THE DEVELOPMENT AND USE OF AN INTELLECTUAL CORRELATES SCALE IN THE PREDICTION OF PRE-MORBID INTELLIGENCE IN ADULTS

By

DAVID EDWIN JOHNSEN

Bachelor of Science
Oklahoma State University
Stillwater, Oklahoma
1976

Master of Science
Oklahoma State University
Stillwater, Oklahoma
1978

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Thesis Approved:

Thesis Adviser

Kenneth D. Sandvold

J. Barbara Wilkinson

Larry T. Brown

Norman N. Durham

Dean of the Graduate College

1312750

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TABLE OF CONTENTS

Chapter Page

I. INTRODUCTION..1

II. REVIEW OF THE LITERATURE............................5

III. METHODOLOGY..23

Subjects..23
Materials...24
Procedure...26
Statistical Analysis..............................30

IV. RESULTS..33

Item Selection Phase..............................33
Validation Phase..................................37

V. DISCUSSION...46

REFERENCES...57

APPENDICES...65

APPENDIX A - CONSENT TO PARTICIPATE FORMS..........65

APPENDIX B - BACKGROUND INFORMATION.................68

APPENDIX C - INSTRUCTIONS FOR COMPLETING THE INTELLECTUAL CORRELATES SCALE ITEM POOL..............................71

APPENDIX D - INITIAL CONTACT LETTER................73

APPENDIX E - INTELLECTUAL CORRELATES SCALE QUESTIONNAIRE AND ANSWER SHEET........75

APPENDIX F - INSTRUCTIONS FOR COMPLETING THE INTELLECTUAL CORRELATES SCALE QUESTIONNAIRE.........................80

APPENDIX G - VETERANS ADMINISTRATION MEDICAL CENTER CONSENT TO PARTICIPATE FORM.................................82

Chapter Page

APPENDIX H - ICS SCORING KEY........................85

APPENDIX I - ANALYSIS OF VARIANCE SUMMARY TABLE FOR THE VERBAL AND PERFORMANCE IQ MEASURES..............................89

APPENDIX J - NEWMAN-KEULS PAIRWISE COMPARISONS FOR VERBAL AND PERFORMANCE IQ SCORES................................91

APPENDIX K - ANALYSIS OF VARIANCE SUMMARY TABLE FOR THE FULL SCALE IQ MEASURE...............................99

APPENDIX L - NEWMAN-KEULS PAIRWISE COMPARISONS FOR FULL SCALE IQ SCORES.............101

LIST OF TABLES

Table Page

1. Values for Subject Demographic Variables Used in the Barona et al. (1984) Equations...........25

2. Correlations Between the ICS Items and Obtained Verbal IQ..............................34

3. Correlations Between the ICS Items and Obtained Performance IQ.........................35

4. Correlations Between the ICS Items and Obtained Full Scale IQ..........................36

5. Means and Standard Deviations of the IQ Measures for both Verbal and Performance IQ..............38

6. Means and Standard Deviations of the IQ Measure for Full Scale IQ..............................40

7. Correlation Coefficients and Significance Levels Between Estimated and Obtained Verbal, Performance, and Full Scale IQ Scores for the Control Group...........................42

8. Squared Multiple Correlation Coefficients Between Estimated and Obtained (Actual) Verbal, Performance, and Full Scale IQs.........51

CHAPTER I

INTRODUCTION

Accurately assessing the extent of intellectual impairment, whether due to aging, cerebral trauma, or disease, is a difficult task and yet is one that is facing clinicians on an ever-increasing basis. Questions related to intellectual impairment are coming from a broad spectrum of our society. The tremendous increase in our elderly population has spawned the specialty of geriatric psychology and subsequently increased the need to determine the extent of the impairment experienced by many of these people. Such knowledge is vital in their treatment planning as well as rehabilitative programming for those of all ages who have suffered damage through injury and/or disease. Similarly, our society's increased focus on liability and compensation has led to a great increase in the number of litigation issues in which the primary question involved is specifically the extent of impairment suffered by the person.

While a comparison of test data obtained prior to and following the specific trauma would indicate both the presence of damage and extent of impairment, such pre-trauma data are seldom available. As a result, clinicians are often forced to estimate the individual's previous (premorbid) intelligence from the subjective impressions of the client, client's friends, and/or family. While often helpful, these impressions may be based more upon emotion than fact. In cases involving litigation, the client's and/or relative's reports may be subject to conscious or unconscious distortions. Similarly, the accuracy of the client's self reports is often questionable due to the tendency of some individuals to react catastrophically and subsequently exaggerate the nature of their deficits, while others respond in the opposite fashion, denying their deficits in the face of indisputable evidence (Lezak, 1976).

The variability of estimates of premorbid intelligence based solely on interviews (Meehl, 1954) prompted a number of attempts to develop objective measures of impairment. In 1944, David Wechsler introduced his Mental Deterioration Index (MDI) in an effort to obtain such a measure (Wechsler, 1944). He had earlier noticed that mental abilities, as measured by the Wechsler-Bellevue Intelligence Test, deteriorated unevenly as a person aged. On some of the W-B subtests older people performed much more poorly than did younger ones, while on other subtests there was no significant difference in performance. Using these differential performance patterns as a basis for the MDI, Wechsler devised a differential test-score method that he purported gave him an accurate assessment of both current and previous levels of intellectual functioning. These current and previous levels were based on the individual's performance on the "don't hold" and "hold" subtests, respectively. Quite simply then, if the difference between the two levels exceeded the normal level attained by the individual's same-age peers, intellectual impairment was indicated.

This selective deficit approach, in which it is believed that performance on certain tasks, such as specific Wechsler subtests, is more likely to be affected by brain damage than performance on other tasks, was the basis for several other impairment indicies (Hewson, 1949; Hunt, 1949; McFie, 1975; Mahan, 1979; Reynell, 1944). The discrepancy between tasks believed to be most and least affected is used as a basis for measuring intellectual loss.

These objective indicies have not lived up to expectations, however. Some of the objections to these include questions surrounding the validity of the selective deficit approach (Russell, 1972; Swiercinsky & Warnock, 1977). Therefore, the purpose of this study was to develop an alternative deterioration index based not on the selective deficit model but rather on the use of personal and vocational interests, attitudes, personal beliefs, and personality traits from which to estimate premorbid intelligence. An attempt was made to show that a group of items, based on the aforementioned areas, that correlated with intelligence could be found and used to develop a scale that would accurately estimate current intellectual functioning. Additionally, this research involved both a validational study to assess the practicality of such an index with actual brain-damaged subjects and a cross-validational evaluation of an existing method of estimating premorbid intellectual functioning.

CHAPTER II

REVIEW OF THE LITERATURE

Although there had been considerable interest in measuring intellectual impairment since the turn of the century, it was 1930 before the first scientific attempt at such a measurement was made (Babcock, 1930). On the basis of her attempts to assess intellectual level and efficiency, Babcock concluded that only vocabulary performance remained relatively intact with respect to aging and possibly other cerebral dysfunction due to injury or disease.

David Wechsler first proposed the diagnostic use of subtest scores in this area in 1944 (Wechsler, 1944). From his observations that intellectual abilities tended to decline with age, he hypothesized that certain Wechsler-Bellevue subtests were more resistant to the effects of aging than were other subtests. He also believed that there was little psychological difference between normal mental deterioration subsequent to aging and impairment resulting from brain injury or disease "except as regards the rate at which deterioration occurs, and in the case of traumatic injury, as regards the number of mental functions involved" (Wechsler, 1944, p. 54). Based on these hypotheses, he divided the subtests up into two groups. The "hold" group contained those subtests considered to hold up to the effects of aging while the "don't hold" group contained those that he felt did not. The tests believed to hold up were Information, Comprehension, Object Assembly, and Picture Completion. The "don't hold" group consisted of Digit Symbol, Arithmetic, Digit Span, and Block Design. A comparison of the performance on the "hold" versus the "don't hold" tests on the MDI yielded a score which indicated the extent of impairment. This score was calculated by subtracting the mean score of the "hold" tests from the mean score of the "don't hold" tests, then dividing that value by the mean score of the "hold" tests. This ratio was thus reported as a percentage score.

Wechsler later expanded his idea of intellectual impairment and revised the "hold" and "don't hold" categories to reflect this change. In _The Measurement and Appraisal of Adult Intelligence_ (Wechsler, 1958), Wechsler replaced the Comprehension subtest with Vocabulary in the "hold" category, wheras the Arithmetic subtest was replaced by Similarities in the "don't hold" group.

Unfortunately, subsequent studies failed to provide much support for the MDI (Allen, 1947, 1948; Anderson, 1951; Bersoff, 1970; Cohen, 1952; Crookes, 1961; Fisher, 1962; Gonen, 1970; Klove & Reitan, 1959; Morrow & Mark, 1955, Reitan, 1955, 1959; Rogers, 1950a; Vogt & Heaton, 1977; Woo-sam, Zimmerman, & Rogal, 1971). For example, Allen

(1947) evaluated the vulnerability of the Wechsler-Bellevue Intelligence Scale subtests to brain damage by surveying the test results of 50 patients, all of whom had suffered open-head injuries. Applying Wechsler's MDI formula resulted in only 54% of the patients being identified as showing any appreciable intellectual loss over that normally expected in the patient's age group. Wechsler's recommendation was that deterioration of 20% or greater over that normally expected in the patient's age group was needed to indicate definite deterioration. No loss was indicated in 28% of the cases while only a slight indication of loss (less than 20%) occurred in the remaining 18%. The Object Assembly subtest, one of Wechsler's "hold" tests, was found to be the third most highly affected subtest of the entire Wechsler-Bellevue Intelligence Scale.

There were a number of other attempts to modify and/or develop objective intellectual impairment indicies (Allen, 1948; Hewson, 1949; Hunt, 1949; Mahan, 1979; McFie, 1975; Reynell, 1944). Like Wechsler's MDI, these indicies were based on the selective deficit model and, similarly, received little support from subsequent research (Rogers, 1950b; McKeever & Gerstein, 1958; Fisher, 1962; Mahan, 1979; Johnsen, Schlottmann, Kane, Bauer, & Quintana, 1985).

Despite the high correlations between some of the "least affected" tasks (e.g., Vocabulary) and IQ, their insensitivity to brain damage is questionable. Russell (1972) conducted a factor analysis of WAIS results of 113 subjects (87 brain-damaged, 26 controls) and found that while the structure of the general verbal, performance, and memory factors are not greatly changed, performance on all of the WAIS subtests is affected by brain damage. T-tests for the point biserial correlations between the WAIS subtests and the criterion variable of brain damage were significant at the .01 level with the exception of the Similarities subtest which was significant at the .05 level. With all subtests being affected, no support was found for the "hold" versus "don't hold" concept. Similarly, Swiercinsky and Warnock (1977) found that the Vocabulary subtest of the WAIS, previously thought to be one of the most resistant subtests to the effects of brain damage, was a highly significant discriminator between brain-damaged and normal subjects. If Vocabulary truly "held up" to the effects of brain damage, no significant difference should have been found between the two groups. Johnsen et al. (1985) revealed that the Mahan (1979) method, which also uses Vocabulary (and Picture Completion) to estimate premorbid intelligence, was not clinically useful in discriminating brain-damaged and normal individuals. Estimated premorbid IQs were calculated on three brain-damaged groups (left-hemisphere damaged, right-hemisphere damaged, and diffuse damaged) and a control group. While statistically significant differences were obtained between the different groups, this method failed to discriminate brain-damaged from control patients any better than simply comparing differences between WAIS Verbal IQs and Performance IQs. Using a discriminant analysis procedure, 84% of the subjects (82% of the controls and 85% of the brain damaged) were correctly classified when all four of Mahan's residual scores were used as predictors. However, the obtained Verbal and Performance IQs were also evaluated as predictors. When used together, the two IQ scores correctly classified 82% of the subjects (78% of the controls and 85% of the brain damaged).

The impairment indicies have been, at best, only marginally successful at providing cut-off scores for indicating the presence or absence of brain damage but have failed to establish an accurate premorbid level of intellectual functioning. While technically, one could consider Wechsler's MDI ratio in terms of percent loss and extrapolate the premorbid IQ, this greatly increases the chance for error. Lezak (1976) reflected current thinking when she commented:

> ...the first step in measuring intellectual deficit...is to establish...the patient's premorbid performance level. The shift in emphasis from simply establishing the fact that there has been deterioration or impairment toward the establishment of a basic pre-morbid functioning level may have surpassed the effectiveness of any index of deterioration (p. 80).

Recent attempts to estimate premorbid intelligence have utilized multiple regression and discriminant function analysis. Leli and Filskov (1979) used two linear stepwise discriminant functions in their attempt to measure intellectual impairment. They devised two deterioration measures: one based on the relationship between education and Full Scale IQ and one based on the relationship between occupation and Full Scale IQ. Their predictor variables were these two deterioration measures (education - FSIQ and occupation - FSIQ), used alone and in combination with other intelligence test scores. The first function, using Verbal IQ, Performance IQ, Full Scale IQ, education, and the two deterioration measures as predictor variables, yielded a 75% correct classification rate (brain-damaged versus non-brain-damaged). The second function, using the two deterioration measures alone as predictors, yielded an 83% correct classification rate.

Wilson et al., (1978) developed multiple regression equations to predict premorbid Verbal IQ, Performance IQ, and Full Scale IQ, using an expanded set of predictor variables (age, sex, race, occupation, and education). Using the 1955 WAIS standardization sample (with the exception of the Kansas City elderly subjects), Verbal, Performance, and Full Scale IQs were regressed in a stepwise fashion on these five demographic variables. With these variables they accounted for 42% to 54% of the variance in IQs. These results represented approximately a 10% increase in explained IQ variance relative to the case when educational level was the sole predictor variable. While holding considerable promise, the clinical utility of these equations is limited somewhat by the large standard errors of estimate - 10.2, 11.4, and 10.2 for the Verbal, Performance, and Full Scale IQs, respectively.

The accuracy of the Wilson et al. (1978) equations was evaluated in five separate cross-validational studies. Wilson, Rosenbaum, and Brown (1979) compared the performance of 140 brain-damaged and 140 control patients with both the Wilson et al. (1978) formulae and Wechsler's deterioration quotient. They used a discriminant analysis procedure to determine an optimum cut-off score from which patients were classified as neurologically impaired or normal, based on the difference between their predicted and obtained IQs. Patients whose discrepancy scores fell below the cut-off score were classified normal while those whose scores fell above were considered impaired. The Wilson et al. (1978) formulae correctly identified 72% of the patients while Wechsler's deterioration quotient identified only 61%.

The second cross-validational study was completed by Klesges, Sanchez, and Stanton (1981). They assessed the relationship between the Wilson et al. (1978) formulae and two clinically relevant, but neurologically unimpaired, samples (60 psychiatric inpatients and 106 outpatients). The correlations between the actual and predicted Verbal, Performance, and Full Scale IQs were .54, .36, and .50, respectively, for the inpatient sample and .66, .56, and .54, respectively, for the outpatient group. All of these correlations were significant at greater than .001. However, the equations were found to overpredict the actual IQs in both inpatient and outpatient samples. Wilson et al. (1978) foresaw this overprediction as a possible problem due to the lower level of educational achievement obtained by individuals in 1955 as compared to 1975. They recommended multiplying the formulae's educational weights by .82 to correct for this. Using this adjustment, Klesges et al. (1981) found the formulae no longer overpredicted the IQs of the outpatient sample, lessened the overprediction in the inpatient sample, and reduced the number of misclassifications. The fact that some overprediction of IQ in the inpatient sample remained was not surprising since it is likely that a reduced intellectual efficiency results from the presence of a mental disorder.

The initial optimism sparked by these cross-validational studies has been tempered somewhat by several studies that have used "functional normals" as controls (Bolter, Gouvier, Veneklasen, & Long, 1982; Gouvier, Bolter, Veneklasen, & Long, 1983; Klesges, Fisher, Vasey, & Pheley, 1985). Rather than using non-psychiatric, non-brain-damaged patients as controls as the initial studies did, these later studies employed as controls individuals referred for neuropsychological and/or neurological evaluation because of suspected cerebral dysfunction but who were later diagnosed as normal on the basis of their evaluation. The rationale for using these individuals as control subjects was that they are the ones the neuropsychologist is typically required to accurately discriminate from actual brain-damaged persons.

Using both the unadjusted and adjusted Wilson et al. (1978) formulae, Bolter et al. (1982) calculated predicted FSIQs on two groups of head-injured patients (11 recovered and 11 non-recovered) and their control group (n = 24). Both recovered and non-recovered patients were evaluated twice. The FSIQs of the "recovered" brain-damaged subjects obtained during the second testing were used as the premorbid intelligence levels for this brain-damaged group. They found significant correlations between predicted premorbid and obtained IQs, similar to those reported by Klesges et al. (1981). Despite this, they recommended against the use of the equations for estimating IQs with individual head trauma cases, citing a lack of predictive accuracy at the individual level with both the unadjusted and adjusted versions. Only 45% of the brain-damaged patients were correctly classified as opposed to 71% of the normals, these classifications being based on the interpretive guidelines of Klesges et al. (1981). By these criteria, both recovered and non-recovered patients obtained FSIQs during the first evaluation that fell outside of one standard error of estimate. Correct classification of a recovered patient occurred when the patient's estimated FSIQ fell within one standard error of estimate of the obtained FSIQ when tested the second time. For the non-recovered patients at the second testing, placement hinged on the estimated IQs falling outside one standard error, thereby not showing the assumed improvement seen in the "recovered" group. Estimated IQs for the control group were classified by the same criterion that applied to the recovered group at the second testing, although the controls were tested only once. That is, the controls' estimated FSIQs were within one standard error of estimate of their actual obtained FSIQs. However, this discrepancy between estimated and obtained IQs may be more a function of the criteria used to establish the premorbid intelligence levels in the brain-damaged subjects than a function of the Wilson et al. (1978) formulae. Problems in defining recovered from non-recovered may have reduced the accuracy of the equations. Similarly, with respect to the use of "functional normals" as control subjects, a normal EEG and/or the absence of other neurological test data identifying specific areas of cerebral dysfunction does not always rule out the presence of brain damage.

Recently, Barona, Reynolds, and Chastain (1984) copied the methodology of the Wilson et al. (1978) study to devise regression equations for predicting premorbid intelligence. However, they used the 1981 WAIS-R (Wechsler, 1981) standardization sample for their subject data. In addition to the predictor variables of age, sex, race, occupation, and education used by Wilson et al. (1978), they added urban-rural residence, geographic region of residence, and handedness, although handedness was subsequently dropped because of its negligible contribution to predictability. Verbal, Performance, and Full Scale IQs were regressed in a stepwise fashion on these seven variables resulting in squared multiple correlations of .38, .24, and .36 for Verbal IQ, Performance IQ, and Full Scale IQ, respectively. Unfortunately, the same relatively large standard errors that plague the Wilson et al. (1978) formulae are also present in these equations (11.79, 13.23, and 12.14 for Verbal IQ, Performance IQ,and Full Scale IQ, respectively.

Barona and Chastain (1986) attempted to improve the accuracy of the Barona et al. (1984) equations by narrowing their applicability. They deleted those WAIS-R standardization subjects whose age fell between 16 and 19 years and/or who were a member of a race other than black or white. Their reasoning was that the occupational classification of the 16 to 19 year olds was based on the occupation of the subjects' head of household since the teenagers were not yet steadily employed in full-time occupations. While this was sufficient for standardization purposes, Barona and Chastain (1986) did not think it accurately reflected the individual's actual occupational status. The second deletion was based on the extremely small number of "other" races in the standardazation sample. Including them in the data analysis was meaningless due to their small numbers. The result of these deletions were slightly improved equations applicable to blacks and whites between the ages of 20 and 74 years. The squared multiple correlations for the Verbal, Performance, and Full Scale IQs were .47, .28, and .43, respectively compared to .38, .24, and .36 obtained with the original equations (Barona et al. 1984).

Prior to the publication of the updated formulae (Barona & Chastain, 1986), Eppinger, Craig, Adams, and Parsons (1987) cross-validated the Barona et al. (1984) equations and evaluated their accuracy in discriminating between a group of 80 neurologically-normal but clinically-relevant criterion subjects and 83 brain-impaired subjects. These neurologically-normal subjects were very similar to the functional normals used by Bolter et al. (1982) and Gouvier et al. (1983) in that they were individuals who had been referred for neuropsychological evaluation but had tested negative for brain damage (55%) or psychiatric referrals (44%). Approximately 1% were referred for other unspecified reasons. Their results generally supported the estimation accuracy of the formulae within a neurologically-normal clinical sample although all three formulae significantly overestimated IQ scores. In an attempt to more accurately discriminate between the two groups Eppinger et al. (1987) used a difference score (D-score) which was the difference between the estimated and obtained IQs. While this D-score provided a slightly higher rate of correct classification, it was not at a greater than chance level. Using obtained IQs, 71% of the subjects were correctly classified, while 76% were correctly classified with the D-score.

In a study closely patterned after that of Wilson et al. (1978), Reynolds and Gutkin (1979) developed regression equations designed to predict premorbid intellectual functioning in children. Using the WISC-R standardization sample (Wechsler, 1974) as their subject data, they correlated the predictor variables of sex, race, socioeconomic status, geographic region of residence, and urban-rural residence with Verbal IQ, Performance IQ, and Full Scale IQ. The results reported were statistically significant (.44, .37, and .44, respectively), although subsequent cross-validational studies (Klesges & Sanchez, 1981; Klesges, 1982) have failed to support them.

In the first cross-validational attempt, Klesges and Sanchez (1981) found, in their sample of 76 controls and 23 neurologically-impaired children, that correlations between actual and formula-predicted Verbal, Performance, and Full Scale IQs were only .19, .13, and .18 for the controls, and .18, .19, and .18 for the neurological group. Using the Reynolds and Gutkin's (1979) difference score between actual and predicted IQ that was necessary to infer intellectual deterioration (a difference of at least one standard error of estimate of the estimated IQ plus one standard error of measurement of the obtained IQ), Klesges and Sanchez (1981) obtained a classification with 65% false negative and 12% false positive errors.

A second cross-validational study of the Reynolds and Gutkin (1979) was conducted by Klesges (1982) in an attempt to correct for the homogeneity of low socioeconomic status and urban residents present in the Klesges and Sanchez (1981) study. Klesges (1982) assessed whether the Reynolds and Gutkin (1979) formulae predicted obtained WISC-R scores in non-impaired patients, and to what extent the formulae discriminated between neurologically-impaired and neurologically-intact subjects. The correlations between predicted and obtained IQs were .14, .13, and .14 for Verbal, Performance, and Full Scale IQs, respectively, for the 35 non-impaired subjects. Low correlations were also obtained for the 26 neurological patients (.09, .04, and .07 for Verbal, Performance, and Full Scale IQ, respectively). None of the three scales were found to discriminate between neurologically-intact and impaired children.

In contrast to the moderate cross-validational support for the Wilson et al. (1978) and Barona et al. (1984) adult regression formulas, it is apparent that there is little support for the use of regression equations with children. This is not particularly surprising given that the IQs of children tend to be much more unstable due to maturational, educational, and developmental influences (Reitan & Davison, 1974; Sattler, 1974).

It is evident that the recent shift from the selective deficit approach to the use of demographic data as the basis for estimating premorbid intellectual levels in adults has yielded encouraging results, especially when a broad range of variables is used to estimate premorbid functioning. Review of the literature on correlates of intelligence indicates that there is a possibility of estimating IQ from a wide variety of sources. Acknowledging that biographical/demographical data correlate well with intelligence, Matarazzo (1972) reports that the level of educational achievement and the independently judged prestige of one's occupation represent intelligence correlates of .50 or greater. Further expanding this concept, Lezak (1976) states:

> It is also assumed that a patient's premorbid ability level can be reconstructed or estimated from many different kinds of behavioral observations or historical facts. Estimates of original intellectual potential may be based on interview impressions, reports from family and friends, test scores, prior academic or employment level, school grades, army rating, or an intellectual product such as a letter or an invention (p. 76).

Personality factors have also been found to correlate with intelligence. Graham (1977, p. 18-102) indicated that there were significant correlations between certain MMPI subscales and intelligence. He indicated that the L scale, scale 1 (Hypochondriasis), and the Prejudice research scale correlated negatively with intelligence while scales 3 (Hysteria) and 5 (Masculinity-Femininity) correlated positively. Megargee (1972, p. 74-81) indicated that the Achievement Potential scales (Achievement via conformance-Ac, Achievement via independence-Ai) and the Intellectual Efficiency scale (Ie) of the California Psychological Inventory correlated significantly with IQ.

Since education and occupation are highly correlated with intelligence, it may be that a person's attitudes, and interests in a particular occupation may also correlate with intelligence. This assumption is, in part, used in the Strong-Campbell Interest Inventory, a vocational interest test that compares the self-reported interests of the subject with the common interests of individuals working in various fields. Gentry (1972) attempted to determine the feasibility of using such items to predict intelligence. He used general and vocational interests, along with attitudes and biographical data to develop a 33-item, true-false scale that correlated with intelligence as measured by the Shipley-Hartford Institute for Living Scale (Shipley & Burlingame, 1939). He then used this total scale score as the predictor variable in a regression equation to predict the estimated WAIS scores of normal college students. The results of the Gentry (1972) feasibility study were quite positive despite some methodological difficulties that limited the scope of the study. For example, the Shipley-Hartford Institute for Living Scale is a largely verbal test that can be quickly administered to large groups. As such, it is most often used for general screening purposes rather than accurate intellectual assessment. The subjects' WAIS IQs were also only estimates, based on a partial administration of the WAIS (Arithmetic, Vocabulary, Block Design, and Picture Arrangement) and the conversion of Shipley scores to WAIS IQ equivalents (Bartz & Loy, 1970). Additionally, the exclusive use of college students implies there was a restricted range of ability, although even with the restricted range, the correlation with IQ during cross validation was .69. Despite these problems, the results indicate that the use of such a scale holds considerable promise for estimating premorbid IQ.

The present study proposed to follow the same basic idea in an effort to develop such a tool. However, rather than using college students, a more representative sample of individuals was used to develop the Intellectual Correlates Scale (ICS). The ICS was also cross-validated on persons having suffered some form of brain injury as well as a matched group of control subjects. Additionally, the Wechsler Adult Intelligence Scale-Revised (WAIS-R) was used to measure intellectual functioning in place of the Shipley-Hartford.

This study involved two separate phases. The first phase involved using personal and vocational interest information, attitudes, beliefs, and personality trait information to establish a reliable scale of items that correlate with intelligence. A major assumption of this study is that this information is believed to be less affected by brain damage, at least initially, than are IQ scores. If this assumption holds true, it could reasonably be expected that such information could be used to predict intelligence and that such a scale could serve as a measure of intelligence against which current test data could be compared. Using the scores in regression equations designed to predict Verbal, Performance, and Full Scale IQs could provide information as to the presence and extent of intellectual loss.

The second phase was a validational effort to determine the efficacy and accuracy of the regression equations when dealing with individuals who have suffered brain damage. These equations, if effective, would fairly accurately predict the actual IQs of the control group but would overestimate the obtained IQs of the brain-damaged groups. Also during this phase, the IQ estimates generated by the Barona et al. (1984) equations were cross-validated on the same group of subjects and compared to the results of the ICS equations.

CHAPTER III

METHOD

Subjects

During the item selection phase of this study, the subjects were 33 adults between the ages of 18 and 60 who had no reported history of organic disease or dysfunction. This initial group was fairly evenly divided with respect to sex (16 males, 17 females) and included 12, 11, and 10 subjects in each of three age brackets (18-29, 30-44, 45-60), respectively. Mean educational levels for each of the three groups were 14.8, 16.1, and 13.2 years, respectively. The subjects were volunteers obtained through either professional or personal contact with the researcher or contact with acquaintances of the researcher.

The validation phase involved an additional 64 subjects (33 brain-damaged, 31 controls). The brain-damaged group consisted of 5 individuals who had suffered confirmed lateralized damage in the left cerebral hemisphere, 14 individuals with confirmed lateralized damage in the right cerebral hemisphere, and 14 individuals with diffuse, or bilateral damage to the brain. The diagnoses of brain damage was based on available medical or neurological/neurosurgical records. Neuropsychological test data were not used in classifying subjects. A breakdown of the number of subjects in the various categories of brain damage revealed that 61% were cerebral vascular accidents, 36% were closed-head injuries, and 3% were degenerative neurological diseases. The control group consisted of individuals who had no reported history of brain damage or mental disorder. These subjects were matched with the brain-damaged subjects on the variables of age and number of years of education. The mean age of the brain-damaged subjects was 47.61, SD = 18.93, while the mean age of the control subjects was 45.97, SD = 17.74. The mean educational levels for the two groups were 12.67, SD = 2.61 and 13.81, SD = 2.94, respectively. No statistically significant differences between the two groups were found for either age, t (62) = .36, or education, t (62) = -1.64. Table 1 shows the results of group comparisons on the additional Barona et al. (1984) variables of sex, race, occupation, region, and residence along with the coded values for each of these categories used in the Barona et al. (1984) analysis.

Materials

The Wechsler Adult Intelligence Scale-Revised (Wechsler, 1981) was used to measure intellectual functioning. This test is designed to comprehensively assess an individual's intellectual aptitude relevant to the culture of the United States. It is widely used and is

TABLE 1

VALUES FOR SUBJECT DEMOGRAPHIC VARIABLES USED IN THE BARONA ET AL. (1984) EQUATIONS

Demographic Variable	Code*	BD n	BD %	Control n	Control %
Sex:					
Female	2	16	48	21	68
Male	1	17	52	10	32
Race:					
White	3	30	91	30	97
Other	2	1	3	0	0
Black	1	2	6	1	3
Occupation:					
Professional/Technical Managerial/Official	6	6	18	8	25
Clerical/Sales	5	5	15	9	29
Skilled Labor	4	1	3	3	10
Not in Labor Force	3	9	27	8	26
Semiskilled Labor	2	11	33	3	10
Unskilled Labor	1	1	3	0	0
Region:					
Northeast	4	0	0	5	16
Western	3	2	6	2	6
North Central	2	2	6	3	10
Southern	1	29	88	21	68
Residence:					
Urban (> 2,500)	2	30	91	30	97
Rural (< 2,500)	1	3	9	1	3

* The code number is the value assigned to the predictor variable in Barona et al. (1984).

often the one to which other intelligence tests are compared. Its validity and reliability have made it one of the most widely accepted of the intelligence tests. The Verbal scale is made up of six individual subtests (Information, Digit Span, Vocabulary, Arithmetic, Comprehension, and Similarities) whereas the Performance scale consists of five additional subtests (Picture Completion, Picture Arrangement, Block Design, Object Assembly, and Digit Symbol). These subtests are used to obtain a Verbal IQ, Performance IQ, and (combined) Full Scale IQ.

The item pool from which the Intellectual Correlates Scale (ICS) was derived consists of 167 items reflecting personal and vocational interests, attitudes, beliefs, and personality traits. The items were taken primarily from the item pool used by Gentry (1972) although 13 of them were modified to improve readiblity.

Procedure

For the item selection phase, all subjects who had been contacted by telephone or in person were told that the purpose of the study was to develop a procedure to more accurately assess the abilities of persons having suffered head injuries, brain trauma, or brain disease. By finding items that have a relationship to verbal and/or non-verbal abilities, the individual's thinking and reasoning abilities may be more accurately estimated, thereby aiding in their treatment. The subjects were informed that the time requirement was approximately two hours and that anonymity was guaranteed. Upon their agreement, a time and place was scheduled for the testing to take place. Immediately prior to the test administration, the researcher again explained the purpose of the study and asked each subject to read and sign a consent form agreeing to the terms of participation (Appendix A-I) as well as complete the Background Information Sheet (Appendix B). Before taking the ICS item pool, each subject was asked to read the instructions printed on the ICS booklet cover page (Appendix C) while the researcher read the instructions aloud. One half of the subjects were administered the ICS item pool first, then the WAIS-R, while the other half were administered the tests in the reverse order, thereby eliminating order of presentation effects.

Following the collection and analyses of the data to select items that correlated ($p < .10$) with Verbal IQ, Performance IQ, and Full Scale IQ, the additional 64 subjects (33 brain-damaged and 31 controls) were contacted in order to initiate the second phase of the study which was the validational portion.

In this validational phase of the study, subjects were obtained through contact with the neurology and rehabilitation units of various local hospitals, professional referral, friendship pyramiding, or personal contact with the researcher. In regard to the various local hospitals, a request to conduct this research was made to the respective research committees. After obtaining the necessary clearances, patients on the neurology and rehabilitation units who fit the research criteria were asked by their attending psychologist or physician if they would participate in the study. The research criteria were that the patient had suffered documented cerebral damage and were testable. That is, patients who were experiencing severe aphasias (expressive or receptive) and were therefore unable to communicate in even a rudimentary fashion, were not included in the sample. It is unknown how many patients were excluded by this process but it is likely to have contributed to the smaller number of left-hemisphere damaged patients in the brain-damaged group. Upon the patients' verbal agreement, the researcher contacted them personally.

Professional people (psychologists, physicians, rehabilitative therapists, etc.) having contact with individuals who had experienced some form of brain injury were asked to obtain permission for participation from those individuals who met the research criteria. Upon obtaining this permission, the researcher sent the individuals a letter (Appendix D) briefly explaining the purpose of the study and notifying them that the researcher would be contacting them by telephone in a few days. They were then contacted by telephone in order to make the necessary arrangements concerning the time and place for the testing.

The third procedure for obtaining subjects involved asking individuals known to the researcher if they knew of anyone who had experienced some type of organic damage and was willing to participate in the study. This same question was also posed to each participant. Any individual referred through this process was contacted via the aforementioned procedure to obtain their consent to participate. These brain-damaged individuals also signed a consent to participate form that contained a clause giving the researcher permission to contact their physicians. In this way pertinent medical records allowing for the documentation of cerebral damage were obtained. Individuals meeting the research criteria who were known personally by the researcher were also contacted for possible participation. All persons contacted were informed that their participation was strictly voluntary and that no financial compensation would be paid for taking part in the study.

All subjects were tested using the WAIS-R and a new version of ICS composed of those items retained from the original item pool (Appendix E). The testing followed the same basic format as that previously outlined, although a slightly different set of instructions reflecting the changes in the ICS was presented to the subjects (Appendix F). In three cases, where the brain damage had resulted in a moderate to severe aphasia, rendering the individual unable to read, the ICS was read to the subjects by the researcher. Where possible, the family members of the brain-damaged subjects served as the control subjects of the study (N = 4). Additionally, some of the brain-injured subjects were asked to sign a slightly different consent form containing an added stipulation allowing the researcher to contact their physician in order to obtain relevant medical records (Appendix A-II). Those subjects who were patients at one of the hospitals located in the southwestern United States also signed another separate consent form that was in compliance with the hospital's standard format for such documents (Appendix G).

Statistical Analysis

In the initial phase of the study, which was for the purpose of item selection, the items on the ICS item pool were correlated with the WAIS-R Verbal, Performance, and Full Scale IQ scores by using a Pearson Product-Moment correlation. Those items that correlated significantly ($p < .10$) with one or more of the three WAIS-R IQ scores were retained for use in the final version of the ICS.

Three scales, one each for VIQ, PIQ, and FSIQ, were developed by correlating ICS scores with subjects' Verbal, Performance, and Full Scale IQ scores. For those items that correlated positively, subjects in the item selection phase were given a score that corresponded to their answers (e.g. 1-Strongly Agree, 2-Agree, 3-Disagree, 4-Strongly Disagree). For those items that correlated negatively, the item score was subtracted from five in order to maintain the same numerical relationship with the positive correlation item scores. These scores were then summed, providing each item selection phase subject with a Verbal IQ ICS score (VICS), a Performance IQ ICS score (PICS), and a Full Scale IQ ICS score (FSICS). Regression equations were developed for each of the three IQ scales using their respective ICS scores. These equations were then used to compute an ICS-estimated VIQ, PIQ, and FSIQ (Appendix H).

The validational phase of the study involved the administration of the WAIS-R along with the retained items from the ICS item pool for the additional 64 subjects. Since the accuracy of the estimation methods (regression coefficients) was reflected in how well they predicted the obtained IQ scores of this control group, most of the statistical analyses in the study involved this group alone. Along with the obtained IQs derived directly from the WAIS-R, two additional sets of IQ scores were calculated for each subject. Verbal, Performance, and Full Scale IQ scores were estimated from the ICS equations (ICS VIQ, ICS PIQ, ICS FSIQ) and from the Barona equations (BAR VIQ, BAR PIQ, BAR FSIQ).

In addition to cross-validating the Barona equations, the accuracy of the ICS- and Barona-based estimates in predicting the obtained (actual) IQ scores of the control subjects was compared. Even though the brain-damaged and control subjects were closely matched on the variables of age and education, a preliminary analysis assessing the need for an analysis of covariance (ANACOVA) was conducted. The ANACOVA was not indicated and the subsequent statistical comparisons were made using an analysis of variance (ANOVA) procedure.

Mean score differences for both brain-damaged and control subjects were analyzed using a 2x3x2 ANOVA. The independent variables were impairment status (brain-damaged or control), IQ measure (obtained, ICS, or Barona), and IQ dimension (Verbal or Performance score). Post hoc analyses utilized the Newman-Keuls tests. Using the same measures as mentioned for VIQ and PIQ, the FSIQs were analysed with a 2x3 ANOVA. The Newman-Keuls post hoc procedures were also used in this analysis.

Appraisal of the predictive value of the ICS and Barona scales individually was included, as well as the predictive value of these two scales in combination. To determine the relative contribution of these scales in predicting the obtained IQs, multiple and semi-partial correlations were calculated.

CHAPTER IV

RESULTS

Item Selection Phase

The number of items that significantly correlated with VIQ, PIQ, and/or FSIQ were 28, 27, and 27, respectively. Due to items correlating with more than one IQ measure, the ICS consisted of 45 items. An additional 26 items that were closely correlated but not significant ($p > .10 < .20$) were also included on the final version of the ICS for future research purposes but were not scored in the present study. Those items that correlated positively were items 2, 7, 8, 11, 19, 23, 24, 26, 33, 41, 43, 48, 49, 52, 57, 58, 62, 64, 67, 68, 69, and 70. Those items that correlated negatively were items 1, 3, 4, 5, 6, 10, 12, 13, 15, 16, 27, 29, 31, 36, 40, 42, 44, 46, 53, 56, 60, 65, and 71.

The overall correlations between VICS and VIQ, PICS and PIQ, FSICS and FSIQ were .86, .84, and .87, respectively, ($p < .01$). The individual item correlations for VIQ, PIQ, and FSIQ are presented respectively in Tables 2, 3, and 4. The regression equations (criterion = x independent variable plus y-intercept) from which the ICS-estimated IQs were

Table 2

CORRELATIONS BETWEEN THE ICS ITEMS AND OBTAINED VERBAL IQ

Item Number	Correlation	p
1.	-.58	.000
2.	.37	.030
3.	-.49	.004
6.	-.43	.010
8.	.30	.080
10.	-.51	.002
11.	.32	.060
13.	-.61	.000
15.	-.34	.050
16.	-.38	.030
19.	.31	.070
23.	.41	.020
29.	-.42	.010
31.	-.34	.050
36.	-.33	.060
41.	.30	.080
42.	-.29	.090
43.	.35	.040
52.	.30	.090
53.	-.30	.090
56.	-.31	.080
57.	.33	.060
58.	.34	.050
60.	-.34	.050
64.	.31	.080
68.	.31	.080
69.	.47	.060
71.	-.29	.090

Table 3

CORRELATIONS BETWEEN THE ICS ITEMS AND OBTAINED PERFORMANCE IQ

Item Number	Correlation	p
2.	.35	.040
3.	-.31	.070
4.	-.30	.080
5.	-.32	.060
6.	-.32	.070
7.	.35	.040
11.	.41	.020
12.	-.30	.090
13.	-.49	.040
15.	-.29	.100
16.	-.36	.040
23.	.30	.020
24.	.33	.060
26.	.32	.060
27.	-.38	.030
40.	-.29	.090
41.	.47	.060
44.	.30	.090
46.	-.29	.090
48.	.38	.030
52.	.30	.080
53.	-.32	.060
62.	.29	.100
64.	.41	.020
65.	-.31	.070
67.	.43	.010
70.	-.46	.007

Table 4

CORRELATIONS BETWEEN THE ICS ITEMS AND OBTAINED FULL SCALE IQ

Item Number	Correlation	*p*
1.	-.42	.020
2.	.39	.020
3.	-.45	.008
5.	-.32	.070
6.	-.42	.010
7.	.33	.060
10.	-.41	.020
11.	.41	.020
13.	-.64	.000
15.	-.35	.050
16.	-.40	.020
23.	.38	.030
24.	.33	.060
29.	-.32	.070
33.	.33	.060
41.	.45	.009
43.	-.33	.060
48.	.32	.070
49.	.29	.090
52.	.32	.060
53.	-.35	.050
57.	.34	.050
64.	.40	.020
67.	.37	.030
68.	.32	.070
69.	.30	.090
70.	.35	.040

obtained produced the following: ICS VIQ = .95 x VICS +46.42, ICS PIQ = 1.36 x PICS + 12.96, and ICS FSIQ = 1.18 x FSICS + 30.42.

Validation Phase

Group means and standard deviations for estimated (by regression equation) and obtained (actual WAIS-R results) Verbal and Performance IQ scores are presented in Table 5. A 2x3x2 ANOVA (impairment status x IQ measure x IQ dimension) procedure was used without a demographic covariant with scores as the dependent variable. A significant three-way interaction was obtained between impairment status (brain-damaged versus control), IQ measure (ICS versus Barona versus obtained) and IQ dimension (Verbal versus Performance), $\underline{F}$ (2, 124) = 10.45, $\underline{p} < .0001$ (Appendix I). Pairwise comparisons using the Newman-Keuls procedure revealed that the brain-damaged group's obtained Verbal and Performance IQ scores were significantly lower than their estimated Verbal and Performance IQ scores (Appendix J-1, J-2). In contrast, the control group's obtained Verbal and Performance IQ scores did not differ significantly from their estimated Verbal and Performance IQ scores (Appendix J-3, J-4). Additionally, the ICS-estimated Verbal and Performance IQ scores of the control group were statistically equal to the ICS-estimated Verbal and Performance IQ scores of the brain-damaged group (Appendix J-5). Likewise, the control and brain-damaged groups did

TABLE 5

MEANS AND STANDARD DEVIATIONS OF THE IQ MEASURES FOR BOTH VERBAL AND PERFORMANCE IQ

	Brain-Damaged		Control	
	Mean	SD	Mean	SD
OBT VIQ	90.73	12.56	104.03	11.66
ICS VIQ	107.67	5.17	104.74	5.28
BAR VIQ	102.91	9.30	108.61	8.78
OBT PIQ	81.94	13.14	107.52	11.79
ICS PIQ	104.61	7.00	107.03	8.04
BAR PIQ	101.15	6.95	105.87	6.57

not differ significantly on the Barona-estimated Performance IQ scores. However, the Barona-estimated Verbal IQ scores for the brain-damaged group were significantly lower than the Barona-estimated Verbal IQ scores for the control group (Appendix J-6). Comparing the ICS and Barona estimation methods, the ICS-estimated Verbal and Performance IQs were not statistically different from the Barona-estimated Verbal and Performance IQs (Appendix J-2, J-3, J-4).

The Full Scale IQs were evaluated in a separate analysis. Group means and standard deviations for the estimated and obtained FSIQs are presented in Table 6. A 2x3 ANOVA (impairment status x IQ measure) also resulted in a significant interaction between impairment status (brain-damaged versus control), and IQ measure (ICS versus Barona versus obtained), $\underline{F}$ (2, 124) = 37.82, $\underline{p} < .0001$ (Appendix K). Pairwise comparisons using the Newman-Keuls procedure revealed results similar to those found in the Verbal and Performance IQ analysis. The brain-damaged group's obtained Full Scale IQ scores were significantly lower than their estimated Full Scale IQ scores (Appendix L-1). Likewise, no significant differences were found between the obtained and estimated Full Scale IQ scores for the control group (Appendix L-2). Also, the control group's estimated Full Scale IQ scores were statistically equal to the brain-damaged group's estimated Full Scale IQ scores (Appendix L-3, L-4). Additionally, the ICS-estimated Full Scale IQs

TABLE 6

MEANS AND STANDARD DEVIATIONS OF THE IQ MEASURES FOR FULL SCALE IQ

	Brain-Damaged		Control	
	Mean	SD	Mean	SD
OBT FSIQ	86.24	10.83	105.83	11.90
ICS FSIQ	105.88	5.76	106.00	7.15
BAR FSIQ	101.97	8.94	107.74	8.40

were not statistically different from the Barona-estimated Full Scale IQs (Appendix L-2).

One of the major issues of the second phase of this study was the relationship between each of the IQ estimation methods (ICS and Barona) and obtained IQ scores for the control group. Both ICS- and Barona-estimated IQ scores were correlated with the respective obtained VIQ, PIQ, and FSIQ scores. These coefficients, along with the significance levels and squared zero-order correlations are presented in Table 7. All three of the zero order correlations for the ICS-based IQ estimates were significantly correlated with the respective obtained IQ scores. Similarly, the Barona-estimated VIQs and FSIQs were also significantly correlated with the obtained IQs although at lower significance levels. Barona-estimated PIQ was the only estimate that did not achieve significance.

Multiple and semi-partial correlations were run in order to determine the relative contributions of the IQ estimation methods combined, and alone, to the actual obtained score. That is, what proportion of the variance associated with the obtained scores was accounted for when using the combined ICS/Barona models as opposed to when only ICS- or Barona-based estimations were used with the influence of the other method removed?

An examination of the amount of variance accounted for when using combined IQ estimates (ICS and Barona) revealed

TABLE 7

CORRELATION COEFFICIENTS AND SIGNIFICANCE LEVELS BETWEEN ESTIMATED AND OBTAINED VERBAL, PERFORMANCE, AND FULL SCALE IQ SCORES FOR THE CONTROL GROUP

Variable	*r*	*p*	r^2
ICS VIQ	.56	.001	.32
ICS PIQ	.53	.002	.28
ICS FSIQ	.65	.000	.42
BAR VIQ	.52	.002	.27
BAR PIQ	.30	.102	.09
BAR FSIQ	.48	.006	.23

that the obtained VIQ and FSIQ scores of the control group were predicted quite well. Almost one half of the total variance associated with the obtained VIQ and FSIQ scores were accounted with the VIQ and FSIQ estimation measures. For the ICS VIQ/BAR VIQ model, $R^2 = .45$, while for the ICS FSIQ/BAR FSIQ model, $R^2 = .48$. The combined amount of variance accounted for by ICS PIQ/BAR PIQ was less impressive, $R^2 = .29$.

In order to determine the amount of unique variance accounted for by the ICS and Barona IQ methods by themselves, semi-partial correlation coefficients were obtained. For example, removing the amount of variance associated with the BAR VIQ ($r^2 = .27$) from the amount of variance accounted for by the ICS VIQ\BAR VIQ combined model ($R^2 = .45$) left the unique variance accounted for by ICS VIQ (.45-.27=.18). This squared semi-partial correlation coefficient of .18 indicated that the ICS VIQ contributed a substantial amount over and above that contributed by BAR VIQ, $F\ (1,28) = 8.89$, $p < .01$. The BAR VIQ added a statistically significant, although relatively small contribution over and above that contributed by the ICS VIQ, (.45-.32=.13), $F\ (1,28) = 6.65$, $p < .05$. This suggests that although both measures account for a significant proportion of the unique variance associated with obtained VIQ, when given a choice, the ICS VIQ is preferable since it accounts for a slightly greater amount.

This same pattern was also found with respect to the estimates for PIQ and FSIQ although to an even greater degree. The squared semi-partial correlation coefficient for ICS PIQ was .20, F (1,28) = 7.17, $p < .05$, while for ICS FSIQ it was .25, F (1,28) = 13.16, $p < .01$. Conversely, neither the BAR PIQ or BAR FSIQ added anything significant to the relationship between estimated and obtained IQ scores. The BAR PIQ semi-partial correlation coefficient was .01, F (1,28) = .40, ns. The BAR FSIQ semi-partial correlation coefficient was .06, F (1,28) = 3.05, ns. From this, it is evident that the three ICS-based IQ estimates accounted for a greater percentage of the variance in obtained IQs than did the Barona-based estimates.

The standard errors of estimate for the ICS-based equations were 9.80, 10.20, and 9.22 for the VIQ, PIQ, and FSIQ, respectively. Little difference in the standard errors of estimate were found when equations were developed using both the ICS- and Barona-based estimates combined. These were 8.96, 10.29, and 8.90 for the VIQ, PIQ, and FSIQ, respectively for the combined ICS/BAR model. In both cases, the error estimates are considerably lower than those obtained during the original Barona et al. (1984) study (11.79, 13.23, and 12.14 for the VIQ, PIQ, and FSIQ, respectively). The cross-validation of the Barona equations conducted in the present study resulted in somewhat lower standard errors of estimate (10.11, 11.44, and 10.61 for the VIQ, PIQ, and FSIQ, respectively) than those obtained in the

Barona et al. (1984) study. However, they were still larger than those standard errors of estimate generated from the ICS equations alone or the combined ICS/BAR model.

CHAPTER V

DISCUSSION

As previously mentioned, a number of attempts have been made to develop a method with which to accurately estimate premorbid intellectual functioning. The majority of methods, particularly the initial ones, were based on the concept of selective deficits. This approach assumed that the best of the remaining skills, such as those reflected by certain Wechsler subtest scores, was representative of all premorbid skills. However, follow-up research has provided little evidence of the reliability of such approaches. In fact, Klesges, Wilkening, and Golden (1981) reviewed a number of premorbid intelligence indices and concluded that the selective deficit method is a "simplistic and inaccurate approach to assessment of premorbid status" (p. 34).

More recently the emphasis has shifted from the selective deficit concept to the use of regression analysis in which selected predictor variables are used to generate estimated premorbid IQ scores. These predictor variables have typically employed demographic data. For the most part, these techniques have resulted in such large standard errors of estimate for criterion variables that they have not been clinically useful.

The present study was undertaken in an effort to develop a scale of other than demographic data items that correlated with intelligence and which, when used in a regression equation, would predict level of intellectual functioning. The items of the ICS reflected attitudes, personal and vocational interests, personal beliefs, and personality traits. The fact that this scale was based on an individual's unique responses suggested that it was a more individualized procedure that might increase the accuracy of the premorbid IQ estimates and reduce the large standard errors of estimate that have plagued the other methods. In addition to developing such a scale and validating it on a brain-damaged population, a cross-validational check of a set of equations that used the previous methodology, demographic data, as predictor variables (Barona et al., 1984) was conducted.

The results of the present study support the use of the ICS as a valid means of estimating premorbid IQ and does so with a reasonable degree of accuracy. A comparison of the obtained (actual) IQs (Verbal, Performance, and Full Scale) on matched groups of brain-damaged and control subjects revealed the expected differences: obtained IQs of the brain-damaged group were significantly lower than the control group (Appendix J-7, K-5). This was expected and provided corroborating evidence that the brain-damaged subjects had in fact suffered cerebral impairment. The estimated IQs (ICS and Barona estimates) were higher than the obtained IQs as would be expected. However, the fact that the estimated IQs (ICS and Barona estimates) were significantly greater than the obtained IQs did not determine the accuracy of estimated IQs in predicting premorbid intellectual functioning. This accuracy was determined by the extent to which the estimated IQs approximated the obtained IQs of a control group. The data revealed no significant differences between these IQs (estimated and obtained for controls) which suggested that in fact the estimated IQs did meaningfully reflect premorbid intellectual functioning.

A statistical comparison of the ICS and Barona methods of estimating premorbid IQ revealed no significant differences between them. However, with respect to the control group, the Barona-based estimates consistently overestimated both the obtained VIQs and FSIQs while underestimating obtained PIQs to a slightly greater degree than did the ICS-based estimates although these were not statistically significant differences.

Additionally, the semi-partial correlation coefficients computed for each of the ICS- and Barona-based IQ estimates favored the ICS IQ estimates. Inspection of the data revealed that the ICS IQ estimates accounted for more of the unique variance associated with the obtained IQ scores than did the Barona estimates. The amount of unique variance in obtained VIQ accounted for by ICS VIQ and that amount in obtained FSIQ accounted for by ICS FSIQ were both significant at the .01 level. The ICS PIQ accounted for an amount of the variance in obtained PIQ that was significant at the .05 level. In comparison, only one of the Barona equations was significant at the point .05 level, that being Barona VIQ. Barona estimated PIQ and FSIQ accounted for so little variance that they were not statistically significant.

An examination of the results using a combined predictor model (ICS and Barona) to estimate premorbid IQ does not appear to hold much promise of any major improvement over the ICS method used alone except possibly estimated VIQ. The variance in obtained VIQ accounted for by ICS VIQ is somewhat less than that accounted for when the ICS VIQ and Barona VIQ estimates are combined (ICS VIQ, $\underline{r}^2 = .32$ versus ICS VIQ/BAR VIQ, $\underline{R}^2 = .45$). The differences are much smaller when this comparison is made with PIQ and FSIQ. The variances are almost equal with respect to PIQ (ICS PIQ, $\underline{r}^2 = .28$ versus ICS PIQ/BAR PIQ, $\underline{R}^2 = .29$) and only slightly less when evaluating FSIQ (ICS FSIQ, $\underline{r}^2 = .42$ versus ICS FSIQ/BAR FSIQ, $\underline{R}^2 = .48$). Similarly, the standard errors of estimate based on the ICS estimates are nearly equal to those based on the combined models. From an inspection of the data, it appears that with a larger sample in selecting items, the improvement afforded by the ICS estimates might be even greater since a number of the rejected ICS items neared significance. If the ICS item pool were expanded it may be more statistically accurate than the Barona estimates.

Interestingly enough, the squared multiple correlations between Barona-estimated IQs and the obtained IQs were smaller than those reported in the Barona et al. (1984) study and a subsequent cross-validational study by Eppinger et al. (1987). Likewise, there were major discrepancies between the Barona et al. (1984) and Eppinger et al. (1987) studies. The squared multiple correlations for each of these studies, as well as those of the present study, are reported in Table 8. Eppinger et al. (1987) obtained higher squared multiple correlations than the original Barona et al. (1984) study. They attributed this to a restricted range on the region variable. All of the Eppinger et al. (1987) subjects fell within the same geographic region. However, this explanation does not appear valid since the present study had a great percentage of its subjects from the same region and yet still obtained much lower squared multiple correlations than reported by Barona et al. (1984).

The rather marked discrepancies between these studies are not particularly surprising when considering the extreme variability inherent in assigning values to individuals for use in regression equations based on demographic data. For example, the generalization that people living in the northeastern section of the country are more intelligent

TABLE 8

SQUARED MULTIPLE CORRELATION COEFFICIENTS BETWEEN ESTIMATED AND OBTAINED (ACTUAL) VERBAL, PERFORMANCE, AND FULL SCALE IQS

	VIQ	PIQ	FSIQ
Barona et al. (1984)	.38	.24	.36
Eppinger et al. (1987)	.61	.36	.58
Barona (present study)	.27	.09	.23
ICS (present study)	.32	.28	.42
ICS/Barona combined	.45	.29	.48

(assigned a higher score) than are people living in the southern United States is, at best, suspect. Not only does this disregard the spectrum of individuality but dividing an incredibly diverse country into four quadrants and assigning scores on the basis of them greatly oversimplifies continental boundries. Also, the question as to how long a person resides in a particular area of the country to qualify a particular "region" score is as yet unanswered. In today's society, it is more the norm to have individuals grow up and live in different sections of the country. This same dilemma exists with respect to determining whether or not the individual residence is urban (population > 2500) or rural (population < 2500). People frequently grow up in small communities and yet move to more metropolitan areas to take up their residence.

Other problem areas that exist with the use of demographic data in the Barona et al. (1984) model include ambiguous ratings for occupational status and educational level. Within any particular occupational or educational level there is great variability due to individual differences. Using the Barona et al. (1984) WAIS-R occupational classification system resulted in numerous occupations that did not fit into the system, thereby making the assigned values questionable. Likewise, a middle range value (3) is assigned to those individuals not in the work force. Therefore, a retired university professor would conceivably receive the same occupational rating score as a chronically unemployed welfare recipient. In the Barona et al. (1984) system, educational level accounts for the most variability within the verbal and full scale formulae. In spite of this, important differences in educational level often result in identical scores. For example, a person graduating with honors from high school is given the same rating score as the person who also graduated but spent his/her entire academic career in special education classes. Also, a person with a bachelor's degree receives the same rating score as someone achieving an advanced graduate degree. An additional complication is the report by Barona et al. (1984) that their formulae are less accurate in estimating intellectual functioning when premorbid FSIQ falls below 69 or above 120. Another problem occurs with those individuals whose motivational level results in their being either underachievers or overachievers. All of these areas introduce considerable error into the formulae.

Given this, it is also not surprising that other methods of attempting to estimate premorbid IQ on the basis of demographic data have yielded such large standard errors of estimate that they are not useful at a clinical level. This was a major problem with the Wilson et al. (1978) equations as well as the Barona et al. (1984) equations. Using those methods, an estimated FSIQ score of 100 with the standard error of estimate of 12.14 (Barona et al., 1984) implies that the individual's premorbid level of intellectual functioning falls somewhere between low average and high average. Unfortunately, a statement this broad can be reasonably accurate without the use of a regression equation.

An index for estimating intelligence that comprise items reflecting a person's personality, interests, beliefs, and attitudes appears, to some degree, to circumvent the overgeneralizations inherent in the demographically-based methods. These characteristics, particularly personality, are well-developed early in life during the time intellectual functioning is intact and typically remain fairly stable throughout life. In cases of adult-onset brain damage, it is reasonable to assume that these traits are less likely to undergo significant transformations secondary to brain damage than are specific intellectual skills/abilities. It is believed that ideas pertaining to characteristics such as social issues, prejudice, tolerance of ambiguity, etc., reflect more of an individual's premorbid intellectual functioning than do location and size of the town of residence, sex, race, etc. It is important to note that personality characteristics are not completely immune from change, however. In fact, changes in personality are often noted following brain damage, particularly over time. Lezak (1976) indicates that some changes occur as fairly specific behavior patterns that reflect damage to specific anatomical sites in the brain. However, other personality and/or behavior changes tend not to be so much a direct product of the tissue damage as is the individual's reaction to the experience of loss, frustration, and change in style of life.

The present research shows considerable promise as far as moving toward a more accurate estimate of premorbid intellectual functioning in adults. The ICS IQ estimates seemed to account for more of the variance associated with the obtained (actual) IQ scores than did the Barona IQ estimates. Additionally, although not at a statistically significant level, the ICS IQ estimates more closely approximated the obtained (actual) IQs and did so with smaller standard errors of estimate than did the Barona et al. (1984) equations. Increasing the size of the sample of the present study may result in some of the borderline significant items becoming significant, thereby contributing further to the predictive accuracy of the ICS-based estimates.

Because of the differences in the types of sequelae seen in brain-damage stemming from CVAs versus closed- or open-head injuries, it will be important to evaluate these equations with respect to the type of injury sustained, extent of laterality of damage, etc. This of course necessitates a greater number of brain-damaged subjects. An inspection of the data from the standpoint of laterality of damage revealed that the ICS-estimated IQs generally overpredicted the actual VIQs of left hemisphere-damaged individuals. Likewise, it overestimated the actual PIQs of right hemisphere-damaged individuals. Should this expectation hold true under more elaborate statistical analysis with a larger sample size, it would have significant implications in the diagnosis of localization of cerebral lesions or sites of damage.

Since this scale reflects interests, attitudes, beliefs, and personality traits, it is also conceivable that someone close to the brain-damaged person, such as a spouse, relative, or friend might be able to answer the questions for the patient based on their knowledge of him/her. This holds considerable promise for those patients whose injuries have left them with a severe aphasia and/or other debilitating handicaps.

The question that originally formed the basis for Gentry's (1972) study was whether one could use the score on a scale consisting of items reflecting vocational interests, personality traits, and general attitudes, to predict an individual's intelligence. Despite some methodological limitations, the outcome of his feasibility study was positive. The present study has attempted to more specifically address this issue with a population of individuals for whom this is a major concern and the outcome appears to be equally positive. The ICS is not ready for clinical use at this time, however. Questions such as the impact of laterality of damage and whether the ICS holds up when used with different individuals in different locations are, at present, unanswered. Further research is therefore indicated to determine the answers to these questions.

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APPENDIX A

CONSENT TO PARTICIPATE FORMS

CONSENT TO PARTICIPATE FORM - I

I____________________________________do hereby agree to participate in the study on assessing the abilities of people who have sustained head injuries or brain trauma/disease being conducted by David Johnsen, M.S. and Robert Schlottmann, Ph.D. The purpose of this study is to develop a method for more accurately assessing the thinking and reasoning abilities of a person who has experienced such medical problems. This will be accomplished, in part, by finding items that have a relationship to verbal and/or non-verbal abilities. This study will require me to take an intelligence test, answer a questionnaire, and provide some background information (e.g., age, education, occupation, etc.). I understand that my participation will take approximately two hours, is totally voluntary, and that I may withdraw at any time. Furthermore, I understand that all identifying information will be kept confidential.

______________________________ ______________________
Signature of Participant Witness

____
Date

CONSENT TO PARTICIPATE FORM - II

I,__________________________________ do hereby agree to participate in the study on assessing the abilities of people who have sustained head injuries or brain trauma/disease being conducted by David Johnsen, M.S. and Robert Schlottmann, Ph.D. The purpose of this study is to develop a method for more accurately assessing the thinking and reasoning abilities of a person who has experienced such medical problems. This will be accomplished, in part, by finding items that have a relationship to verbal and/or non-verbal abilities. This study will require me to take an intelligence test, answer a questionnaire, and provide some background information (e.g., age, education, occupation, etc.). I understand that my participation will take approximately two hours, is totally voluntary, and that I may withdraw at any time. Furthermore, I understand that all identifying information will be kept confidential.

I also agree to allow David Johnsen to contact:

Dr. ____
(name)

at: ____
(address)

_____________________________ ____________________
Signature of Participant Witness

____
Date

APPENDIX B

BACKGROUND INFORMATION

BACKGROUND INFORMATION

Subject Number:________ Group: A(I/W) B(W/I) Age:_____

Education:________________________ Sex:_____ Race:_____
(last grade completed)

Occupation:____

List degrees, diplomas, certificates, etc. held:____________

____

____

Spouse's age:____ Education:____ Occupation:______________

Father's age:____ Education:____ Occupation:______________

Mother's age:____ Education:____ Occupation:______________

How would you describe your family's financial situation when you were growing up? (circle one)

a) wealthy

b) comfortable

c) barely adequate

d) poor

How would you describe your current financial situation? (circle one)

a) wealthy

b) comfortable

c) barely adequate

d) poor

Where did you grow up? (city & state)_______________________

Where do you currently live? (city & state)_________________

Have you ever been treated or hospitalized for a head injury? ______. If yes, please explain. ____________________

____

____

Have you ever been treated or hospitalized for a mental disorder? ______. If yes, please explain. __________________

____

____

Are you currently taking any medications?_____. If yes, please explain. ____

____

____

APPENDIX C

INSTRUCTIONS FOR COMPLETING THE INTELLECTUAL CORRELATES SCALE ITEM POOL

INSTRUCTIONS FOR COMPLETING THE INTELLECTUAL CORRELATES SCALE ITEM POOL

The following questionnaire consists of 167 items that reflect your interests, attitudes, and some relevant biographical/demographical information. Read each item and blacken in the number that most accurately reflects your feelings about it (1-Strongly Agree, 2-Agree, 3-Disagree, 4-Strongly Disagree). Remember to answer every item and mark your answer on the answer sheet. Do not write on the questionnaire booklet. Each time you complete a page on the questionnaire booklet, you will move to the next column on the answer sheet.

There is no time limit but respond to the questions as quickly as you can. Your first impressions are usually the most accurate. Are there any questions?

APPENDIX D

INITIAL CONTACT LETTER

"current date"

Dear

Thank you for your willingness to participate in the research study on assessing the abilities of persons who have sustained head injuries or brain trauma. The purpose of this study is to develop a method for more accurately assessing the thinking and reasoning abilities of a person who has experienced such medical problems. This will be accomplished, in part, by finding items that have a relationship to verbal and/or non-verbal abilities.

Your participation will take approximately two hours and will involve your taking an intelligence test, answering a questionnaire, and providing some background information (e.g., age, education, occupation, etc.). All information will remain totally confidential as code numbers will be used on the data rather than individual names. Your participation is totally voluntary and you may withdraw at any time.

I will be contacting you by telephone in a few days to schedule a testing time convenient for you. Again, thank you for your cooperation.

Sincerely,

David E. Johnsen, M.S.

APPENDIX E

INTELLECTUAL CORRELATES SCALE QUESTIONNAIRE AND ANSWER SHEET

1. People who swear do not offend me.
2. Parents are too soft on their kids nowadays.
3. I like to read articles on hard to understand technical problems.
4. I dislike being fooled.
5. I have read several articles about the origins and nature of the universe.
6. I know how to play chess.
7. People sincerely care about their fellow man.
8. I could not enjoy being an auto mechanic.
9. I do not enjoy operating business machines.
10. If my boss gives me unreasonable orders, I feel like doing the opposite.
11. I do not enjoy listening to classical music.
12. There are better ways to save money than regular savings accounts.
13. I like working on mathematical problems.
14. It is difficult to take orders without getting angry or resentful.
15. I could complete my own Federal Income Tax forms if I had the directions.
16. I can generally live up to others' expectations.
17. I was never interested in reading about atoms and molecules.
18. For every decision there is only a right or wrong answer.
19. I like to wander through an art gallery.
20. I am (or would like to be) active in community affairs.
21. If I am not good at a game, I won't play it.
22. I would enjoy being an officer in the Army so I could tell others what to do.
23. When you take a new job, promotions are based on your ability, not on who you know.
24. The American system of government is good and should not be questioned.
25. My father would not be an example of a perfect man.

26. I would like working as a beautician or barber.

27. I would not like to study law.

28. I usually made "A"s and "B"s in school.

29. I know very little about the history of my home state.

30. I would enjoy looking at things in a hardware store.

31. Playing practical jokes is my idea of fun.

32. I consider it difficult to be friendly to people who make obvious errors.

33. I may not be overly intelligent, but I do have common sense.

34. I often find myself thinking about problems that have no real answers.

35. Strangers often make judgments about people they don't know.

36. It is impossible to get to the top without lying.

37. I would like to teach gifted children.

38. I have read about Einstein's theory of relativity.

39. I would not enjoy working on a car for pay.

40. My opinions are seldom questioned.

41. You can't break the law and expect to get away with it.

42. I can repair the carburetor on a car.

43. Even though things are going badly, I sometimes feel great.

44. As a teenager I never belonged to a gang.

45. Our society owes a lot more to the working man than it does to the colleges.

46. Even when the truth is easy to see, most people need to be convinced.

47. I like easy work.

48. I feel the punishment I have received was well deserved.

49. When striving for success, you can't overcome bad breaks.

50. You should get everything you can while you are still alive.

51. Reading poetry is an enjoyable activity.

52. Will power is the key to success.

53. I don't believe in the Devil and Hell.

54. I don't know how to play bridge.

55. I would not enjoy attending a lecture on world affairs.

56. To be honest, I find rules and regulations a hassle.

57. If I can't figure things out, I quit trying.

58. I would like working as a florist.

59. I cannot tolerate vulgar people.

60. A good woman or man is hard to find.

61. I don't enjoy rough sports like ice hockey.

62. I never do more than what is expected of me.

63. With hard work you can overcome many handicaps.

64. I would not like to explore new ideas in a laboratory.

65. Solving difficult puzzles is a challenge to me.

66. I try to understand what makes our economy work.

67. I don't feel you can make decisions unless the Bible gives you the answer.

68. I am not always part of the "action."

69. The only limit on one's achievement is your will to press on.

70. I feel it is important to read the newspaper editorials each day.

71. Spelling is not difficult for me.

ICS QUESTIONNAIRE ANSWER SHEET

	SA	A	D	SD		SA	A	D	SD		SA	A	D	SD
1.	(1)	(2)	(3)	(4)	26.	(1)	(2)	(3)	(4)	51.	(1)	(2)	(3)	(4)
2.	(1)	(2)	(3)	(4)	27.	(1)	(2)	(3)	(4)	52.	(1)	(2)	(3)	(4)
3.	(1)	(2)	(3)	(4)	28.	(1)	(2)	(3)	(4)	53.	(1)	(2)	(3)	(4)
4.	(1)	(2)	(3)	(4)	29.	(1)	(2)	(3)	(4)	54.	(1)	(2)	(3)	(4)
5.	(1)	(2)	(3)	(4)	30.	(1)	(2)	(3)	(4)	55.	(1)	(2)	(3)	(4)
6.	(1)	(2)	(3)	(4)	31.	(1)	(2)	(3)	(4)	56.	(1)	(2)	(3)	(4)
7.	(1)	(2)	(3)	(4)	32.	(1)	(2)	(3)	(4)	57.	(1)	(2)	(3)	(4)
8.	(1)	(2)	(3)	(4)	33.	(1)	(2)	(3)	(4)	58.	(1)	(2)	(3)	(4)
9.	(1)	(2)	(3)	(4)	34.	(1)	(2)	(3)	(4)	59.	(1)	(2)	(3)	(4)
10.	(1)	(2)	(3)	(4)	35.	(1)	(2)	(3)	(4)	60.	(1)	(2)	(3)	(4)
11.	(1)	(2)	(3)	(4)	36.	(1)	(2)	(3)	(4)	61.	(1)	(2)	(3)	(4)
12.	(1)	(2)	(3)	(4)	37.	(1)	(2)	(3)	(4)	62.	(1)	(2)	(3)	(4)
13.	(1)	(2)	(3)	(4)	38.	(1)	(2)	(3)	(4)	63.	(1)	(2)	(3)	(4)
14.	(1)	(2)	(3)	(4)	39.	(1)	(2)	(3)	(4)	64.	(1)	(2)	(3)	(4)
15.	(1)	(2)	(3)	(4)	40.	(1)	(2)	(3)	(4)	65.	(1)	(2)	(3)	(4)
16.	(1)	(2)	(3)	(4)	41.	(1)	(2)	(3)	(4)	66.	(1)	(2)	(3)	(4)
17.	(1)	(2)	(3)	(4)	42.	(1)	(2)	(3)	(4)	67.	(1)	(2)	(3)	(4)
18.	(1)	(2)	(3)	(4)	43.	(1)	(2)	(3)	(4)	68.	(1)	(2)	(3)	(4)
19.	(1)	(2)	(3)	(4)	44.	(1)	(2)	(3)	(4)	69.	(1)	(2)	(3)	(4)
20.	(1)	(2)	(3)	(4)	45.	(1)	(2)	(3)	(4)	70.	(1)	(2)	(3)	(4)
21.	(1)	(2)	(3)	(4)	46.	(1)	(2)	(3)	(4)	71.	(1)	(2)	(3)	(4)
22.	(1)	(2)	(3)	(4)	47.	(1)	(2)	(3)	(4)					
23.	(1)	(2)	(3)	(4)	48.	(1)	(2)	(3)	(4)					
24.	(1)	(2)	(3)	(4)	49.	(1)	(2)	(3)	(4)					
25.	(1)	(2)	(3)	(4)	50.	(1)	(2)	(3)	(4)					

APPENDIX F

INSTRUCTIONS FOR COMPLETING THE INTELLECTUAL CORRELATES SCALE QUESTIONNAIRE

INSTRUCTIONS FOR COMPLETING THE INTELLECTUAL CORRELATES SCALE QUESTIONNAIRE

The following questionnaire consists of 71 items that reflect your interests, beliefs, and attitudes. Read each item and blacken in the number that most accurately reflects <u>your feelings</u> about it (1-Strongly Agree, 2-Agree, 3-Disagree, 4-Strongly Disagree). Remember to answer every item and mark your answer on the answer sheet. Do not write on the questionnaire booklet. Each time you complete a page on the questionnaire booklet, you will move to the next column on the answer sheet.

There is no time limit but respond to the questions as quickly as you can. Your first impressions are usually the most accurate. Are there any questions?

APPENDIX G

VETERANS ADMINISTRATION MEDICAL CENTER
CONSENT TO PARTICIPATE FORMS

VAMC: CONSENT TO PARTICIPATE

I,____________________________________, voluntarily agree to participate in this study entitled: The Development and Use of an Intellectual Correlates Scale for Predicting Premorbid Intelligence in Adults. This study is under the supervision of William Leber, Ph.D. and is sponsored by the Veterans Administration Medical Center.

I understand:

PURPOSE: The purpose of this study is to develop a method for more accurately assessing the mental abilities of people who have experienced head injuries. My test results will be used to determine the accuracy of this method.

STATUS: The Wechsler Adult Intelligence Scale-Revised (WAIS-R) is the standard test for measuring intellectual functioning. The Intellectual Correlates Scale (ICS) is a 71 item questionnaire reflecting attitudes, beliefs, and personal/vocational interests.

DESCRIPTION OF STUDY: I will take an intelligence test, answer a questionnaire, and provide some background information. This requires approximately two hours and does not involve any activity restrictions.

BENEFITS: The evaluation results may be useful for the treatment planning of some of the brain-injured patients. I will not receive any financial compensation, however.

RISKS: No known risks

ALTERNATIVE PROCEDURES: If I choose not to participate in this study, I will receive the usual course of therapy that my doctor would prescribe.

SUBJECT ASSURANCES: Whereas no prediction can be make concerning my results that may be obtained (because results from investigational studies cannot be predicted with certainty), Dr. Leber, acting as principal investigator, will take every precaution consistent with the best psychological practice.

By signing this consent form, I acknowledge that my participation in this study is voluntary. I also acknowledge that I have not waived any of my legal rights or released this institution from liability for negligence.

I may revoke my consent and withdraw from this study at any time without penalty of loss of benefits. My treatment by, and relations with the physicians and staff at the University of Oklahoma Health Sciences Center, now and in the future, will not be affected in any way if I refuse to participate, or if I enter the study and withdraw later.

Records of this study will be kept confidential with respect to any written or verbal reports making it impossible to identify me individually.

If I have any questions about my rights as a research subject, I may take them to the Director of Research Administration, University of Oklahoma Health Sciences Center, Room 115, Library Building, Telephone number (405) 271-2090, or to the Associate Chief of Staff, Veterans Administration Medical Center, Telephone number (405) 272-9876, Extension 3156.

SIGNATURES: I have read this informed consent document. I understand its contents and I freely consent to participate in this study under the conditions described in this document. I understand that I will receive a signed copy of this document.

________________	________________________________
(Date)	(Signature of research subject)
________________	________________________________
(Date)	(Signature of witness)
________________	________________________________
(Date)	(Signature of principal investigator)

APPENDIX H

ICS SCORING KEY

Appendix E

ICS SCORING KEY

Item	VICS	PICS	FSICS
1.	5-X		5-X
2.	X	X	X
3.	5-X	5-X	5-X
4.		5-X	
5.		5-X	5-X
6.	5-X	5-X	5-X
7.		X	X
8 .	X		
9.			
10.	5-X		5-X
11.	X	X	X
12.		5-X	
13.	5-X	5-X	5-X
14.			
15.	5-X	5-X	5-X
16.	5-X	5-X	5-X
17.			
18.			
19.	X		
20.			
21.			
22.			
23.	X	X	X
24.		X	X
25.			
26.		X	
27.		5-X	
28.			
29.	5-X		5-X
30.			
31.	5-X		
32.			
33.			X
34.			
35.			
36.	5-X		
37.			
38.			
39.			
40.		5-X	

ICS SCORING KEY (continued)

41.	X	X	X
42.	5-X		
43.	X		X
44.		5-X	
45.			
46.		5-X	
47.			
48.		X	X
49.			X
50.			
51.			
52.	X	X	X
53.	5-X	5-X	5-X
54.			
55.			
56.	5-X		
57.	X		X
58.	X		
59.			
60.	5-X		
61.			
62.		X	
63.			
64.	X	X	X
65.		5-X	
66.			
67.		X	X
68.	X		X
69.	X		X
70.		X	X
71.	5-X		

X - The score (number) corresponding to the item answer (e.g., 1-Strongly Agree, 2-Agree, 3-Disagree, 4-Strongly Agree)

To derive the ICS-estimated IQ score:

1. Sum the scores from each scale (VICS, PICS, FSICS).
2. Insert the score into the relevant regression equation:

   ICS VIQ = .95 x VICS + 46.42

   ICS PIQ = 1.36 x PICS + 12.96

   ICS FSIQ = 1.18 x FSICS + 30.42

APPENDIX I

ANALYSIS OF VARIANCE SUMMARY TABLE FOR THE VERBAL AND PERFORMANCE IQ MEASURES

APPENDIX I

ANALYSIS OF VARIANCE SUMMARY TABLE FOR THE VERBAL AND PERFORMANCE IQ MEASURES

Variable	df	MS	*F*	*p*
Impairment Status - A	1	6345.98	23.63	.0001
IQ Measures - B	2	3947.52	53.58	.0001
IQ Dimension (V-P) - C	1	328.19	10.25	.0022
AB	2	3303.40	44.83	.0001
AC	1	737.50	23.04	.0001
BC	2	48.69	1.45	.2389
ABC	2	351.34	10.45	.0001
Error	383	142.70		

APPENDIX J

NEWMAN KEULS PAIRWISE COMPARISONS FOR VERBAL AND PERFORMANCE IQ SCORES

Appendix J-1

NEWMAN-KEULS PAIRWISE COMPARISONS BETWEEN BRAIN-DAMAGED SUBJECT'S OBTAINED, ICS-ESTIMATED AND BARONA-ESTIMATED VERBAL IQ SCORES

		Means			
Group	Means	90.73	102.91	107.67	q_r
1	90.73	-	12.18*	16.94*	5.44
2	102.91		-	4.76	4.79

* $p < .01$

Group 1 (OBT VIQ - brain-damaged) = 90.73

Group 2 (BAR VIQ - brain-damaged) = 102.91

Group 3 (ICS VIQ - brain-damaged) = 107.67

Appendix J-2

NEWMAN-KEULS PAIRWISE COMPARISONS BETWEEN BRAIN-DAMAGED SUBJECT'S OBTAINED, ICS-ESTIMATED AND BARONA-ESTIMATED PERFORMANCE IQ SCORES

		Means			
Group	Means	81.94	101.15	104.61	q_r
1	81.94	-	19.21*	22.67*	5.44
2	101.15		-	3.46	4.79

* $p < .01$

Group 1 (OBT PIQ - brain-damaged) = 81.94

Group 2 (BAR PIQ - brain-damaged) = 101.15

Group 3 (ICS PIQ - brain-damaged) = 104.61

Appendix J-3

NEWMAN-KEULS PAIRWISE COMPARISONS BETWEEN CONTROL SUBJECT'S OBTAINED, ICS-ESTIMATED AND BARONA-ESTIMATED VERBAL IQ SCORES

		Means			
Group	Means	104.03	104.74	108.61	q_r
1	104.03	-	.71	4.58	5.44
2	104.74		-	3.87	4.79

Group 1 (OBT VIQ - control) = 104.03

Group 2 (ICS VIQ - control) = 104.74

Group 3 (BAR VIQ - control) = 108.61

Appendix J-4

NEWMAN-KEULS PAIRWISE COMPARISONS BETWEEN CONTROL SUBJECT'S OBTAINED, ICS-ESTIMATED AND BARONA-ESTIMATED PERFORMANCE IQ SCORES

		Means			
Group	Means	105.87	107.03	107.52	q_r
1	105.87	-	1.16	1.65	5.44
2	107.03		-	.49	4.79

Group 1 (BAR PIQ - control) = 105.87

Group 2 (ICS PIQ - control) = 107.03

Group 3 (OBT PIQ - control) = 107.52

Appendix J-5

NEWMAN-KEULS PAIRWISE COMPARISONS BETWEEN BRAIN-DAMAGED AND CONTROL SUBJECTS FOR ICS-ESTIMATED VERBAL AND PERFORMANCE IQ SCORES

		Means				
Group	Means	104.61	104.74	107.03	107.67	q_r
1	104.61	-	.13	2.42	3.06	5.26
2	104.74		-	2.29	2.93	4.91
3	107.03			-	.64	4.33

Group 1 (ICS PIQ - brain-damaged) = 104.61

Group 2 (ICS VIQ - control) = 104.74

Group 3 (ICS PIQ - control) = 107.03

Group 4 (ICS VIQ - brain-damaged) = 107.67

Appendix J-6

NEWMAN-KEULS PAIRWISE COMPARISONS BETWEEN BRAIN-DAMAGED AND CONTROL SUBJECTS FOR BARONA-ESTIMATED VERBAL AND PERFORMANCE IQ SCORES

		Means				
Group	Means	101.15	102.91	105.87	108.61	q_r
1	101.15	-	1.76	4.72	7.46*	5.26
2	102.91		-	2.96	5.70*	4.91
3	105.87			-	2.74	4.33

* $p < .01$

Group 1 (BAR PIQ - brain-damaged) = 101.15

Group 2 (BAR VIQ - brain-damaged) = 102.91

Group 3 (BAR PIQ - control) = 105.87

Group 4 (BAR VIQ - control) = 108.61

Appendix J-7

NEWMAN-KEULS PAIRWISE COMPARISONS BETWEEN BRAIN-DAMAGED AND CONTROL SUBJECTS FOR OBTAINED VERBAL AND PERFORMANCE IQ SCORES

		Means				
Group	Means	81.94	90.73	104.03	107.52	q_r
1	81.94	-	8.79*	22.09*	25.58*	5.26
2	90.73		-	13.30*	16.79*	4.91
3	104.03			-	3.49	4.33

* $p < .01$

Group 1 (OBT PIQ - brain-damaged) = 81.94

Group 2 (OBT VIQ - brain-damaged) = 90.73

Group 3 (OBT VIQ - control) = 104.03

Group 4 (OBT PIQ - control) = 107.52

APPENDIX K

ANALYSIS OF VARIANCE SUMMARY TABLE FOR THE FULL SCALE IQ MEASURE

APPENDIX K

ANALYSIS OF VARIANCE SUMMARY TABLE FOR THE FULL SCALE IQ MEASURE

Variable	df	MS	*F*	*p*
Impairment Status - A	1	3461.82	21.45	.0001
IQ Measure - B	2	1995.10	47.02	.0001
AB	2	1624.60	37.82	.0001
Error	191	135.76		

APPENDIX L

NEWMAN-KEULS PAIRWISE COMPARISONS FOR FULL SCALE IQ SCORES

Appendix L-1

NEWMAN-KEULS PAIRWISE COMPARISONS BETWEEN BRAIN-DAMAGED SUBJECT'S OBTAINED, ICS-ESTIMATED AND BARONA-ESTIMATED FULL SCALE IQ SCORES

		Means			
Group	Means	86.24	101.96	105.88	q_r
1	86.24	-	15.72*	19.64*	6.73
2	101.96		-	3.92	5.93

* $p < .01$

Group 1 (OBT FSIQ - brain-damaged) = 86.24

Group 2 (BAR FSIQ - brain-damaged) = 101.96

Group 3 (ICS FSIQ - brain-damaged) = 105.88

Appendix L-2

NEWMAN-KEULS PAIRWISE COMPARISONS BETWEEN CONTROL SUBJECT'S OBTAINED, ICS-ESTIMATED AND BARONA-ESTIMATED FULL SCALE IQ SCORES

		Means			
Group	Means	105.84	106.00	107.74	q_r
1	105.84	-	.16	1.90	6.73
2	106.00		-	1.74	5.93

Group 1 (OBT FSIQ - control) = 105.84

Group 2 (ICS FSIQ - control) = 106.00

Group 3 (BAR FSIQ - control) = 107.74

Appendix L-3

NEWMAN-KEULS PAIRWISE COMPARISONS BETWEEN BRAIN-DAMAGED AND CONTROL SUBJECTS FOR ICS-ESTIMATED FULL SCALE IQ SCORES

		Means		
Group	Means	105.88	106.00	q_r
1	105.84	-	.16	5.93

Group 1 (ICS FSIQ - brain-damaged) = 105.88

Group 2 (ICS FSIQ - control) = 106.00

Appendix L-4

NEWMAN-KEULS PAIRWISE COMPARISONS BETWEEN BRAIN-DAMAGED AND CONTROL SUBJECTS FOR BARONA-ESTIMATED FULL SCALE IQ SCORES

		Means		
Group	Means	101.96	107.74	q_r
1	101.96	-	5.78	5.93

Group 1 (BAR FSIQ - brain-damaged) = 101.96

Group 2 (BAR FSIQ - control) = 107.74

Appendix L-5

NEWMAN-KEULS PAIRWISE COMPARISONS BETWEEN BRAIN-DAMAGED AND CONTROL SUBJECTS FOR OBTAINED FULL SCALE IQ SCORES

		Means		
Group	Means	86.24	105.84	q_r
1	86.24	-	19.60*	5.93

*$p < .01$

Group 1 (OBT FSIQ - brain-damaged) = 86.24

Group 2 (OBT FSIQ - control) = 105.84

2

VITA

David Edwin Johnsen

Candidate for the Degree of

Doctor of Philosophy

Thesis: THE DEVELOPMENT AND USE OF AN INTELLECTUAL CORRELATES SCALE IN THE PREDICTION OF PREMORBID INTELLIGENCE IN ADULTS

Major Field: Psychology

Biographical:

Personal Data: Born in Oklahoma City, Oklahoma, June 16, 1954, son of Odd K. Johnsen and Edith O. Payne. Married to Kathleen L. Johnsen, August 2, 1975. One daughter, Lauren C. Johnsen, born March 27, 1984

Education: Graduated from Putnam City High School, Oklahoma City, Oklahoma, in May, 1972; received Bachelor of Science degree in Psychology from Oklahoma State University in May, 1976; received Master of Science degree in Psychology (Mental Health Specialty) from Oklahoma State University in May, 1978; completed requirements for Doctor of Philosophy degree in Psychology from Oklahoma State University in December, 1987.

Professional Experience: Psychological Assistant, Oklahoma State University, September, 1976 to August, 1977 and Bethany Guidance Center, September, 1977 to December, 1977; Mental Health Specialist Intern, Bethany Guidance Center, January, 1978 to June, 1978; Assistant Director, Bethany Guidance Center, July, 1978 to July, 1981; Teaching Assistant, Department of Psychology, Oklahoma State University, August, 1981 to May, 1982 and June, 1984 to July, 1984; Psychological Assistant, Oklahoma Department of Corrections, August, 1982 to July, 1984; Teaching Assistant, Indiana University-Purdue University at Indianapolis, August, 1984 to December, 1984; Clinical Psychology Intern, University of Indiana

School of Medicine, September, 1984 to September, 1985; Psychological Technician, September, 1984 to present; Treatment Coordinator, High Pointe Adolescent Psychiatric Treatment Center, March, 1987 to present.