlone & Davidson, 1973, McGlone, 1978, McGlone, 1980). She concluded that although there is a paucity of studies on normal subjects, there is evidence for some degree of right hemisphere speech representation in women but not in men. She described the different kinds of asymmetry in different parts of the brain and noted that

these may be at least to some degree a function of gender.
However, the reader is cautioned to remember that functional
asymmetries are not necessarily based on structural ones.
Ray, Morrell, and Frediani (1976) came to the same
conclusion using various made-up tests and EEG measures.
They found different patterns of brain waves between males
and females on a variety of tasks, and concluded that males
and females process the same environmental events in
different ways. Tucker (1976) utilized EEG measures and
performance on visuospatial and vocabulary tasks to look at
sex differences, and found considerable sex differences in
hemispheric utilization and in regional usage. Lake and
Bryden (1976) used different tests, but also found
significant sex differences in male and female processing,
concluding that there are possible sex differences in
cognitive strategies. Thus the consensus over a broad band
spectrum of investigations is that at the very least, there
is evidence that females process some types of data
differently than males, and utilize different strategies to
reach the same conclusions in some cases.

WAIS. Wechsler (1958) described small but significant
differences in male and female performance in the original
WAIS standardization sample. Males score higher on Verbal,
Performance, and Full Scale IQ, with clear-cut sex
differences on eight of the 11 subtests. Males score better
on I, C, A, PC, BD, and females score better on S, V, and

DSy. Wechsler noted that there appeared to be differences in the patterns of performance based on sex. Inglis and Lawson (1984) re-examined the original WAIS sample, looking at the mean differences between handedness and sex groups, and found reliable but small sex effects. However, Heaton and Crowley (1981) examined performance of normal subjects in a large group of paired samples, and found significant differences only on Comprehension.

Bornstein and Matarazzo (1982), in a literature review of studies of sex differences in cognitive functioning of persons with unilateral brain lesions, concluded that differences in results of various studies appeared to be related to differences in the compositions of the samples regarding sex. Inglis and Lawson (1982) also reviewed the current literature for research on sex differences on WAIS performance by persons with unilateral brain damage, and concluded that the differential effects of unilateral brain damage may result from differences in strategies employed by men and women in the solution of nonverbal tasks. In another study (Inglis, Ruckman, Lawson, MacLean & Monga, 1982) low effects of age and education were found on WAIS performance by right handed unilateral brain damaged adults of both sexes, but there were significant interactions regarding side of lesion and sex. It appears that both sexes may have functional asymmetry, but "after a different fashion". Snow and Sheese (1985) also examined WAIS Verbal

and Performance IQ scores in unilaterally brain damaged persons, and failed to find significant sex by side of lesion interactions: they recommended large scale collaborative studies to resolve the sex difference issue. One of the problems appeared to be inadequate matching of size and location of lesions when matching for sex. Bornstein (1984) studied patients with unilateral lesions, using intragroup examination of VIQ-PIQ discrepancies, and found the only main effect to be site of lesion. He cautioned that because various groups of patients may have different premorbid levels, it does not effectively demonstrate deficits to compare across groups on individual variables: intergroup comparisons may lead to inaccurate interpretations of sex differences. These findings were supported in a study by Herring and Reitan (1986) who examined 124 matched pairs of unilaterally lesioned and normal controls using the Wechsler-Bellevue scales. They found no sex by lesions interactions, and found similar patterns of deficits in males and females. They did note that lateralization patterns with women did not seem to be as large as that seen with men. As noted earlier however, there appears to differences in laterality as measured by the Wechsler Bellevue and the WAIS (Snow, Freedman & Ford, 1986). In another recent study (Sundet, 1986) significant sex differences were found in WAIS performance by persons with unilateral brain damage, with left lesions in females

affecting both verbal and performance subtests, and the traditional verbal-performance dichotomy upheld among men. Sundet concluded that sex differences in cognitive style and mode of thinking may account for a major part of the observed test differences following brain damage.

Category Test. There are few published studies which examine sex differences on Category Test performance. Gordon and O'Dell (1983) examined performance by 36 normal right handers, and found no sex differences. Similarly, Heaton, Grant and Matthews (1986) also found no sex effects on CT performance among a sample of normals. Hesselbrock, Weidenman and Reed (1985) examined sex effects on alcoholics with and without Antisocial Personality diagnoses, and found sex interactional effects: females with the diagnosis made more CT errors, males with the diagnosis made less CT errors. They also found a main effect for sex on CT scores. Lin and Rennick (1974) looked at correlations between CT and WAIS scores in a large epileptic sample, and found lower correlations in females. However, they determined the difference in correlation to be statistically insignificant.

Interactions with other variables. Snow, Freedman, and Ford (1986) reviewed recent literature on sex differences, and note that age, education, and chronicity may potentially account for the relationship between sex and lateralized brain damage. They suggest that it should be possible to address this problem through multiple regression statistics,

but state that there are not currently enough studies which report relevant information to make this possible.

Vandenberg and Kuse (1979) in a review of sex differences in spatial ability, concluded that there are perhaps different spatial factors for males and females that remain unaffected by age. Waber (1976, 1977) linked such differences to age of sexual maturity, finding that late maturers perform better on tests of spatial ability.

Handedness

While preferred writing hand has been the traditional determinant for hand preference for many years, handedness studies have recently become less simplistic. A recent study (Healy, Liederman & Geschwind, 1986) utilized factor analysis of data from an extensive hand preference questionnaire to identify four general factors in hand preference. The items that loaded the highest on the four factors were: (1) write, draw; (2) point, snap; (3) bat baseball, carry suitcase; and (4) throw darts, bowl, throw. The authors argue that lumping right handers together only on the basis of writing preference obscures an important group of persons with mixed handedness that write with their right hand, but perform many other tasks with their left hand. This group appears to differ in cognitive strategies (and perhaps neural organization) from other right handers. These four factors are above and beyond the familial-non-familial factor that has been cited as a major factor in

handedness differences (Kocel, 1980). Another important
issue in the study of handedness is that of distribution or
changes over the lifespan. Swanson, Kinsbourne, and Horn
(1980) examined school performance among mixed and pure
right and left handers, and found that the distribution of
deficit scores changed over time. They concluded that
perhaps there is a lag in or premature termination of higher
cognitive developmental sequences in left handers.

Sex and handedness. There are few recent studies of
handedness that do not address the interaction of handedness
and sex differences. Carter-Saltzman (1979) emphasized the
importance of considering familial handedness when looking
at sex differences in spatial abilities. She noted that
subjects who are familial left handers appear to show less
laterality effects in auditory and visual modalities. This
may be related to an absence of lateral bias for hemispheric
specialization, but it is possible that males and females
differ in such specialization. She also noted that the
assumption that abstract representations of cognitive
abilties or strategies are qualitatively identical in males
and females should be reexamined. Hannay and Boyer (1978)
looked at laterality differences in processing of a
tachistoscopic task by right-handed males and females, and
found larger laterality measures obtained for females. They
noted that the laterality task chosen for measurement of
asymmetry may have a significant impact on results, as

subjects might use either a verbal or nonverbal mode of processing to attain "correct" results. They concluded that the mode of processing employed by subjects may be of more interest than the results of the processing, and recommended studies using the sodium amytal technique for normal males and females in order to track more accurately the hemisphere actually utilized to resolve a problem.

It is difficult to separate out the effects of sex and handedness. Herron (1980) studied performance on various tasks related to EEG results, and found sex differences in hemispheric specialization among left handers and not among right handers. Levy and Gur (1980) believe that variations in cerebral laterality are associated with variations in handedness which appear to be largely genetically determined. In their review of current literature, they noted that literature published during the past few years is consistent in reporting less lateralization in females and left handers, with even less lateralization in females than in left handed males. They believe that right hemisphere language is more prevalent in left handed females than in left handed males, which has implications for performance on cognitive tests. They caution that well known sex related differences in cognitive structure may pertain only to persons with language functions mediated in the left hemisphere.

Harshman, Hampson and Berenbaum (1983), utilizing

preferred writing hand to determine handedness, found significant differences between left and right handed males and females based on differences in level of reasoning skills. They emphasized that sample composition is more important than previously realized, as patterns of performance are different between children and adults, and between persons with average or better intelligence and persons with below average intelligence. For instance, for subjects with high reasoning ability, left handedness was associated with lower spatial performance in males but not females; and for low reasoning-ability subjects, left handedness was associated with higher scores in males than females. Heim and Watts (1976) found left handed males better than right handed males or either handed females on certain tasks. However, their sample was large, heterogeneous, and included both children and adults. Fleminger, Dalton and Standage (1977) found that the distribution of handedness was not significantly different between the sexes, and that increasing age was associated with a significant shift toward dextrality. They offered a tentative explanation by citing a perhaps greater tolerance of sinistrality within this century. Of course, their data might also be explained by a higher mortality rate among left-handers.

WAIS. Inglis and Lawson (1984) in their re-analyses of WAIS scores from the original standardization sample, used

preferred writing hand to designate handedness. They found no significant handedness effects. Johnson and Harley (1980) studied WAIS performance in a sample of moderately intelligent college students, and found a significant main effect for sex and significant handedness by subtest interactions. They concluded that in their rather homogeneous sample, handedness was a better predictor of cognitive abilities than was gender. Bradshaw, Nettleton and Taylor (1981) examined performance on the WAIS, contrasting sex and handedness based on familial dextrality, and found both handedness and sex differences. Criteria for non-familial dextrality included the requirement that the subjects have at least two sinistral close relatives. They found males produced higher Performance IQ (PIQ) than females except for familial-sinistral females, and females performed better on Verbal IQ (VIQ) than males, except for the same population of familial-sinistral females, where the pattern reversed. They found that non-familial dextrals performed best and familial sinistrals worst on both Verbal and Performance IQ scores, and concluded that the modes of cognitive processing as measured by the WAIS may be genetically determined.

Category Test. The writer has been unable to locate any literature addressing the effects of handedness on Category Test performance.

Age

There is little controversy over the fact that for most persons, intellectual ability, after reaching a peak in early maturity, declines progressively with age (Wechsler, 1958). However, it appears that general intelligence as evaluated by pragmatic criteria declines at a much slower rate than do typically measured mental abilities, and various specific abilities decline at different rates. Verbal and arithmetic skills are generally stable up into the 80's, and the normal aging processes do not appear to affect immediate memory span (Lezak, 1983). Lezak identifies those cognitive abilities that tend to decrease with normal aging as including the following: encoding of new material into memory; retrieval of stored knowledge; abstract and complex conceptualization skills; mental flexibiity; and performance on timed tests. Thus, with advancing age, one would expect to find relative unimpairment on the Verbal subtests of the WAIS, with more impairment on WAIS Performance subtests, and on the Category Test.

WAIS. Wechsler (1958) claimed that after age 25, the correlation between age and scores on tests of intelligence is always negative. He noted that findings with the WAIS are in line with this generalization. He proposed that "general intelligence is a multivariate construct, the differentiae of which may and do alter with successive

periods in the individual's life". He cited data showing that decline is of a larger magnitude on Performance subtests. Aftanas and Royce (1969) examined factor analyses of the WAIS for both normals and "brain damaged" individuals ranging in age from 16 to 70, and found similarity of factors for both normals and brain damaged. They noted that differences due to age were greater than differences due to brain damage. Bak and Greene (1980) examined two groups of normal subjects, aged 50 - 62 and 67 - 86. Results suggested that age has a pronounced effect on most sub-tests, with younger groups performing better. They concurred with Wechsler (1958) in that decline is most evident on the Performance subtests. They recommended studies to generate level of performance data for 10 year age intervals, based on specific educational groupings, to be repeated every 10 years to control for cohort (generation) differences. Berger, Bernstein, Klein, Cohen, and Lucas (1964), utilizing most of the original WAIS sample, performed factor analyses for different age groups, and examined the similarity of factoral structure based on these age groups. They found substantive differences related to age, and then compared these results with a similar analysis of pathological groups. Again, age differences were greater than differences related to pathology. Heaton, Grant, and Matthew (1986) examined age effects on the WAIS for three age groups: less than 40, 40-

59, and over 60. They found the following overall age effects listed in order from most to least: Digit Symbol (DSy), Picture Arrangement (PA), Block Design (BD), Object Assembly (OA), Picture Completion (PC), Similarities (S), Digit Span (DS), Arithmetic (A), Vocabulary (V), Information (I), and, finally, Comprehension (C). They recommended different norms for subjects at different age and educational levels. Hesselbrock, Weidenman, and Reed (1985) studied alcoholics, and found age significantly correlated with scores on BD and DSy, with an increase in errors among person aged 40-49, and a dramatic increase among subjects 50 and older. A study of normo- and hyper-tensives (Schultz, Elias, Robbins, Streeten, & Blakeman, 1986) found age negatively correlated with Performance IQ.

Category Test. Aftanas and Royce (1969) examined age effects on CT performance, and found a negative correlation between performance and age: that is, performance on the CT worsens with increasing age. Prigatano and Parsons (1976) examined the relationship of age and education to Halstead Test performance in different patient populations. They found significant correlations between age and CT scores in both brain damaged and non-brain damaged subjects, even when education effects were partialed out. Bigler (1982) in a study of 112 brain-damaged patients, found CT to be the most sensitive of all Halstead-Reitan tests to age effects, consonent with earlier findings (Bigler, Steinman, & Newton,

1981) with a normal population. In the latter study, it was suggested that higher CT errors in the oldest group, aged 51 - 75, reflected a slight decrement in abstract reasoning and problem solving. Heaton, Grant, & Matthews (1986) in a study of persons without neurological illness, found CT scores most vulnerable of all the Halstead-Reitan tests to age effects. Chaney, O'Leary, Fehrenback, & Donovan (1980) factor analyzed CT performance by alcoholics of different ages, and found that CT scores weighted heavily on both a fluid and crystallized intelligence factors, the former traditionally thought to show more significant age effects. The older alcoholics did more poorly on the CT. Hesselbrock, Weidenman, & Reed (1985) found similar results in their study of alcoholics, with a significant increase in errors among persons 40-49, and a dramatic increase in errors for persons over 49. In the Fromm-Auch and Yeudal (1983) study cited above which examined age effects on both WAIS and CT, it was determined that the CT cut-off of above 50 errors signifying brain damage was only appropriate for subjects under age 40, as the number of errors rose significantly after that age. Fromm and Schopflocher (1984) looked at test performance by depressed and psychotic patients, before and after treatment. They found that depressed persons scored similar to aged groups, and suggested that perhaps depression and aging may affect the same brain areas.

Diabetes

The term Diabetes refers to several different pancreatic disorders that lead to chronically high blood glucose levels. Individuals with relatively long duration of the disorder have increased risk of heart attacks, strokes, gangrene of the feet, impaired vision, end-stage renal disease, and peripheral neuropathy. The sample utilized in this study is comprised of juvenile onset or Type I, insulin dependent diabetes. In this category of diabetes, virtually all cases are diagnosed before age 30, and most are diagnosed between ages 10 and 14. The primary medical therapeutic goal with these persons is to maintain good metabolic control by avoiding excessively high or low blood glucose levels as they are prone to both hyper- and hypoglycemia. Juvenile onset diabetics learn to take responsibility for daily, self-administered injections of insulin, must pay careful attention to dietary and exercise regimens, and engage in periodic testing. The disorder is particularly disruptive during childhood and adolescence, sometimes causing changes in appearance such as increased body weight, smaller stature, and delayed puberty. It is not surprising that as a group, they have an increased incidence of emotional disturbances and more serious psychosocial problems than their peers.

One might also expect a higher incidence of cognitive dysfunction, but a review of the literature does not offer

clear-cut support of this contention. However, Surridge et al. (1984), in a descriptive study of insulin-dependent diabetics, found that symptoms such as reduced energy level, increased fatigue and irritability, depression, and delayed psychosexual maturation often made the diabetics' lives uncomfortable and reduced their functional capacity. Reske-Nielsen, Lundbeck and Rafaelsen (1965) examined brain tissue of 16 dead juvenile diabetics, all with retinopathy and severe nervous disease, and found diffuse, degenerative abnormalities of brain tissue beyond that which would be expected for persons with vascular disease. One would expect that such abnormalities would affect intellectual functioning, but test results or behavioral information on the subjects described was not available. In a review article, Ryan and Morrow (in press) stated that onset of diabetes before age five appears to lead to cognitive impairments characterized by diffuse deficits in some persons, and diabetics who have had multiple episodes of serious hypoglycemia early in the course of the disease are also more likely to be impaired. They concluded that there is little compelling evidence regarding extensive structural damage being responsible for subtle information processing decrements sometimes found in later onset diabetics. As the sample utilized in this study is composed of insulin dependent diabetics, it is important to review current literature investigating possible relationships between

various facets of diabetes and level and pattern of cognitive functioning.

WAIS. As noted above, there has, in the past, been some question about the effects of diabetes on cognitive functioning, and several studies have examined the performance of diabetics with different degrees of disease severity on intelligence tests. Lawson et al. (1984) examined performance on the WAIS by insulin dependent diabetics, some of whom had moderate to severe peripheral neuropathy. They failed to find correlations between symptom severity and WAIS performance, and concluded that there is no evidence that the IQ of diabetics is significantly affected by duration of disease, age of onset, or either peripheral or autonomic neuropathy. Ryan, Vega, Longstreet, and Drash (1984) examined performance of adolescent diabetics on the WAIS and WISC-R, and found that on visual information processing tasks with a motor component, diabetics were significantly slower than normal controls, but scores were still within the average range of performance. They found no evidence of deficits in learning, complex problem solving or memory, and concluded that if deficits had been attributable to structural damage, one would expect a much wider range of poor performance on neuropsychological tests. They presented alternative explanations which include a more cautious response style, and residual effects of poorer school attendance due to

disease. In a 1985 study, Ryan, Longstreet and Morrow examined the relationship between school absense and intelligence test performance on diabetic adolescents. They found that scores on school achievement tests were best predicted by school absences but visuomotor test scores were predicted by a combination of grade and sex, not absences. They did not find significant IQ differences. They concluded that slight deficits on measures of general knowledge may be secondary to school absence, but noted that all scores were within normal limits.

Category Test and other neuropsychological measures. Skenazy and Bigler (1984) studied juvenile-onset diabetics, 20 of whom were blind, and found a positive correlation between severity of the disease and certain neuropsychological deficits. Diabetics performed worse on somatosensory examination, motor strength and motor speed tasks, with more consistent and pronounced impairment among male diabetics than among female diabetics. There were statistically significant correlations between CT performance and duration of the disease, and between WAIS PIQ and incidence of severe hypoglycemic reactions. They found no significant differences between performance of normals and diabetics on overall measures of cognitive ability and problem solving, and concluded that there is no evidence of deficit in higher cortical processes among diabetics with more severe disease. However, Ryan, Vega,

and Drash (1985) in their study of adolescent diabetics, found that neither history of hypoglycemic seizures nor other diabetic variables predicted neruopsychological test results. They did, however, find a relationship between age of onset and performance on verbal tests associated with funds of general knowledge, such as Vocabulary, Information, and Comprehension subtests of the WAIS.

<u>Sex</u>. Ryan and Morrow (1986) examined sex differences in diabetic adolescents on self esteem, and found that girls who developed diabetes before age five had poorer self concept than early onset boys, and boys and girls with later onset had equivalent scores. They noted that perhaps there are sex differences in strategies for coping with physical and psychosocial problems: also, girls who have been diabetic for a long time tend to be heavier, shorter, and less mature sexually.

<u>Handedness</u>. The writer was unable to locate any publications addressing the relationship of handedness to cognitive functioning in diabetics.

The studies cited here include subjects with more serious and longstanding secondary symptoms of diabetes than are found in the sample utilized in this study. Listing of exclusionary criteria employed in sample selection is included in Appendix A of this paper, and is stringent in exclusion of persons with the kinds of symptoms and history associated in the literature with cognitive deficits. It is

therefore be assumed for the purposes of this study that the well-screened, healthy sample of diabetics utilized represents a normal sample of individuals with above average intelligence. Scores on the extensive list of neuropsychological and cognitive measures support this assumption, as mean scores on each and every measure are well within average or normal limits.

Conclusions

There appears to be increasing interest among psychologists and behavioral neurologists in differences in cerebral functioning mediated by (or correlated with) sex, age, and handedness. Evidence is accumulating that, at the very least, males and females differ in their cognitive strategies and problem solving approaches. There are indications that females utilize verbal strategies to solve what are traditionally thought of as "spatial" problems. There is a growing awareness of the complexity of determining handedness, and possible interactions between gender, familial handedness, and level of reasoning power. It also appears that both age and level of intellectual functioning affect the patterns of test performance. It is becoming evident that the relationship between age and intelligence is more complex than was previously thought, and may also be related to gender.

There is currently a large body of research regarding various facets of the Wechsler scales in many different

population samples. However, there is little literature addressing sex and handedness-mediated differences. Neither do most normative data for neuropsychological tests address these potentially important demographic variables. There is a paucity of data regarding sex and handedness differences on Category Test performance in particular, and although it is generally conceded that the test is particularly sensitive to age effects, interactions between age, sex, and handedness have not been addressed in large studies of normal males and females. The Category Test, with its seven subtests requiring potentially different cognitive strategies, provides an exciting base from which one might examine sex differences in cognitive strategies and handedness differences in differential cognitive efficiency on various tasks. Further, relationships between performance on these subtests and WAIS subtests could provide potentially important information regarding differences in patterns of performance based on age, gender, and handedness.

The sample utilized for this study represents the upper range of the normal curve as related to level of intelligence and education. Generalization of findings will therefore be qualified by these limits. Within these constraints, this study addresses certain of these gaps in research to date by investigating the hypotheses listed below.

(1) Subtest scores of the WAIS and total errors on the CT when subjected to exploratory factor analysis, will yield differently weighted factors based on age and sex. As some of the literature cited above on sex differences suggests that females utilize verbal strategies even when solving what are traditionally thought of as non-verbal problems, it is likely that some verbal subtests will load with performance subtests and the CT on a perceptual/organization subtest factor with females. With males, the pattern might show a more traditional combination of pure perceptual/organization subtests in that factor. Unfortunately, the number of left-handers in the sample is too small to effectively utilize factor analysis to investigate the effects of handedness on test scores.

(2) Prediction formulae for CT total error scores will differ for males and females. As there is a documented differential decline among designated skills with age, it is possible that even within the rather constricted age range of the subject population studied here (ages 16 to 39) age will affect the prediction of CT scores. In order to further examine the relationship between demographic variables of age and sex and WAIS and CT scores, regression analyses will be prepared to determine formulae for predicting total CT errors from WAIS scores for different subpopulations of the sample. The possibility of interactions between these demographics will be

investigated.

(3) Level of performance on the CT will discriminate among the sample as a function of age, sex, and WAIS scores. In order to provide a potentially useful reference for clinicians and researchers, discriminant function analyses will be employed to examine demographic and WAIS profiles of groups who score low and high on CT total errors.

Method

Overview of Research Design:

The present study examined WAIS and Category Test scores
from 218 subjects who completed a neuropsychological test
battery in 1983 in conjunction with a large longitudinal
NIMH study. Specifically, WAIS and Category Test scores
were analyzed for specific patterns of performance related
to gender, age, and various other demographic variables.

Subjects

Subjects were 218 persons (109 males and 109 females)
aged 16-39, with the diagnosis of insulin dependent diabetic
mellitus. These subjects were part of a large, longitudinal
study funded by NIMH, and have been diabetic for from 5 to
15 years. The sample is predominantly white, right handed,
well educated and generally scored above average on
neuropsychological tests. Demographic information is shown
in Table 1.

Insert Table 1 about here

The purpose of the original NIMH study was to compare
the effect of experimental and standard approaches to the
control of blood glucose on early vascular complications in

persons with insulin dependent diabetes mellitus (IDDM).

Patients were recruited over a period of six months from 21

centers throughout the United States. Their eligibility was

determined by examination and interview in accordance with

the eligibility criteria listed in Appendix A. Generally,

persons with chronic conditions other than diabetes, with

history of psychiatric disturbance, diabetic neuropathy, or

major illnesses precipitated by diabetes, were excluded.

The sample is principally healthy, with no history of drug

and alcohol abuse, extreme obesity, or demonstrated failure

to maintain normal growth and development. Elaborate

informed consent and patient education programs were

utilized for this program, and these are described in

Appendix B of this study. This investigator was not privy

to subject identifying information regarding the data used

in this analysis.

Assessment Instruments and Procedures

The subjects were administered a battery of 17

neuropsychological tests including the WAIS (Wechsler,

1955), Controlled Oral Word Association Test (Benton &

Hamsher, 1978), Category Test (Halstead, 1947), WRAT

Arithmetic (Jastak, 1978); Symbol-Digit Paired-Associate

Learning Test (Talland, 1965), Visual Reproductions (from

Wechsler Memory Test, Wechsler, 1945), Four Word Short-Term

Memory Test; Logical Memory (from Wechsler Memory Test,

Wechsler, 1945), Embedded Figures Test (Talland, 1965),

Symbol Digit Modalities Test (Smith, 1973), Tactual
Performance Test (Halstead, 1947), Trailmaking Tests A and B
(Army Individual Test Battery), Digit Vigilance Test (Lewis
& Kupke, 1977), Grooved Pegboard (Matthews & Klove, 1964),
Halstead Finger Tapping Test (Halstead, 1947), and Star
Drawing. The subjects also completed a Quality of Life
measure and the SCL-90.

All tests were administered by persons with graduate
training in psychology and/or trained technicians. A
training manual was furnished to all administrators, and
they attended a two day training program prior to baseline
testing to insure their ability to accurately record
performance. The order of administration was standardized,
as were opening remarks and instruction for all testing
instruments. Administrators were each observed initially,
and randomly spot-checked throughout the testing period by
their supervisors who were doctoral level psychologists.

All tests were scored by doctoral level
neuropsychologists at two centers, who were blind to
subjects' treatment group. Standardized scoring criteria
included test manuals and additional instruction specific to
this project.

As the present study examines scores on the WAIS and
Category Test, the following is a brief synopsis of the
reliability and validity of these instruments

WAIS

Reliability coefficients for the WAIS Full Scale Scores and IQ's vary from 0.90 to 0.97, and for the Performance and Verbal parts from 0.84 to 0.96 (Wechsler, 1958). Split-half reliabilities on the main standardization population for all subtests as well as the principal parts of the Scale range from 0.60 (Picture Arrangement for ages 25-34) to 0.97 (Full Scale IQ, all ages) (Wechsler, 1958). As regards concurrent (Criterion) validity, Matarazzo (1972) reviewed numerous studies and concluded that there is a correlation of approximately 0.50 between measured intelligence (IQ) and performance in school. He found similar correlations between grades and measured IQ, and reported a correlation of 0.70 between IQ and years of educational attainment or schooling completed (predictive validity). Test-retest reliability was investigated in a small normal sample by Matarazzo, Weins, Matarazzo, & Manaugh (1973), who report reliability coefficients for Full Scale, Verbal, and Performance IQs at 0.91, 0.87, and 0.84, respectively.

Category Test

Shaw (1966) reported on the reliability and validity of the Category Test for a sample of 674 adult patients. Reliability was determined by the split-half method, odd-even split, which yielded a reliability coefficient of 0.98. Validity was assessed indirectly, by hypothesizing that number of errors would vary with severity of brain damage,

and this was verified for the sample. Matarazzo and colleagues demonstrated that the Halstead Battery Impairment Index possessed adequate reliability for classifying normal individuals, and was reliable for an older brain damaged population (Matarazzo, Weins, Matarazzo, & Goldstein, 1974; Matarazzo, Matarazzo, Weins, Gallo, & Klonoff, 1976). Reitan (1955) investigated validity of the Halstead Battery (which included the Category Test) by replicating results of Halstead's original study (1947) in the discrimination of brain damaged subjects. He noted that the Category Test discriminates between brain-damaged and non-brain-damaged subjects almost as well as does the Impairment Index. Vega and Parsons (1967) replicated the ability of the Halstead Battery to discriminate between brain damaged and non-brain damaged persons even though their sample differed on absolute level of performance. Filskov and Goldstein (1974) also investigated the validity of the Halstead Battery and found that, when interpreted by adequately trained neuropsychologists, it produced information about the integrity of brain functions that compared favorably with other medical procedures.

<div align="center">Data Analysis</div>

The SPSS-X statistical programs (1986) (Nie, Hull, Jenkins, Steinbrenner, & Benjt, 1975) were utilized for all computations listed herein unless otherwise stated. This study meets generally accepted criteria regarding the

relationship between sample size and number of predictors. However the small number of left-handers (25) precluded them from meaningful factor, regression, and discriminant function analysis.

Hypotheses

Hypothesis 1. As seen in previously cited literature, females may utilize verbal strategies even when solving what are traditionally thought of as non-verbal problems. Consequently, these data were subjected to separate factor analyses for males and females. Among female subjects, a perceptual organization factor was expected to include verbal subtests while for males, this factor was expected to be comprised solely of more traditional non-verbal subtests. In other respects factor analyses were expected to replicate prior WAIS-R factor analytic research.

(1) To test the hypothesis of sex differences on a perceptual organization factor, the data were first examined from within an exploratory correlation matrix, (2 X 22), comprised of correlations of sex and age with CT total error scores, seven CT subtest scores, 11 WAIS subtest scores and 3 WAIS summary scores. Point biserial correlation coefficients were utilized, as sex is a dichotomous variable. It should be noted that the point biserial correlation coefficient is simply a Pearson correlation coefficient, and is calculated with the established Pearson

formulae. The obtained correlational matrix was examined to determine whether the data were appropriate on the basis of the following criteria: (1) the percentage of off-diagonal elements in the anti-image covariance matrix greater than 0.9 (Mulaik, 1972); (2) the Kaiser-Meyer-Olkin Index (Dziuban & Shirkey, 1974); and (3) Bartlett's Test of Sphericity. The number of factors to be retained from the initial solution were determined by using the scree test, the value of the squared multiple correlations, the Chi Square Goodness of Fit test, the size of the Eigenvalues of the rotated factors, and the interpretability of the factors. The method of factor analysis was the Maximum Likelihood factor extraction technique (Joreskog and Lawley, 1968) using program FACTOR of SPSS-X. It has certain advantages over several of the other extraction processes, as it is scale invariant, and statistical tests (Chi Square) can be applied to examine the appropriateness of the hypothesized number of factors (Gorsuch, 1983; Dillon & Goldstein, 1984). After computing the initial orthogonal factor matrices, solutions were rotated to simple structure according to varimax (orthogonal) and direct oblimin (oblique) criteria.

(2) An exploratory factor analysis of WAIS subtest scores across all right handed subjects was prepared, to determine if the scores fit into a stable and interpretable factorial structure. Only factors with Eigenvalues greater than one were retained for initial rotation (Tabachnick &

Fidell, 1983). Factor loadings of 0.30 and greater were retained for examination. Two types of rotations were utilized. The Varimax orthogonal rotation was utilized to produce factor loadings which were statistically comparable and which could be squared and summed to produce variance accounted for by each factor. Direct oblimin rotations, with delta value of zero, were utilized to produce the "best fit" of variables to factors (Cattell, 1952). These exploratory factor analyses were compared with other studies to investigate the extent to which factors for this study are similar to others cited in published studies (Cohen, 1957; Matarazzo, 1972; Zillmer, Fowler, Newman & Archer, 1986; Fowler, Zillmer & Newman, 1987).

(3) Another exploratory factor analysis included both WAIS subtest scores and the CT total error score for all right-handers. This was to determine where the CT total error score might load when grouped with WAIS subtests.

(4) Another factor analysis employed WAIS and CT (error) subtest scores for all right-handers, to determine how particular CT subtests would load when grouped with WAIS subtests.

(5) Finally, separate factor analyses were prepared based on subtest scores for males and females.

As noted above, tests were expected to load differently, i.e. with different weights on the same factors or on different factors, for males and females. Block Design and

Vocabulary were utilized as marker variables to identify verbal and performance factors, and patterns of factors were interpreted through visual comparison.

Hypothesis 2. In order to further examine the relationship between demographic variables of age and sex and WAIS and CT scores, regression analyses were prepared. Separate regression formulae were computed for males and females in an effort to predict total CT errors from WAIS scores and age. The possibility of interactions between these demographic variables was investigated by introducing multiplicatory factors as additional independent variables. Specifically it was hypothesized that there are significant relationships between CT total error scores (the dependent variable),and WAIS subtest and summary scores (VIQ and PIQ), and the demographic variables of sex and age. It was further expected that the formulae for predicting total CT errors from WAIS scores would differ among males and females, and that WAIS summary measures are less powerful as predictors than are WAIS subtest scores (Moses, 1985, Zillmer et al, 1986). Only right handers were utilized in the regression calculations.

(1) The exploratory correlation matrix described above was utilized to look at relationships between the demographic variables, CT total error score, and WAIS subtest and summary scores. These data was examined for evidence of multicollinearity, to determine the suitability

of stepwise regression techniques.

(2) Next, the following regressions with the noted independent variables were run with CT total error score as the dependent variable, i.e. the item to be predicted.

(a. Age and sex

(b. WAIS summary scores

(c. WAIS subtest scores and age

(3) In order to examine sex differences, the following regressions were computed:

(a. WAIS subtest scores and age for males

(b. WAIS subtest scores and age for females

The probability of F to enter or remove from regression equations were kept constant at $p<.05$ and $p<.10$ respectively. The categorical data of sex were classified as "dummy variables" ("0" and "1") in the data entry so that it was not necessary to further transform these data in order to perform regression analyses (Pedhazer, 1982).

A preliminary regression formula was extracted to determine the amount of variance accounted for by sex and age alone. Then the stepwise regressions described above were performed for all right handers, followed by formulae for the various sub-populations. Regression formulae for comparison groups (Male and Female) were compared using the multiple coefficient of determination, adjusted for the number of variables included in the regression formulae (Tabachnick & Fidell, 1983). To elaborate on this

adjustment, R is almost always overestimated. In calculating the weights to obtain a maximum R, the zero-order correlations are treated as if they were error-free. Thus when applying these weights to another sample there is shrinkage. The amount of overestimation of R is affected, among other things, by the ratio of the number of independent variables to the size of the sample; and the larger this ratio, the greater the overestimation (Pedhazur, 1982). The following formula was utilized to correct for this overestimation, and yielded an adjusted R (Dillon & Goldstein, 1984).

$$R^2 = 1 - (1-R^2) \ ((N-1) \text{divided by} \ (N-k-1))$$

Hypothesis 3. In order to determine whether age and WAIS scores could distinguish between subjects who were grouped according to CT errors, discriminant function analyses were employed using three classification groups: right handed subjects who scored low, medium, and high on CT total errors.

(1) CT error scores were divided into three groups comprised of the top 25 percent; the bottom 25 percent; and the middle 50 percent. Group cut-offs were calculated separately for males and females due to two tailed T tests showing a significant difference on error scores for these groups. Independent variables were defined as age, sex, and WAIS summary and subtest scores. Since WAIS summary and subtest scores are interrelated, it was necessary to set up

separate discriminant analyses to investigate their relative discriminant power. In addition, two analyses were prepared to assess the relative discriminant power of WAIS summary scores, and the discriminant power of all subtests plus age. Only those subtests determined through regression analyses to best predict Category Test errors were used in the final discriminant analyses. As there were three groups of CT performers, two discriminant functions were produced for each discriminant analysis.

(2) The following separate discriminant analyses were computed:

(a. All right handers, with WAIS summary scores

(b. All right handers, with WAIS subtest scores and age

(c. All right handers, with regression formula-designated WAIS subtest scores and age

(d. Males, with regression formula-designated WAIS subtest scores and age

(e. Females, with regression formula-designated WAIS subtest scores and age

A stepwise method of ordering entry of variables was utilized based on first entering the variable that minimizes the Wilks' lambda. Wilk's lambda is a multivariate measure of group differences over the discriminating variables, and, as it is an inverse measure, an increase toward its maximum value of 1.0 signifies progressively less discrimination.

This facilitates the identification of homogeneous groups that are maximally different from each other. All variables were considered for removal. Minimum tolerance criterion are 0.01, and the probability of F to enter are 0.05, the probability to remove are 0.10. Successive discriminations were evaluated for significance by Chi square tests.

Results

Preliminary Calculations

Mean scores and standard deviations of WAIS summary

scores and total Category errors are displayed in Table 2.

Insert Table 2 about here

Mean scores and standard deviations for the various

population groups on WAIS and Category subtests are

displayed in Tables 3 and 4 respectively.

Insert Tables 3 and 4 about here

All scores for all groups are above average in relation to

previously published norms for these instruments, but the

number of total errors on the Category Test is significantly

higher in this sample for females than for males, as

determined by a two-tailed T test, p<.05. Other significant

differences between males and females are scores on VIQ,

Inf, Ar,and PC, on which males in this sample scored higher,

and DSy, on which females scored higher. Bonferroni t

statistics were utilized to control for the possible

effects of multiple T tests (Miller, 1981), and significant

results were replicated using these control statistics.

Correlation coefficients for all subjects (right and left handers) are presented in Table 5, displayed in a 3 x 22 matrix. Correlations for right handed subjects only are shown in Table 6 (2 x 22 matrix).

Insert Tables 5 and 6 about here

Hypothesis 1

Factor analyses were first performed on WAIS subtest scores only. Table 7 summarizes criteria used to determine the suitability of the data for factor analyses, and to evaluate the resultant factors, their reliability, and the adequacy of the extraction techniques.

Insert Table 7 about here

Within Table 7, the number of factors listed is the number extracted when using a minimum Eigenvalue of 1.0. The Kaiser-Meyer-Olkin (KMO) Index assesses suitability of data for factor analysis, with higher numbers suggesting greater suitability, and an index above .70 is considered "meritorious" (Kaiser, 1974). Bartlett's Test of Sphericity is also an index of suitability, with an insignificant result desirable as evidence of suitability. The number of off-diagonals in the anti-image covariance matrix greater

than 0.9 is as another suitability measure, with greater
numbers of off-diagonals indicating less suitability
(Gorsuch, 1983). The Chi-Square is a measure of the
adequacy of extraction, such that if enough factors have
been extracted, Chi Square will be insignificant. The
percent of residuals also measures adequacy of extraction,
and should not exceed 50 percent (SPSS-X, 1986). Finally,
the squared multiple loadings (SMC) are criteria for
determining reliability of factors, with a higher SMC
associated with a more stable factor. Factors with SMC less
than .60 are considered to be of questionable stability and
reliability (Tabachnick & Fidell, 1983).

As can be seen, several of the factor analyses with WAIS
subtest scores-only did not meet minimum criteria for
suitability of factor analysis: the percent of off-diagonals
greater than 0.09 in the anti-image correlation matrix alone
was too high (Fowler, 1987) and the Chi Square was
significant for both the total and the female groups. Thus,
the factor analyses of WAIS subtest scores-only will not be
reported.

Regarding the factor analyses which examined both WAIS
subtest scores and the Category Test total error score,
one criterion failed to suggest suitability for factor
analysis. The percent of off-diagonals greater than
0.09 in the anti-image correlation matrix, although lower
than in the analyses of subtest scores-only, exceeds

acceptable levels (Fowler, 1987). Thus, these factor analyses will also not be reported.

There were three factor analyses which included both WAIS subtest and Category subtest scores resulting in six factors for all the subgroups, as shown in Tables 11, 12, and 13. Subgroups were all right handers, female right handers, and male right handers. Factor loadings shown in all cases are from the oblimin, oblique rotation, which optimizes the separation of factors.

Insert Tables 8, 9, and 10 about here

The correlations between factors for the various samples are reported in Tables 11, 12, and 13.

Insert Tables 11, 12, and 13 about here

For the all right handers and female right handers groups (Tables 8 and 10), there were two squared multiple loadings less than 0.60, indicating that the six factor solution may not be reliable and stable for these samples. For the all right hander group the factors explained 49.3 percent of the variance before rotation, and the oblimin rotation converged in 10 iterations. The first factor includes the verbal subtests plus PA and DSy. The second factor contains only Category subtests C5 and C6. The third factor includes the

perceptual organizational subtests, OA and BD, and also PC.
The fourth factor again contains exclusively Category
subtests C3, C7 and C4. The fifth and sixth factors each
contain only one Category subtest, C2 and C1 respectively.
According to the squared multiple loadings (SMC) the last
two factors are unreliable in any case, both being less than
0.60. Thus, for the total right-handed sample, there are
four interpretable factors, two exclusively WAIS subtests
and two exclusively Category subtests. The factor
correlation matrix presented in Table 11 reveals mild
correlations between factors, the largest being between the
factor including DS and that including the verbal WAIS
scores.

For the male only right handed sample, Table 9, there
are again six factors which, before rotation, explain 55.2
percent of the variance. The oblimin rotation of six factors
converged after 14 iterations producing factors which,
according to the SMC criteria are reliable. The first
factor includes only the WAIS subtest DS and is therefore
uninterpretable as a factor. The second factor includes the
perceptual organizational WAIS subtests BD and OA and the
Category subtest C2. It must be noted however, that C2 loads
only 0.11 on this factor, which nevertheless is its highest
loading on any factor. The third factor is comprised
exclusively of Category subtests C5 and C6, and the fourth
includes all the WAIS verbal subtests and PA and DSY. The

fifth is another exclusive Category subtest factor including C7, C3 and C4, and the sixth factor includes PC and C1, with C1's loading being only 0.16. Thus, there are again four interpretable factors for this sample, with DS and PC loading outside the parameters of the other factors. The factor correlation matrix shown in Table 12, reveals correlations within acceptable limits to justify retaining the interpretable factors. The highest correlation is between the two major WAIS factors.

The female only right handed group, Table 13, also produced six factors after 10 iterations, with the last two yielding SMC's of 0.60 and 0.59, borderline reliable. Before rotation, these factors explained 48.5 percent of the variance among the variables. The first and second factors are Category subtest factors, the first including C7 and C3 and the second containing C6 and C5. The third factor includes the WAIS verbal subtests, and the fourth the three WAIS performance subtests OA, BD and PC, and DS plus part of the AR loading. The fifth factor includes PA, C2 and part of the Com loading, and the sixth includes C4, C1, part of the BD loading, and DSy (with a loading of only 0.24). Thus it appears that there are five interpretable factors, two containing exclusively Category subtests, two containing only WAIS subtests, and one containing a mixture of both. The factor correlation matrix, Table 13, reflects moderate correlations between the two WAIS factors, but the size of

the correlation is such that it is obvious that the two factors represent different constructs.

Hypothesis 2.

The regression analysis for the total right-handed group with WAIS subtests and demographic variables was first examined to ascertain that these data satisfied the appropriate assumptions for this statistical analysis. The scatterplot of Category error score residuals against predicted scores revealed slight heteroscedasticity, suggesting that the variance of Category scores varied with the number of errors, increasing with an increase in error score. In addition, examination of the distribution of error scores revealed a moderate positive skewness, with a pileup of cases with very low error scores. Square root transformations were accomplished, and another regression run with the same population. Results of the second analysis were virtually unchanged from those garnered with non-transformed scores. Thus the non-normality of the error score distribution was acknowledged, but analysis proceeded with more interpretable non-transformed error scores.

Multicollinearity was investigated through SAS regression procedures (SAS, 1985), and the WAIS summary scores were found to be highly redundant with each other. WAIS subtests Inf, Voc and Com also exhibited moderate collinearity suggesting that collectively they tend to suppress the contribution made by each separately.

Therefore, for each sub-population, only the VIQ and PIQ summary scores were utilized in the summary regression analysis. Also a confirmatory regression analysis was performed reversing the order of entrance of these variables which replicated the formula listed below. Descriptive parameters for the regression formulae are listed in Table 14.

Insert Table 14 about here

Both R and adjusted R are listed in Table 14, as well as the change in R which occurs with the addition of each new variable into the formula. The significances of the F of the change in the formulae are reported as Sig. Ch., a measure of the significance of the contribution of the regression coefficients of each variable entering the equation. A significant F ratio of the change in R^2 resulting from the addition of another independent variable leads to the rejection of the null hypothesis that the the regression formulae before and after the addition of the new variable are not significantly different.

All the variables entered for all formulae produced a significant change in the regression formulae except for DS in the Males' formula. This added only one percent to the accounted-for variance.

The actual regression formulae are as follows:

All right handers, Age and Sex

9.538 Sex + .458 Age + 18.147 = Cat.

All right handers, Summary scores

-.559 PIQ - .486 VIQ + 153.300 = Cat.

All right handers, Subtest scores and age

-3.064 BD - 1.813 Inf + .7128 Age - 1.218 Ar +

90.740 = Cat

Right handed males, Subtest scores and age

-2.613 Inf + .932 age -1.896 BD -.882 DS + 72.883 =

Cat.

Right handed females, Subtest scores and age

-4.1172 BD -1.8666 Voc + 112.7694 = Cat.

These formulae account for the amount of variance as listed
in Table 14 under the heading "Adjusted R^2". Use of summary
scores as predictors in the Total right handed group
resulted in 10 percent less variance accounted for than use
of subtest scores, justifying the utilization of subtest
scores for the sub-population formulae.

The formula derived for males, when applied to the
females in the sample, results in a multiple R of .46
compared to .55 for males and females' CT error score is
underestimated when predicted from the male equation. When
the formula derived for females is applied to males, it
results in a multiple R of .34 compared to .53 for females,
and males' CT error score is overestimated when predicted
from the female equation.

As it seems notable that age did not enter in the female
regression formula the relative position of varibles not
entering the equation was made. A perusal of the variables
not in the regression equation for females revealed that, of
the variables left out of the regression equation, age was
the one of the least powerful. To further investigate the
effect of age on female Category total errors, a
hierarchical regression was performed, entering BD, Voc and
Age in that order. The addition of the variable Age
increased the value of R^2 .007 and produced a non-
significant Chi Square change.

Hypothesis 3

Frequency histograms of total CT errors with cumulative
percentiles were reviewed to derive appropriate cut-offs at
the 25 and 75th percentiles for the different groups. The
obtained cut-offs expressed in number of errors are as
follows:

	Top 25%	Mid 50%	Bot.25%
All right handers:	19	>19,<47	>47
Male right handers:	16	>16,<44	>44
Female right handers:	21	>21,<52	>52

These cut-offs are congruent with the results of the two
tailed T-test of significant difference comparing male and
female performance on the Category test which indicates that
females in this sample scored significantly worse on the
Category Test than did males (p=.004). 11 percent of males

scored in the impaired range compared to 25 percent of females. Group means for each of the Category groups on the WAIS subtests and age are listed in Table 15, for each group.

Insert Table 15 about here

The descriptive statistics for the discriminant function analyses are shown in Table 16 and include the Wilks' Lambda, Chi Square, with degrees of freedom and significance, and the significance of the Box's M for determining homogeneity of variance and covariance.

Insert Table 16 about here

The size of Wilk's Lambda decreases as the significance of the addition of new variables to the discriminant function increases. This is further indicated in the Chi Square statistic and its significance. A significant Chi Square signifies that the new discriminant function contributes significantly to the ability of the discriminant analysis to separate groups. Groups were tested for homogeneity of variance/covariance, and the Box's M test was used to evaluate equality of group covariance matrices: Box's M are insignificant if the matrices are statistically equal. For all population samples, groups appear to be homogeneous

regarding variance and covariance, producing non-significant Box's M.

Separate exploratory discriminant function analyses were run for all right handers utilizing the above listed cut-offs with WAIS subtest scores and age, and with WAIS summary scores as the discriminating variables. Next, discriminant function analyses were produced for the right handed total, right handed male and right handed female groups using those subtests and demographic variables which had entered into their respective regression formulae. The formulae for the various discriminant functions are as follows:

All, subtests

Func.1 -15.8886 - .03 Age + .26 Inf + .14 Sim + .24 Ar + .15 DS + .14 PC + .15 OA + .28 BD + .03 Dsy.

Func.2 -1.08 + .02 Age + .07 Inf + .13 Sim - .09 Ar -.20 PC + .11 OA + .02 BD + .11 Dsy.

All, Summary scores

Func.1 -13.65 + .09 VIQ + .03 PIQ

Func.2 -14.08 + .26 VIQ + .10 PIQ

All, Reg. variables

Func.1 -8.76 -.06 Age + .33 Inf + .29 BD + .12 Ar

Func.2 -1.82 -.06 Age - .06 Inf + .06 BD + .29 Ar

Males, Reg. variables

Func.1 -4.85 + .10 BD + .35 Inf - .05 Age + .06 DS

Func.2 -5.44 + .19 BD - .01 Inf - .01 Age + .28 DS

Females, Reg. variables

Func.1 -5.47 + .40 BD + .05 Voc

Func.2 -5.58 + .04 BD + .42 Voc

Classification tables and significance of F for

discriminating between groups are shown in Table 17.

Insert Table 17 about here

Classification results are shown as the percent of group

membership correctly predicted. It should be noted that

prior probabilities for group membership were 25, 50, and 25

percent respectively. The F statistic and significance of

difference between pairs of groups have been reported as one

measure of the discriminative power of the function.

Classification matrices were prepared for each discriminant

function analysis showing the relationship between predicted

and known case classification into the three groups. It is

recognized that the statistical techniques used to prepare

these discriminant function analyses and the resulting

prediction formulae tend to overestimate the power of the

classification functions, as the equations utilize

idiosyncratic sampling error to create classification

functions which are more accurate for this particular sample

than they would be for the full population (Klecka, 1980).

Shrinkage is considered to be a serious methodological

problem with discriminant function analysis (Fletcher, Rice,

& Ray, 1978). Shrinkage refers to the amount of the

variance accounted for by prediction variables which would be expected to shrink on cross-validation with a different sample. The effect of shrinkage is to exaggerate the strength of the predictor-criterion relationship, and it is affected by both the absolute sample size and the number of predictor variables per group. A 5:1 ratio of subjects per number of predictor variables generally inflates estimates of the variance accounted for by the discriminant function equation by about 10 percent. Considering the size of the overall sample in this study (218) and the maximum number of possible predictor variables (17), it is doubtful that shrinkage will exceed 10 percent.

The discriminant analysis for all right handers using all subtests and age utilized all but three subtests, with Com, Voc and PA not entering the equations. Considering the collinearity of Com, Voc, and Inf, this is not surprising. The resulting discriminant functions correctly classified 57.5 percent of the sample. Yet the analysis utilizing summary scores produced a hit rate of 54.9 percent with only two variables contributing to its functions. However, this analysis arrives at its hit rate by correctly placing the middle 50 percent group, and does quite poorly in discriminating Group 1, the best performers. When the variables which entered into the regression formula for all right handers entered into the discriminate function analysis, the hit rate is 54.4 percent, with minimal

improvement in classification of Group 1 membership.

For the male and female sub groups, discriminant function analyses were produced utilizing the variables which had entered their respective regression formulae. For males, the functions were able to correctly predict 53.9 percent of the groups, again predicting Group 1 membership the most inadequately. The same pattern held for the female sample where the functions also predict 53.9 percent correctly, but only four percent of Group 1.

The discriminant function analysis for females is more efficient than that for males, as there were only two variables which entered the female regression formula, BD and Voc, they were utilized for the discriminant function analysis. It appears from the magnitude of total discriminating power at 99 percent that only BD predicts group membership.

Discussion

Hypothesis 1

The first hypothesis of this study was that the combined

factor analyses of WAIS and Category Test subtests would

produce different factors or different weightings on factors

for males and females such that males would show the

traditional two factor WAIS solution of perceptual

organization and verbal comprehension and females would show

a more diffuse factor composition. Actual results suggest

that the factor composition is indeed different for males

and females, with neither group showing a clean division

into the perceptual organization (e.g. WAIS Performance

subtests) and verbal comprehension (WAIS Verbal subtests)

factors.

Block Design (BD) was utilized as a marker for

Performance subtests and Information (Inf) as a marker for

Verbal subtests. Among male subjects, only Block Design

(BD) and Object Assembly (OA), commonly thought of as

perceptual organizational variables, load together while the

other WAIS Performance subtests load either with verbal

subtests or alone, on unreliable factors. Among female

subjects, there was a more traditional Performance-Verbal

split, although Arithmetic (Ar) loaded on both factors, and Digit Span (DS) loaded on the performance factor. Combining male and female right handers obscures results and yields an altogether different and diffuse factor composition. Factors which include only one variable with a loading of 0.30 or higher, and those factors which produce a SMC of less than 0.60 were considered unreliable and unstable for the purpose of interpreting these results.

To recap the findings briefly, the factor analysis of WAIS and CT subtest scores for males produced four stable factors (factors F-2 through F-5 shown in Table 9) two of which are exclusively composed of Category subtests and two composed exclusively of WAIS subtests. Among females, the factor analysis produced five interpretable factors, two of which were exclusively Category subtests, two exclusively WAIS subtests, and one of which was a mixed array of subtests from both instruments. The results of these factor analyses show that the factor loadings of Category subtests differ for right handed males and females of above-average intelligence.

Hypothesis 2

The second hypothesis was that the regression formulae for predicting overall Category performance would differ for males and females. This was indeed the case. The male regression formula contains four variables compared to two for the female formula. Age is a more powerful predictor

for males, and BD is a more powerful predictor for females. Again, perusal of the formulae for all right handers shows that combining females and males obscures these sex differences. It is important to note that these different male and female formulae account for only 26 and 27 percent of the variance respectively, making prediction of Category performance from WAIS performance inefficient for either group. However, the hypothesis that the composition of regression formulae will be different for males and females is strongly confirmed, leading the way for further confirmation through discriminant analyses.

Hypothesis 3

The third hypothesis was that sex, age, and WAIS scores could be used to classify subjects according to their good or bad Category performance. Again, the discriminant function analyses for the combination of male and female right handers obfuscates sex differences. WAIS data is much more useful for predicting poor Category performance, especially for females. In addition, poor Category performance for females in this sample was closely related to relatively poor performance on BD, though the average BD score for females even in the poor performance group was still 10.6. Among males, poor performance is better predicted by FSIQ (as evidenced by the prime loading of Inf) and age than BD performance.

Clinical Implications of Results

The two most salient findings of this study with respect to clinical interpretation of these instruments are that: (1) the Category Test contributed unique variance in all factor analyses, and (2) Right handed males with above average intelligence performed better on the Category Test than did their female counterparts.

With respect to unique Category Test variance, these results corroborate earlier research regarding the unique and separate contributions of the Category Test and the WAIS to a neuropsychological test battery, and extend these findings to samples of high functioning right handed subjects. Moses (1985a, 1985b) reached the same conclusions based on a study of a large sample of psychiatric patients, control subjects, and brain impaired subjects.

Regarding male female differences, these findings do not necessarily suggest spatial superiority for either sex. The differences in the patterns of performance are much more striking than are differences in levels of performance. However, in this high functioning population, data do not replicate results of recent studies (Heaton, Grant, & Matthews, 1986; Gordon & O'Dell, 1983) which found no sex effects on Category Test performance. The differences in patterns of performance found in this study suggest that, at least for high functioning subjects, the Category Test measures different constructs in males and females. The

unique loading of the Category Test with BD females and their less accurate performance on the Category Test might suggest male superiority for spatial ability (Harris, 1979). However, Category Test performance correlated more strongly with Inf than BD in the male sample, suggesting that for males, this instrument might tap abstract reasoning and well learned abilities rather than spatial reasoning.

Prior research has produced varied results. Lansdell and Donnelly (1977) and Wiens and Matarazzo (1977) found CT loading highest on a performance factor that included BD. Fowler, Zillmer, and Newman (1987) found the largest correlation between PIQ and Category Test errors, in a large psychiatric sample of below average intelligence. However Shore, Shore and Pihl (1971) and Pendleton and Heaton (1982) found the highest correlation between FSIQ and CT total errors. Perhaps at least some of these discrepancies might be explained by the failure to control for sex and level of performance in most of the studies. For example, Logue and Allen (1971) noted that at the high end of the IQ range WAIS FSIQ scores were poor predictors of CT errors.

Based on findings in this study, for females the Category Test is closely related to BD and seems more a spatial, non-verbal problem solving task. For males, it is most closely related to overall level of intellectual performance and to age (worsening at older ages). Other studies have found that Category Test performance declines

with age (Heaton, Grant, & Matthews, 1986; Fromm-Auch & Yeudal, 1983; Bigler, Steinman, & Newton, 1981), have used older samples than this one and have not addressed sex differences.

It is unclear how these results fit into the current controversy over sex related brain asymmetries. The question of difference in strategy versus difference in cerebral organization cannot be finally resolved through a study focusing on test results (Bryden, 1979). Also, the interaction of handedness with sex differences could not be explored due to the paucity of left-handers in the sample. The recent spate of studies of sex differences in cognitive functioning of persons with unilateral brain lesions are not helpful in interpreting this data, and indeed highlight the need for normative data.

A major question remains regarding the meaning of scores on the Category Test for persons who are of above average intelligence. Almost one fourth of the "normal" women in this study scored in the impaired range on the Category Test, despite an average FSIQ of 108. Thus, in interpreting Category Test performance, one runs a risk of including false positive identifications, perhaps particularly for women. The Category Test appears to measure logical analysis, abstract reasoning, and new concept formation (Reitan, 1974; Heaton & Pendleton, 1981). Yet, this series of factor analyses suggests that this test may measure

different constructs for men and women.

This study generates many new questions. There appear to be clear differences in the pattern of performance of WAIS and Category Test subtests in males and females of above average intelligence, and these differences are differentially affected by age. It remains to be seen whether these differences transfer to a sample with a less constricted intellectual base, are related to handedness,and if the differences are related in any way to the diabetic nature of the sample.

Limitations of the Study

First, the sample utilized here is diabetic and it is possible that the patterns of performance found here are a result of a subtle disease process found exclusively in persons with diabetes mellitus. Based on the level of IQ scores and the normal performance on a series of widely divergent neuropsychological measures, this is not thought to be likely. Ryan, Vega, Longstreet, and Drash (1984) found slowed performance on a task of visual information processing with a motor component in diabetics, but performance by this sample on the subtest analogous to this type of task, Digit Symbol, is above average.

Second, this sample is of above average intelligence, and the standard deviations of subtests is smaller than that found in the general population. Based on studies by Harshman, Hampson and Berenbaum (1983), patterns of

performance might well be different depending on levels of intellectual functioning, and further research with samples of differing levels of performance are necessary to address this question. Hiscock (1986) also discusses striking sex differences at extreme upper portions of the score distribution of some tests. Actually, the findings are more powerful when one considers the constricted range and standard deviations of scores in the sample studied.

Differences between males and females on WAIS measures are for the most part insignificant, and even when statistically significant, are clinically trivial. However, Heaton, Grant, and Matthew's (1986) findings of female superiority in DSy are replicated. It is important to note that examination and comparison of discrete scores does not address the possibility of differences in patterns of performance, the focus of this study.

Directions for Future Research

There is an abundance of existing research dealing with performance on the WAIS and the Category Test. In many cases, it would be possible to reanalyze the data to determine if the differences in patterns of performance found in this study are replicated in more heterogeneous population samples. The question of sex differences, no matter how politicized, will not disappear, and future research should endeavor to take note of the sex composition of samples, and report results based on sex when possible.

More representative normative data are needed to provide
answers to questions regarding the impact of demographic
variables such as sex and age on test performance.

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Table 1

Demographic Information

Subject Variables	Number	Percent	Mean Age (SD)	Mean Ed. (SD)
Sex				
Male	109	50	26.6	14.6
			(6.8)	(2.1)
Female	109	50	26.4	14.3
			(6.6)	(2.1)
Handedness				
Right	193	88.5	26.8	14.4
			(6.5)	(2.1)
Left	25	11.5	25.0	14.4
			(7.5)	(2.1)
Total	218		26.6	14.4
			(6.6)	(2.1)

Table 2

WAIS and Category Test Scores

| Mean scores | | WAIS | | CATEGORY |
| Subject | Mean VIQ | Mean PIQ | Mean FSIQ | Mean ERRORS |
Variables	(SD)	(SD)	(SD)	(SD)
Sex				
Males	114.7	113.3	115.0	31.2
	(10.7)	(9.1)	(9.4)	(19.6)
Females	110.7	113.4	112.6	39.5
	(10.4)	(11.2)	(10.1)	(24.6)
Handedness				
Left	117.0	113.0	116.1	34.4
	(8.6)	(9.5)	(8.0)	(21.1)
Right	112.1	113.4	113.5	35.5
	(10.9)	(10.3)	(10.0)	(22.8)
Total	112.7	113.4	113.8	35.4
	(10.7)	(10.2)	(9.9)	(22.5)

Table 3

WAIS Subtest Scores

		WAIS Subtest Scores										
Subject Variables		INF	VOC	COM	SIM	AR	DS	PC	PA	OA	BD	DSY

Sex

		INF	VOC	COM	SIM	AR	DS	PC	PA	OA	BD	DSY
Males	$\bar{x}$	12.3	12.2	12.6	12.8	12.6	12.3	11.8	11.3	12.0	13.1	12.2
	SD	2.2	2.0	2.3	2.4	2.9	3.2	1.8	2.4	2.8	2.3	2.3
Females	$\bar{x}$	11.2	12.1	12.0	12.2	11.4	11.8	10.8	11.0	11.8	12.3	14.2
	SD	2.5	2.5	2.7	2.1	2.2	2.7	1.9	2.4	3.0	2.7	2.5

Handedness

		INF	VOC	COM	SIM	AR	DS	PC	PA	OA	BD	DSY
Left	$\bar{x}$	12.3	12.6	13.1	13.1	13.1	13.0	11.6	11.2	11.4	13.2	12.6
	SD	1.9	1.8	2.6	1.8	2.4	3.4	2.0	2.0	2.5	2.3	2.6
Right	$\bar{x}$	11.7	12.1	12.2	12.4	11.8	11.9	11.3	11.1	12.0	12.6	13.3
	SD	2.5	2.3	2.5	2.3	2.7	2.9	1.9	2.4	2.9	2.5	2.6

		INF	VOC	COM	SIM	AR	DS	PC	PA	OA	BD	DSY
Total	$\bar{x}$	11.8	12.1	12.3	12.5	12.0	12.1	11.3	11.1	11.9	12.7	13.2
	SD	2.4	2.3	2.5	2.3	2.7	3.0	1.9	2.4	2.9	2.5	2.6

Table 4

<u>Category Subtest Scores</u>

		CATEGORY Subtest Scores						
Subject Variables		C1	C2	C3	C4	C5	C6	C7
Sex								
Males	$\bar{x}$	0.0	0.2	11.7	4.1	8.8	3.8	2.7
	SD	0.1	1.2	10.6	5.9	5.2	4.1	2.3
Females	$\bar{x}$	0.0	0.1	15.3	6.0	10.1	5.0	2.9
	SD	0.3	0.3	11.8	8.7	5.8	5.0	2.1
Handedness								
Left	$\bar{x}$	0.0	0.1	13.4	6.2	8.4	3.8	2.4
	SD	0.0	0.3	11.4	7.8	6.2	5.3	1.9
Right	$\bar{x}$	0.0	0.2	13.5	4.9	9.6	4.4	2.8
	SD	0.2	0.9	11.4	7.4	5.5	4.5	2.2
Total	$\bar{x}$	0.0	0.2	13.5	5.0	9.5	4.4	2.8
	SD	0.2	0.9	11.4	7.5	5.6	4.6	2.2

Table 5

WAIS/Category Test Scores and Sex/Age/Handedness Correlations for All
Subjects

Subject				Test Scores							
	VIQ	PIQ	FSIQ	Inf	Voc	Com	Sim	Ar	DS	PC	PA
Variables											
Sex	-.19	.01	-.12	-.23	-.03	-.11	-.14	-.24	-.09	-.28	-.05
Age	.18	.17	.20	.23	.06	.12	.19	.08	-.01	.17	.23
Hand	.15	-.01	.09	.08	.07	.11	.09	.15	.12	.06	.00

	OA	BD	DSY	C1	C2	C3	C4	C5	C6	C7	Cat
Sex	-.05	-.15	.39	.07	-.08	.16	.13	.12	.13	.06	.18
cAge	.12	.04	.08	.06	-.04	.08	.12	.03	.07	.22	.12
Hand	-.07	.07	-.08	-.06	-.01	-.00	.06	-.07	-.04	-.06	-.01

Correlations >.14 significant at p<.05
Correlations >.18 significant at p<.01

Table 6

WAIS/Category Scores and Sex/Age Correlations for Right
Handed Subjects

Subject	Test Scores										
	VIQ	PIQ	FSIQ	Inf	Voc	Com	Sim	Ar	DS	PC	PA
Variables											
Sex	-.17	-.02	-.12	-.23	-.04	-.08	-.10	-.22	-.06	-.28	-.07
Age	.21	.20	.23	.24	.07	.12	.24	.10	.03	.18	.24

	OA	BD	DSY	C1	C2	C3	C4	C5	C6	C7	Cat
Sex	-.07	-.15	.37	.06	-.08	.17	.14	.13	.19	.05	.20
Age	.16	.06	.08	.06	-.03	.11	.09	.02	.06	.24	.12

Correlations>.14 significant at p<.05
Correlations>.18 significant at p<.01

Table 7

Factor Analyses Suitability Criteria and Criteria for Evaluating
Factor Stability for Right Handed Subjects

	# factors	K-M-O	Bartlett	% off-diag >.09	ChiSq	% Res <.05	SMC's <0.6
Factor analyses with WAIS subtests only							
Total	2	.84	.00	27%	.005	32	0
Males	3	.80	.00	29%	.828	16	0
Females	2	.81	.00	42%	.043	38	0
Factor analyses with WAIS subtests and Category Total Error Score							
Total	3	.85	.00	24%	.208	21	0
Males	3	.81	.00	29%	.703	21	0
Females	2	.82	.00	33%	.086	37	0
Factor analyses with WAIS subtests and Category Subtests							
Total	6	.82	.00	16%	.802	5	2
Males	6	.74	.00	20%	.940	9	0
Females	6	.80	.00	18%	.862	13	2

Table 8

Results of Factor Analysis with WAIS Subtests and Category Subtests for Right Handed Subjects

			FACTORS			
Tests	F-1	F-2	F-3	F-4	F-5	F-6
Voc	.98					
Inf	.78					
Com	.58					
Ar	.53					
Sim	.43					
DS	.35					
PA	.31					
DSY	.24*					
C5		.90				
C6		.77				
OA			.89			
BD			.55			
PC			.41			.30
C3				-.85		
C7				-.72		
C4				-.40		
C2					.26*	
C1						.34
SMC	.90	.86	.83	.82	.58	.49

* <.30, but highest loading on any factor for this variable

Table 9

Results of Factor Analysis with WAIS subtests and Category subtests
for Right Handed Males

		FACTORS				
Tests	F-1	F-2	F-3	F-4	F-5	F-6
DS	.93					
BD		-.99				
OA		-.41				
C2		.11*				
C6			.89			
C5			.79			
Voc				.90		
Inf				.83		
Ar				.56		
Com				.56		
Sim				.49		
PA				.40		
Dsy				.28*		
C7					.87	
C3					.83	
C4					.53	
PC						.77
C1						.16*
SMC	.99	.99	.87	.90	.87	.73

* <.30 but highest loading on any factor for this variable

Table 10

Results of Factor Analysis with WAIS subtests and Category subtests
for Right Handed Females

| | FACTORS | | | | | |
Tests	F-1	F-2	F-3	F-4	F-5	F-6
C7	.90					
C3	.56					
C6		-.99				
C5		-.70				
Voc			.83			
Inf			.79			
Com			.70		.37	
Ar			.34	.33		
Sim			.31			
OA				.77		
PC				.53		
BD				.48		.32
DS				.32		
C2					-.34	
PA					.34	
C4						.49
C1						.46
DSY						-.24*
SMC	.98	.98	.88	.79	.60	.59

* <.30 but highest loading on any factor for this variable

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Table 11

Factor Correlation Matrix, Factor Analysis with WAIS subtests and
Category subtests for Right Handed Subjects

			FACTORS			
Factors	F-1	F-2	F-3	F-4	F-5	F-6
F-1	1.00					
F-2	-.07	1.00				
F-3	-.08	.04	1.00			
F-4	.35	-.33	-.07	1.00		
F-5	-.16	-.04	.30	-.21	1.00	
F-6	.13	-.20	-.06	.17	-.09	1.00

Table 12

Factor Correlation Matrix, Factor Analysis with WAIS subtests and
Category subtests for Right Handed Males

	FACTORS					
Factors	F-1	F-2	F-3	F-4	F-5	F-6
F-1	1.00					
F-2	-.24	1.00				
F-3	.40	-.23	1.00			
F-4	.27	-.33	.28	1.00		
F-5	.31	-.03	.16	.03	1.00	
F-6	-.09	.20	-.02	-.05	—.13	1.00

Table 13

Factor Correlation Matrix, Factor Analysis with WAIS subtests and
Category subtests for Right Handed Females

| Factors | FACTORS | | | | | |
	F-1	F-2	F-3	F-4	F-5	F-6
F-1	1.00					
F-2	-.37	1.00				
F-3	-.15	.29	1.00			
F-4	-.22	.29	.48	1.00		
F-5	-.01	.11	.26	.20	1.00	
F-6	.17	-.33	-.17	-.20	-.10	1.00

Table 14

Descriptive Data for Regression Formulae for Right Handed Subjects

Group	Step #	IV	R^2	ADJ.R^2	RCh.	Sig. Ch.
Total	1	Sex	.04	.04	.04	.00
	2	Age	.06	.05	.02	.06
Total	1	PIQ	.15	.14	.15	.00
	2	VIQ	.19	.18	.04	.00
Total	1	BD	.19	.19	.19	.00
	2	Inf	.23	.22	.04	.00
	3	Age	.27	.26	.04	.00
	4	Ar	.29	.27	.02	.05
Male	1	Inf	.15	.14	.14	.00
	2	Age	.23	.22	.08	.00
	3	BD	.28	.26	.05	.01
	4	DS	.30	.27	.02	.14
Female	1	BD	.25	.24	.24	.00
	2	Voc	.28	.26	.03	.04

Table 15

WAIS Means and Age Means for Right Handed Subjects Grouped by
Category Performance

	Group1 (Hi)	Group2	Group3 (Lo)
All Cut-off	<19 errors		>47 errors
VIQ	116.0	113.6	106.1
PIQ	116.2	115.0	108.1
Age	25.6	26.7	28.1
Inf	12.3	12.1	10.4
BD	13.5	13.0	11.3
Ar	12.9	12.0	10.5
Males Cut-off	<16 errors		>44 errors
BD	13.8	13.1	12.3
Inf	13.2	12.6	10.9
Age	25.7	26.8	29.1
DS	13.7	12.1	10.7
Females Cut-off	<21 errors		>52 errors
BD	13.3	12.7	10.6
Voc	12.8	12.2	10.9

Table 16

Discriminant Function Descriptive Statistics for Right Handed Subjects

Group	Wilk's Lambda	Ch Sq.	D.F.	Sig.	Box's M sig.
All, WAIS subtests					.28
Func. 1	.697	66.38	18	.00	
Func. 2	.926	14.08	8	.08	
All, WAIS summary scores					.64
Func. 1	.856	29.52	4	.00	
Func. 2	.998	.31	1	.58	
All, Regression loadings					.67
Func. 1	.765	50.46	8	.00	
Func. 2	.990	1.89	3	.60	
Males, Regression loadings					.13
Func. 1	.739	26.14	8	.00	
Func. 2	.979	1.77	3	.62	
Females, Regression loadings					.36
Func. 1	.813	20.31	4	.00	
Func.2	.997	.21	1	.64	

Table 17

Discriminant Function F Statistics and Classification Results
for Right Handed Subjects Grouped by Category Performance

Group	Predicted %			Overall Hit Rate	Sig. F	
	1	2	3		2	3
All, WAIS subtests				57.5		
Group1 (Hi)	45.7				.02	.00
Group2		61.1				.00
Group3 (Lo)			61.5			
All, WAIS summary scores				54.9		
Group1 (Hi)	4.3				.43	.00
Group2		76.8				.00
Group3 (Lo)			59.6			
All, Regression Loadings				54.4		
Group1 (Hi)	8.7				.23	.00
Group2		72.6				.00
Group3 (Lo)			61.5			
Males, Regression Loadings				53.9		
Group1 (Hi)	15.0				.23	.00
Group2		77.6				.00
Group3 (Lo)			36.4			
Females, Regression Loadings				53.9		
Group1 (Hi)	4.3				.47	.00
Group2		76.9				.00
Group3 (Lo)			51.9			

Appendix A

Exclusionary Criteria for Subjects

Each subject has less retinopathy than would characterize either eye as P2 or worse based on grading of stereo fundus photographs, and exhibits visual acuity of 45 letters (20/32 Snellen equivalent) or better in both eyes. Subjects have less than or equal to 200 mg. albumin/24 hour on a four-hour timed urine collection.

The following exclusionary criteria were utilized in subject determination.

1. previous treatment for Diabetes with either three or more daily injections of insulin or with an insulin infusion pump

2. three or more documented episodes of diabetic ketoacidosis requiring hospitalization during the 12 preceding months

3. insulin resistance

4. pregnancy

5. hypertension: treatment during prior two years; sitting blood pressure greater than 140 systolic or 90 diastolic.

6. history of treatment for hyperlipidemia; serum cholesterol greater than three standard deviations above

mean for sex and age

7. renal disorders: active urinary tract infection;
several exclusions based on evaluation of urinary sediment

8. history of substance abuse or dependence during five
years prior. (exact criteria)

9. any non-diabetic condition that potentially limits
life expectancy or will interfere with participation

10. residence so far from clinic that it presents likely
impediment to complete followup

11. any form of hemoglobinopathy or hemolytic process
which interferes with reliable assessment of diabetic
control (e.g. sickle trait)

12. diabetic neuropathy

13. previous or current endocrine disorder other than
diabetes, corrected primary hypothyroidism or functional
menstrual disorders

14. obesity, body weight greater than 130% of ideal body
weight (table included)

15. chronic disease requiring prescription medication
for more than four months of past 12 months

16. major electrocardiographic abnormalities or clinical
history of ischemic heart disease or symptomatic peripheral
vascular disease: angina, myocardial infarction, congestive
heart failure, gangrene, loss of both pedal pulses in same
foot and/or loss of either groin pulse; myocardial
infarction, EKG suggestive of heart disease or heart block

17. epilepsy or seizures (not caused by hypoglycemia) requiring medication during past five years

18. psychological and behavioral criteria. Psychotic, neurotic, or personality disorders and conditions which will interfere with ability to maintain complete followup. Recent pattern of behavior that indicates high likelihood of non-compliance

19. clinical characteristics of IDDM but with either basal or stimulated Peptide response greater than .2 pmol/ml.

20. siblings, parents, children or spouses of patients included (staff members also excluded)

21. current participation in another clinical trial or any study which may interfere with participation.

22. any condition or use of any medication which will interfere with application of treatment

23. history or demonstrated failure to maintain normal growth and development for previous two years for any reason (criteria included)

24. hypoglycemia. More than 2 seizures not clearly related to inappropriate therapy during previous 5 years. History of recurrent episodes resulting in cerebral impairment (coma, severe confusion, seizure) before development of warning symptoms of hypoglycemia

25. presence of significant chorioretinal scars, etc.

26. aphasia in one or both eyes or prior ocular surgery

27. intraocular pressure greater than or equal to 23 mm of mercury in one or both eyes or glaucoma requiring medication

28. rubeosis iridis in one or both eye

29. myopia of greater than 7 diopters in one or both eyes

30. chronic requirement for any ocular medication

31. inability to obtain adequate quality stereo fundus photographs

32. prior photocoagulation

INFORMED CONSENT FORM #1 (PROTOTYPE)

Diabetes·Control and Complications Trial (DCCT)

Institution: _____

Principal Investigator: _____

1.   I have   been told that I may   be eligible for
participation in the Diabetes Control and Complications
Trial (DCCT).

2.   I have been given   copies of the DCCT Research
Volunteer's Information Handbook and the Manual of Diabetes
Tests, Terms and Special Procedures.   I have read both of
these, I have had my questions answered, and I now clearly
understand the following:

     a)   The purpose of the study.   (Research Volunteer's
Information Handbook, pages 4-6)

     b)   The nature of a clinical trial.   (Research
Volunteer's Information Handbook, page 5)

     c)   The two groups to be   studied -- the Standard Group
          and the Experimental Group -- and the fact that
          there is no proven advantage to being placed in one
          group or the other.   (Research   Volunteer's

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Information Handbook, pages 5 and 8)

d) The fact that I shall be assigned to one of these two groups based on a process called random assignment, which means that neither my doctor nor I can choose to which group I will be assigned. Instead, I will be assigned by chance. I am willing to accept an assignment to either of the two treatment groups. (Research Volunteer's Information Handbook, page 5)

e) That blood tests and urine tests (including tests I will perform at home) will be used to measure diabetes control. (Research Volunteer's Information Handbook, pages 8-9; Manual of Diabetes Tests, Terms and Special Procedures, page 12)

f) That special tests of my eyes, kidneys, nervous system, heart, blood vessels, and psychological tests will be conducted to look for the appearance or progress of early diabetes complications. (Research Volunteer's Information Handbook, page 10; Manual of Diabetes Tests, Terms and Special Procedures, pages 4-8)

I have been given a complete description of these special tests in the Manual of Diabetes Tests, Terms and Special Procedures. I understand that if I am eligible to volunteer for this

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clinical trial, I shall be given a thorough explanation in writing of any tests not covered below before I am asked to sign a second permission form for those tests.

g) The responsibilities I agree to carry out if I decide to be a volunteer for the clinical trial involve my. willingness to follow the treatment program of the group to which I have been assigned and to keep my appointments as scheduled. I understand that some of these appointments will take considerable time. (Research Volunteer's Information Handbook, pages 12-13)

I also understand that my responsibilities will include blood tests and urine tests I will do at my home. One of the required blood tests is a 3:00 a.m. sample. I will also keep records of my test results and treatment program, even though this may be time consuming. (Research Volunteer's Information Handbook, pages 8-9; Manual of Diabetes Tests, Terms and Special Procedures, page 12)

3. I have had a chance at this time to ask all questions which I feel are necessary. I now feel I have enough understanding to allow me to make a preliminary decision about my participation in this clinical trial.

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4. Understanding the above, and having been made aware of the potential risks and benefits of the overall program (Research Volunteer's Information Handbook, pages 14-15; Manual of Diabetes Tests, Terms and Special Procedures, pages 4-12), I give you my permission to conduct the tests and procedures necessary to see whether I will qualify as a volunteer for the DCCT. I do this because I am willing to volunteer for participation in the DCCT if I do qualify.

I understand that if any of the test results show that I am not eligible to be in the trial, the rest of the tests will not be done. If this happens, I will be informed of the reasons why I will not be eligible to participate in the trial. I understand some test results may make me ineligible, even though they have nothing to do with the state of my health.

5. I specifically give my permission at this time for the following:

a) A complete medical history and physical examination. I understand that there is no risk involved in this thorough examination, and that there may be some benefit to me in terms of my being more aware of my exact health.

b) Collection of urine samples at different times; these samples will be used for various tests.

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There is no risk involved in this procedure. One test involves four hour timed urine collection during a visit to the center.

c) The collection of approximately two ounces of my blood from a vein in my arm, a procedure which will be carried out by a skilled technician. This blood sample will be used for various laboratory tests. I understand that there is a very small risk of a black and blue mark when this procedure is done. One blood sample will be taken after I drink four ounces of a commonly used formula which is not pleasant tasting. This drink may make me sick to my stomach. (For women: I understand that one of the tests which will be performed on a blood or urine sample will tell me whether or not I am pregnant.)

d) A thorough eye examination by an eye specialist using standard techniques. This will include a test of my vision and a measurement of the pressure in my eyes. To carry out these tests, drops will be put in my eyes to make them dilate; I understand some people find this uncomfortable. I know that I will not be able to drive, or read clearly, for a few hours after this test.

Photographs will be taken of my eyes.

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Additional photographs of my eyes will be taken after a dye called fluorescein has been injected into a vein in my arm. I understand that both these techniques are used in standard clinical practice, but there may be some discomfort associated with each. With fluorescein I understand that it is also possible that I shall experience some nausea. I have also been told that on rare occasions some people have a very serious allergic reaction to this dye. I understand that trained personnel will be available when I take the test to lessen the possibility of any such reaction, or to treat it should it occur.

e) I agree to undergo evaluation of my nervous system. This evaluation will consist of a thorough physical examination in which my strength, reflexes and sensations will be tested. Then I will undergo a nervous system evaluation (nerve conduction test) to evaluate certain nerve functions. Some people feel a slight pain during this test. In other people, the test produces a temporary numb feeling.

f) I understand that a standard electrocardiogram will be done. There is no risk or discomfort involved in this test.

g) I agree to take several psychological tests. I

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recognize that this testing is being performed to determine if it is in my best interest to be included in the trial. The tests are designed to be sure I have no problems which could interfere with my participation in the trial. The tests will include:

1) Questionnaires: Several paper and pencil tests will be given to me to complete.

2) A formal interview with a member of the health care team.

I agree to participate in other meetings, which will include my family or a person I live with, in which the various procedures involved in this clinical trial will be discussed.

A few people find some of the questions embarrassing. I understand that I may refuse to answer such a question.

I understand that all information obtained during these interviews will be confidential. The results will be given to my doctu. only if the results will have an effect on my participation in the study. No information will be released to anyone else without my specific consent.

6. I also agree to carry out to the best of my abilities

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several tasks, some at home, as part of this program to see
if I qualify to be a participant in the DCCT. These
include:

a) Keeping records about my current treatment program
for two weeks.

b) Meeting with members of the health care team to
review my program.

c) Collecting blood samples at home. (A 3:00 a.m.
self blood glucose monitoring sample will be
required during this two-week period.)

7) I understand that I will be given a questionnaire to
test my understanding of the objectives and nature of the
DCCT. I understand that I must answer 100% of these
questions correctly before I will be considered qualified to
be a participant in the DCCT. If I give the wrong answer to
any of the questions, I understand that I must come back
another day to retake the questionnaire. If I feel that I
would benefit from viewing the orientation slide show or by
re-reading the Research Volunteer's Handbook, I may do so.
If I have any questions regarding my incorrect answers, I
would be able to discuss them with a member of the team
before taking the questionnaire again.

8) I understand that during the period of this study (if I
am accepted as a volunteer), my doctor at the center will be

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made aware of all information that may affect my personal care. However, I also understand that my doctor may not be aware of possible beneficial or detrimental results from my involvement in the study, until it is determined by an independent group of experts that these data are conclusive and meaningful. The results of some tests may not be made known to my physician or to me unless a change in my treatment is needed. (Research Volunteer's Information Handbook, pages 5 and 11)

9) I understand that the choice I have is to volunteer to participate in the DCCT and have the DCCT health care team take care of me or to continue in my present program for ·diabetes management with my current doctor.

10) I understand that I may choose not to participate in the DCCT, or that I may change my mind at any time concerning participation, without placing in jeopardy my continuing medical care.

11) I understand that the information concerning my diabetes will be combined with that of many other volunteers, and that I will not be personally identified in any publications or public documents which result from this study.

12) Neither this institution nor the government agency

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funding this research project will automatically provide special services, free care, or compensation for any injuries or adverse reactions resulting from this research. Treatment for such injuries or adverse reactions will be provided under the same financial arranagement as those under which treatment is usually provided.

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If I believe that I may have suffered any injury or adverse reaction as a result of participating in this research, or have questions about my rights as a research subject, I may contact Dr. _____ (_____) or the Associate Vice President of this medical center (_____). They can review the matter with me, identify other resources that may be available to me, and provide me with further information as to how to proceed.

Signature _____

Date _____

Witness _____

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DCCT Form 031.2

(IN THE CASE OF A VOLUNTEER UNDER 18 YEARS OF AGE)

We, as parents or legal guardians of _____, have read and understand this material, have had our questions answered, and give our permission for our child to participate in this clinical trial. (Both parents should sign, if available.)

Signature _____

Date _____

Witness _____

Signature of
Principal Investigator _____

Date _____

Witness _____

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DCCT Form 032.1
August 11, 1983

INFORMED CONSENT FORM #2 (PROTOTYPE)

Diabetes Control and Complications Trial (DCCT)

Institution: _____

Principal Investigator: _____

1.   I have been told that I am eligible to participate in the Diabetes Control and Complications Trial (DCCT).

2.   I have been given copies of the DCCT Research Volunteer's Information Handbook and the Manual of Diabetes Tests, Terms and Special Procedures.   I have read both of these, I have had my questions answered, and I now clearly understand the following:

    a)   The purpose of the study.   (Research Volunteer's Information Handbook, pages 4-6)

    b)   The nature of a clinical trial.   (Research Volunteer's Information Handbook, page 5)

    c)   The two groups to be studied — the Standard Group and the Experimental Group — and the fact that there is no proven advantage to being placed in one group or the other.   (Research Volunteer's Information Handbook, pages 5 and 8)

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d) The possible risks and benefits of being assigned to the Standard Group or the Experimental Group. (Research Volunteer's Information Handbook, pages 14-15; Manual of Diabetes Tests, Terms and Special Procedures, pages 4-12)

e) The fact that I shall be assigned to one of these two groups based on a process called random assignment, which means that neither my doctor nor I can choose to which group I will be assigned. Instead, I will be assigned by chance. I am willing to accept an assignment to either of the two treatment groups. (Research Volunteer's Information Handbook, page 5)

f) That blood tests and urine tests (including tests I will perform at home) will be used to measure diabetes control. (Research Volunteer's Information Handbook, pages 8-9; Manual of Diabetes Tests, Terms and Special Procedures, page 12)

g) That special tests of my eyes, kidneys, nervous system, heart, blood vessels, and psychological tests will be conducted during the trial to look for the appearance or progress of early diabetes complications. I have been given a complete description of these special tests in the Manual of Diabetes Tests, Terms and Special Procedures.

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(Research Volunteer's Information Handbook, page 10; Manual of Diabetes, Tests, Terms and Special Procedures, pages 4-8)

h) That I am agreeing to participate in a clinical trial that may last for ten years. I understand the extent of the responsibilities I agree to carry out if I agree to be a volunteer for the clinical trial. These involve my willingness to follow the treatment program of the group to which I have been assigned and to keep my appointments as scheduled. I understand that some of these appointments will take considerable time. (Research Volunteer's Information Handbook, pages 12-13)

I also understand that my responsibilities will include blood tests and urine tests I will do at my home. One of the required blood tests is a 3:00 a.m. sample once a week. I will also keep records of my test results and treatment program, even though this may be time consuming.

3. I have had a chance at this time to ask all questions which I feel are necessary. I now feel I have enough understanding to allow me to decide to participate in this clinical trial.

4. Understanding the above, and having been made aware of

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DCCT Form 032.1

the potential risks and benefits of the overall program, I give you my permission to conduct the tests and procedures listed below during the clinical trial. I further understand that if any new tests are required, I shall be given a thorough explanation in writing before I am asked to sign another permission form covering these new tests.

5. I specifically give my permission at this time for the following tests and examinations:

a) A complete medical history and physical examination. I understand that there is no risk involved in this thorough examination, and that there may be some benefit to me in terms of my being more aware of my exact health. This examination will be done once a year.

b) Collection of urine samples once a year; these samples will be used for various tests. There is no risk involved in this procedure. One test involves a four hour timed urine collection during a visit to the Center once a year.

c) The collection of blood from a vein in my arm, a procedure which will be carried out by a skilled technician. These blood samples will be used for various laboratory tests. I understand that there is a very small risk of a black and blue mark when

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this procedure is done. These blood tests which will require about one tablespoon of blood will be done routinely at three-month intervals in the Standard Treatment Group and monthly in the Experimental Treatment Group. At the annual clinic visit, an additional two tablespoons of blood will be taken. (For women: I understand that one of the tests which will be performed on a blood or urine sample will tell me whether or not I am pregnant.)

d) A complete and thorough eye examination by an eye specialist using standard techniques. This will include a test of my vision every year and a measurement of the pressure in my eyes every year. To carry out these tests, drops will be put in my eyes to make them dilate; I understand some people find this uncomfortable. I know that I will not be able to drive, or read clearly, for a few hours after this test.

Photographs will be taken of my eyes after three months, six months, and then every six months. A set of additional photographs of my eyes may be taken in a few years and for this a dye called fluorescein will be injected into a vein in my arm. I understand that both these techniques are used in

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DCCT Form 032.1

standard clinical practice, but there may be some discomfort associated with each. With fluorescein I understand that it is also possible that I shall experience some nausea. I have also been told that on rare occasions some people have a very serious allergic reaction to this dye. I understand that trained personnel will be available when I take the test to lessen the possibility of any such reaction, or to treat it should it occur.

e) I agree to undergo evaluation of my nervous system every year. This evaluation will consist of a thorough physical examination in which my strength, reflexes and sensations will be tested. Then I will undergo a nervous system evaluation (nerve conduction test) to evaluate certain nerve functions. Some people feel a slight pain during this test. In other people, the test produces a temporary numb feeling.

f) I understand that a standard electrocardiogram will be done. There is no risk or discomfort involved in this test. The electrocardiogram will be done every two years.

g) I agree to take several psychological tests. The tests will include:

1) Questionnaires: Several paper and pencil tests

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will be given to me to complete every six months.

2) A series of tests (neurobehavioral assessment) of my intelligence, memory, problem-solving ability, motor coordination and attention will be performed at the beginning of the trial and every year thereafter.

A few people find some of these questions embarrassing. I understand that I may refuse to answer such questions.

I understand that all information obtained during these interviews and tests will be confidential. The results will be given to my doctor only if the results will have an effect on my personal care. No information will be released to anyone else without my specific consent.

6) I understand that during the period of this study my doctor at the center will be made aware of all information that may affect my personal care. However, I also understand that my doctor may not be aware of possible beneficial or detrimental results from my involvement in the study until it is determined by an independent group of experts that these data are conclusive and meaningful. The results of some tests may not be made known to my physician

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or to me unless a change in my treatment is needed.
(Research Volunteer's Information Handbook, pages 5 and 11)

7)   I understand that the choice I have is to volunteer to participate in the DCCT and have the DCCT health care team take care of me or to continue in my present program for diabetes management with my current doctor.

8)   I understand that I may choose not to participate in the DCCT, or that I may change my mind at any time concerning participation, without in any way placing in jeopardy my continuing medical care or incurring any danger or health risk provided I continue on an appropriate insulin regimen.

9)   I understand that the information concerning my diabetes will be combined with that of many other volunteers, and that I will not be personally identified in any publications or public documents which result from this study.

10)   Neither this institution nor the government agency funding this research project will automatically provide special services, free care, or compensation for any injuries or adverse reactions resulting from this research. Treatment for such injuries or adverse reactions will be provided under the same financial arranagement as those under which treatment is usually provided.

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If I believe that I may have suffered any injury or adverse reaction as a result of participating in this research, or have questions about my rights as a research subject, I may contact Dr. _____ (_____) or the Associate Vice President of this medical center (_____). They can review the matter with me, identify other resources that may be available to me, and provide me with further information as to how to proceed.

Signature _____

Date _____

Witness _____

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DCCT Form 032.1

(IN THE CASE OF A VOLUNTEER UNDER 18 YEARS OF AGE)

We, as parents or legal guardians of

_____, have read and understand this

material, have had our questions answered, and give our

permission for our child to participate in this clinical

trial. (Both parents should sign, if available.)

Signature _____

Date _____

Witness _____

Signature of
Principal Investigator _____

Date _____

Witness _____

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Autobiographical Statement

Julia Ann Shelton was born in Oklahoma City, Oklahoma on November 19, 1934. She attended Oklahoma A & M during 1953 and 1954, and then worked in the structural engineering field for many years, culminating in a career in engineering specification writing. She attended the University of Maryland evening school during the '70's, and received a B.A. in Psychology in 1976. She then completed course work for a Master's in Clinical Psychology from Loyola College, Baltimore, Maryland, but did not complete her thesis. In 1983 she completed a career change and entered the Virginia Consortium for Professional Psychology.

During the first two years, Ms. Shelton obtained positions as research assistant, for the ODU Counseling Center, and for Thomas Cash, Ph.D. of ODU. Following her predoctoral internship at the Pittsburgh VA Consortium, she chose a fourth year specialization in neuropsychology, and worked at the CMHC Associates, The Therapy Center, Portsmouth Naval Hospital, and Norfolk General Hospital Rehabilitation Ward.