MEASUREMENT OF PREMORBID INTELLECTUAL ABILITY IN BRAIN-INJURED INDIVIDUALS

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Measurement of Premorbid Intellectual Ability In Brain-Injured Individuals

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Abstract

Prediction of premorbid intellectual ability in brain-injured populations was investigated using two sets of regression equations and the Intellectual Correlates Scale (ICS). Eighty subjects completed the WAIS-R and the ICS. When possible, the Katz Adjustment Scale: Relatives Form was administered to a significant other to obtain a measure of adjustment. The four subject groups consisted of individuals with either right-hemisphere, left-hemisphere, or diffuse brain injury or without any brain injury. As expected, brain-injured groups obtained lower IQs than controls. Also, estimated IQs approximated obtained IQs for controls, while overestimating IQs for brain-injured groups. Support was provided for the continued use of the Barona, Reynolds, and Chastain (1984) and the Barona and Chastain (1986) regression equations as measures of premorbid intellectual functioning. The ICS, however, was found to be invalid and previous findings supporting its use as a measure of premorbid intellectual functioning were not replicated.

Introduction

Brain injuries afflict a large number of individuals and their families each year. The significance of assisting the brain-injured individual becomes apparent when the frequency of this condition is considered. Head injuries affect over 500,000 Americans annually (Swiercinsky, Price, & Leaf, 1987). Approximately 2,500 persons per million are estimated to be affected by strokes each year (Sahs, Hartman, & Aronson, 1979). Reitan and Wolfson (1985a) state that "The overall incidence of brain tumor is estimated to be within 4.2 and 5.4 per 100,000 population" (p. 174). These estimates do not include relatives or friends who take care of the afflicted person and attempt to adapt to the patient's behavioral changes. The estimates noted here provide only a sampling of the numbers of individuals affected by brain injuries. There are numerous forms of brain injury in addition to head injuries and strokes, including the dementias, various diseases, and the growth of tumors, all of which can result in some type of psychological deficit (Reitan & Wolfson, 1985b). Brain injury typically results in a lowering of intellectual abilities as compared to the abilities of non-impaired controls (Chelune, Ferguson, & Moehle, 1986). Johnson and Almi (1978) observed that, following brain injury, there typically is some degree of recovery of initial deficits over time.

The measurement of premorbid intellectual ability is a significant area of concern in working with brain-injured populations. Knowledge of premorbid intellectual functioning assists the clinician in assessing the extent of impairment and in formulating a maximally effective treatment plan. Identification of recently impaired abilities serves to highlight areas of difficulty in readjustment. A comparison of premorbid abilities and post-injury functioning may be useful when there are legal concerns.

It is often difficult to obtain accurate information regarding premorbid abilities, as previous psychological testing frequently has not been performed (Chelune et al. 1986). Incagnoli (1986) points out the usefulness of obtaining information from a significant other, stating that, "In many cases, the patient is unaware of or denies deficits that are conspicuous to those who live with or know the patient" (p.4). Retrospective information, however, frequently is subject to various biases and distortions in recall. The development of an accurate measure of premorbid ability would reduce the influence of such biases and increase the precision of obtained information.

Historically, several different approaches have been used to estimate premorbid intellectual functioning. One of the earliest efforts was Wechsler's (1944) Mental Deterioration Index (Chelune et al. 1986). More recent attempts to predict premorbid intellectual functioning have focused on the use of regression equations containing demographic information (e.g. Barona & Chastain, 1986; Barona, Reynolds, & Chastain, 1984; Reynolds & Gutkin, 1979; Wilson, Rosenbaum, Brown, Rourke, Whitman, & Grisell, 1978). A third type of approach involves assessment of an individual's attitudes, interests, and beliefs to estimate premorbid intellectual functioning (Gentry, 1972; Johnsen, 1987).

The present research provides a review of the major approaches which have been used to estimate premorbid intellectual functioning. The use of regression equations to predict premorbid functioning will be reviewed in depth, as this approach has become a frequently used form of predictor in recent years. However, these regression equations have large standard errors of estimate, which decreases their usefulness in predicting the level of premorbid functioning for the individual case. Therefore, it may be useful to adopt an approach, such as using the Intellectual Correlates

Scale (ICS), which is based on interests, attitudes, and beliefs found to correlate with intellectual functioning (Johnsen, 1987). This type of approach theoretically allows consideration of individual differences to a greater extent than the regression equations, however, it does not take demographic variables into account.

The purpose of the current research is to investigate whether the use of the ICS will provide a more accurate measure of premorbid intellectual functioning than is provided by currently used regression equations, namely the original Barona equations (Barona, Reynolds, & Chastain, 1984) and the revised Barona equations (Barona & Chastain, 1986). More generally, this research involves an attempt to compare the use of an individual's attitudes, beliefs, and interests (ICS) with the use of demographic information (regression equations) to provide accurate estimates of premorbid intellectual abilities. It goes beyond previous research efforts in that the effects of lateralization, time of onset since injury, and level of adjustment on the accuracy of the premorbid measures are taken into account. The major approaches which have been used to measure premorbid intellectual functioning will be reviewed.

Literature Review

In working with brain-injured patients, it is important to be able to accurately and rapidly assess premorbid intellectual functioning. This can assist the clinician both in the assessment of the patient's difficulties and in the formulation of a maximally effective treatment or rehabilitation plan. In addition, a comparison of present and premorbid functioning allows for a clearer identification of the severity of the problems that the recovering patient is likely to face. The ability to accurately assess premorbid functioning may also provide useful information when legal questions arise.

Intellectual Functioning and Brain Injury

It is a generally accepted notion that intellectual functioning typically is impaired in brain-injured individuals. Fogel (1964) found that he could discriminate between brain-injured and medically ill inpatients a maximum of 71% of the time by observing a lower level of intellectual functioning on the Wechsler Adult Intelligence Scale (WAIS) than would be expected given the patient's level of education. Also controlling for the effects of education, Ladd

(1964) found that the scores obtained by brain-injured subjects on the WAIS tended to be lower than the scores obtained by the neurotic subjects.

Russell (1972) used factor analysis to investigate the effects of brain injury on WAIS IQ scores. The subjects in his study belonged to one of four groups, either right-hemisphere damaged, left-hemisphere damaged, diffusely-damaged, or not damaged. All of the subjects had sustained brain injury at least six months prior to testing. Russell (1972) found that brain injury has a negative impact on obtained Full Scale IQ, Performance IQ, Verbal IQ, and on each of the subtests of the WAIS. He did not detect differences in the effects of right and left lateralization of damage on the WAIS Performance and Verbal factors, although it is generally agreed today that such differences do exist (Chelune et al. 1986). Verbal scores tend to be more impaired by left hemisphere damage and decreases in performance scores may reflect right hemisphere damage (Matarazzo, 1972; Parsons, 1970). However, studies such as Russell´s (1972) do provide evidence that an individual´s level of intellectual functioning is likely to decrease after brain damage has occurred.

Recovery

Heaton and Pendleton (1981) reviewed the literature relevant to the use of neuropsychological and intelligence tests in the prediction of readjustment after hospitalization. Their review found support for a relationship between performance on the WAIS and the later ability of psychiatric, retarded, and organic populations to function independently. Readjustment is also likely to be influenced by factors such as the complexity of occupational demands, the amount of available social or familial support, and the degree of adaptation required by a patient when compared with his or her previous lifestyle (Heaton & Pendleton, 1981; Lezak, 1983).

Effects of severe diffuse head-injury on intellectual functioning as measured by the WAIS were investigated by Mandleberg and Brooks (1975). They found that severely head-injured patients tended to show improvement on all WAIS measures except for the Similarities subtest within three years of injury. They also observed greater improvement occurring over a shorter period of time for Verbal tasks than for Performance tasks.

McKinlay, Brooks, Bond, Martinage, and Marshall (1981) investigated social adjustment and the types of changes occurring in 55 individuals with severe diffuse head-injury by interviewing a relative or significant other person at three, six, and nine months after the injury occurred. They found that the most common difficulties that were reported involved personality changes such as irritability, moodiness, difficulties in concentration, memory impairment, verbosity, and slowness. Those relatives who reported more numerous personality changes in the patient also reported greater levels of distress. These findings appear to suggest that social readjustment is better for those patients who do not manifest severe personality changes.

Use of Premorbid Estimates of Intellectual Functioning

There are several advantages of knowing or estimating a patient's premorbid level of intellectual functioning. Such knowledge is necessary to determine the degree of brain impairment that a patient has sustained (Klesges, Sanchez, & Stanton, 1981; Lezak, 1983). Correct interpretation of test data is promoted as the clinician can consider whether poor performance reflects an impairment of an ability or a lack of having acquired a particular ability (Lezak, 1983). Comparison of premorbid and post injury functioning highlights potential areas of increased difficulty, thus allowing formulation of realistic expectations of the patient and making readjustment easier for both patients and their families (Lezak, 1983).

Background

Since most patients have not undergone psychological testing prior to the onset of brain injury, it frequently is necessary to estimate premorbid abilities (Fogel, 1964). A number of different approaches to determining premorbid intellectual functioning have been attempted. In the past, a great deal of research focused on the use of scatter on intelligence tests as a method of determining the existence of brain impairment. Reynolds and Gutkin (1982) summarized the scatter research as typically falling into one of three categories, namely "Verbal-Performance IQ discrepancies, the range (highest minus lowest subtest scaled scores), and the number of deviant subtests (subtests deviating at a statistically significant level from the mean level of performance on all subtests)" (p. 5). Measures of scatter appear to provide some information regarding the possibility of brain impairment. However, they are not sufficient discriminators on their own and may indicate the existence of brain impairment in normal individuals. Also, they do not provide a measure of premorbid intellectual functioning. Rather, they can only suggest that brain-impairment may have occurred.

There have historically been several other approaches to the development of accurate measures of premorbid intellectual functioning. Lezak (1983) observes that, in the past, brain-injured patients were thought to perform better on tasks requiring a knowledge of vocabulary words than on tasks measuring other intellectual abilities. Thus, comparison of performance on the Vocabulary subtest with performance on other subtests of the intelligence test was believed to serve as a useful measure of premorbid intelligence (Lezak, 1983). However, a patient´s comparative ability on different tasks is dependent upon the location and severity of brain injury (Lezak, 1983). Thus, performance on a single subtest, such as Vocabulary, does not clearly indicate premorbid ability in all brain-injured patients.

In 1949, Hunt investigated Wechsler´s hypothesis that the Hold and Don´t Hold subtests of the Wechsler Bellevue Scale are differentially affected by aging. The Hold subtests are those subtests in which adult performance is not expected to be affected by increasing age. The Don´t Hold subtests are those subtests in which adult performance is expected to decline with increasing age. Hunt (1949) investigated the relationship between the Hold and the Don't Hold subtests by using Wechsler's Mental Deterioration Index, found by obtaining the difference between the sum of the Hold subtests and the sum of the Don't Hold subtests, and dividing the difference by the sum of the Hold subtests. The Mental Deterioration Index requires the use of age-corrected scaled scores in their computation so that impairment beyond that seen with normal aging will be detected. As opposed to the Wechsler hypothesis that Information, Comprehension, Picture Completion, and Object Assembly were Hold subtests, and that Digit Span, Arithmetic, Block Design, and Digit Symbol were Don't Hold subtests, Hunt (1949) found that Information and Comprehension were the only subtests not affected by aging and that Block Design and Digit Symbol were the only subtests which deteriorated at a regular rate with age.

In Rabin's (1965) review regarding diagnostic concerns and intelligence testing, he discusses the use of both the WAIS Vocabulary subtest and the Wechsler (1958) Mental Deterioration Index as measures of premorbid intellectual functioning. He criticizes both of these methods because of their potential for "false negatives and false positives" (p. 486).

Demographic Estimates of Premorbid Intelligence

More recent attempts to predict premorbid intellectual functioning have focused on the use of demographic estimates. Demographic estimates of premorbid intelligence rely on regression equations which use demographic information about an individual to predict his or her likely IQ score as compared to individuals with a similar background (Klesges & Troster, 1987). Wilson, Rosenbaum, Brown, Rourke, Whitman, and Grisell (1978) attempted to predict WAIS Verbal, Performance, and Full Scale IQs for subjects in the WAIS standardization sample by creating regression equations based on education, sex, race, age, and occupation. They found that the variables in these equations had squared multiple correlations of .53 with Verbal IQ, .42 with Performance IQ, and .54 with Full Scale IQ.

The use of regression equations provides a time efficient and objective method of estimating premorbid intellectual functioning. Thus, there were a number of research efforts to develop accurate equations for both adults and children, using the WAIS, the WAIS-R, and the WISC (e.g. Barona, Reynolds, & Chastain, 1984; Wilson et al, 1978). Although there are different regression equations for estimating intellectual functioning in adults and children, the basic reasoning behind their use is the same for all age groups. Therefore, the development of regression equations for the prediction of intellectual functioning in both adults and children will be reviewed briefly.

Reynolds and Gutkin (1979) developed regression equations for children in order to predict performance on the Wechsler Intelligence Scale for Children-Revised (WISC-R). Their equations were based on the "variables of sex, race, socioeconomic status, urban vs. rural residence, and region of residence in the United States" (p. 36). A large standard error of estimate was found to be associated with these equations (Reynolds & Gutkin, 1979). An attempt by Klesges and Sanchez (1981) to cross validate the Reynolds and Gutkin (1979) regression equations was unsuccessful in that estimated IQs were not found to be significantly correlated with obtained WISC-R Full Scale, Verbal, and Performance IQs.

Klesges, Sanchez, and Stanton (1981) attempted to cross-validate the Wilson regression equations for adults to determine their ability to predict intellectual functioning as measured by the WAIS. Their subjects were obtained from inpatient and outpatient psychiatric populations in order to investigate the predictive ability of the equations for individuals who had not sustained organic brain impairment. Positive correlations were found to exist between the equations and the actual WAIS IQ scores. However, Klesges et al. (1981) concluded that the Wilson regression equations tend to overestimate Full Scale, Verbal, and Performance IQ for both the outpatient and inpatient groups. In selecting subjects, they screened patients for neurological difficulties, but not for psychiatric difficulties. Rabin (1965) points out that psychiatric patients, particularly those with psychosis, tend to obtain lower IQ scores than individuals who are not obtaining psychiatric care. Thus, a regression equation would be expected to estimate only the premorbid level of intellectual functioning in individuals with either functional or organic impairment. It would not be expected to estimate the actual level of intellectual functioning after the onset of psychological impairment. Klesges et al. (1981) do not appear to have initially taken this consideration into account. Rather, they attempted to adjust Wilson´s formulas, specifically the weighting given to educational status, so that the regression equations would predict actual IQ rather than premorbid functioning. Finding that their corrected formulas still overpredicted actual functioning, they concluded that their subjects obtained IQ scores may have been lowered due to psychological difficulties.

Klesges (1982) investigated the Reynolds and Gutkin (1979) regression equations for children to determine their ability to differentiate brain-injured and normal children. Subjects belonged to either a normal group, consisting of psychiatric outpatients who did not have positive results on neurological examinations, or an impaired group, who had positive results on neurological examinations. Klesges did not find significant correlations between the Reynolds and Gutkin equations and the obtained WISC-R scores. After analysis of the difference scores within the two groups, Klesges (1982) concluded that the differences between obtained and estimated IQs were not statistically significant, and, thus, that they did not differentiate between brain-injured and normal groups. However, Klesges again did not control for the tendency of psychiatric impairment to decrease intellectual functioning. He disregarded this criticism, stating that "some of these [normal] children were suspected (and later diagnosed) as having learning disabilities, hyperactivity, or a seizure disorder. However, the prevalence of the above disorders were significantly higher in the brain dysfunction group" (p. 16). Apparently, this question would be better addressed by using a control group composed of individuals in whom both psychiatric and organic impairment had been screened out.

Bolter, Gouvier, Veneklasen, and Long (1982) investigated the ability of the Wilson et al. (1978) regression equations to predict premorbid intellectual functioning in head injury patients. They used the following three groups of subjects: (1) a recent head-injury group with impairment on the Halstead-Reitan Neuropsychological Battery, (2) a recovered head-injury group who did not show impairment on the Halstead-Reitan Neuropsychological Battery at follow-up, and (3) a control group of individuals who had been referred due to suspected neurological impairment, but in whom none was found. Again in this study, it is likely that the control group displayed some type of functional psychological impairment in that these subjects had initially been referred for neurological testing. Bolter et al. (1982) found correlations between the estimated IQ and Full Scale IQ to be .73 for controls, .68 for recovered head-injury patients, and .68 for nonrecovered head-injury patients. They compared the results of using Wilson's (1978) regression equations with WAIS IQs obtained at two periods of time after injury to determine the ability of the equations to estimate obtained IQ within one standard error of estimate. Comparing the estimated IQs with the actual IQs obtained at the second testing produced correct classification of individuals in the control group 67% of the time, of recovered individuals 45% of the time, and of nonrecovered individuals 55% of the time. Bolter et al. (1982) concluded that even though the Wilson et al. (1978) regression equations produced reliable estimates "for groups of patients, this does not insure that the estimates generated by such regression procedures will be reasonably accurate for individual cases" (p. 173). However, it is possible that actual IQ scores were lowered in the control group due to psychiatric impairment or that individuals in the recovered group were still functioning below their actual level of premorbid intellectual ability.

Klesges, Fisher, Vasey, and Pheley (1985) conducted another study investigating the Wilson et al. (1978) equations. They used a control group composed of individuals who had been referred for evaluation of brain damage and for whom positive results had not been found. They addressed the criticism regarding lowered intellectual functioning in psychiatric patients by stating, "It can be assumed that someone (e. g., physician, spouse) suspected a problem with these individuals. However, in clinical practice, these are precisely the types of subjects that the neuropsychologist must attempt to discriminate from those with cerebral dysfunction" (p.2). However, this does not appear to be a valid use for the regression equations, as intellectual functioning may be impaired by either psychological or neurological dysfunction. As one would expect, Klesges et al. (1985) again found that the formulas overestimated obtained IQs in both their control group and in their neurologically-impaired group.

It would appear that several investigations expected the regression equations to differentiate between functional and organic difficulties. However, the only information that these regression equations provide is an estimate of intellectual ability based on the performance of individuals with similar demographic characteristics. When this estimate differs substantially from the observed IQ scores, impairment of intellectual functioning is a possibility. None of the regression equations regarding intellectual functioning are likely to provide information on the cause of such impairment. Further research on regression equations should take this into account. Klesges and Troster (1987) provide a comprehensive review of the literature published on premorbid estimators of intellectual functioning for children and adults between 1981 and 1986. Another review in this area of study is provided by Klesges, Wilkening, and Golden (1981).

The Wechsler Adult Intelligence Scale-Revised (WAIS-R) has currently replaced the use of the WAIS as a measure of intellectual functioning. In a comparison of the two scales, Urbina, Golden, and Ariel (1982) found a high correlation between obtained scores on the WAIS and the WAIS-R, with a tendency for the WAIS scores to be higher. Klesges and Troster (1987) pointed out that the Wilson et al. (1978) regression equations are now "out of date", as these equations were constructed for use with the WAIS rather than with the WAIS-R. Regression equations based on demographic information have been created for use with the WAIS-R by Barona, Reynolds, and Chastain (1984) and Barona and Chastain (1986).

Barona, Reynolds, and Chastain (1984) created a set of equations using demographic variables to predict intellectual ability as measured by the WAIS-R. These equations will be referred to as B84 throughout the remainder of this paper. The B84 equations contained two variables in addition to those used in 1978 by Wilson et al. The two additional variables were geographic region and urban/rural background. It was suggested by Barona et al. (1984) that these equations could be used to provide an estimate of the premorbid level of intellectual functioning in head-injury patients. They developed the equations using the 1981 WAIS-R standardization sample. Their regression equations correlated .60 with Full Scale IQ, .62 with Verbal IQ, and .49 with Performance IQ. In 1986, Barona and Chastain (1986) recalculated these equations without including any subjects who were younger than 20 years of age or who were not either black or white. Their purpose in refining these equations was to increase their accuracy of prediction with respect to black and white adults. These equations will be referred to as B86 throughout the remainder of this paper. These regression equations correlated .65 with Full Scale IQ, .68 with Verbal IQ, and .53 with Performance IQ. Both the B84 and the B86 sets of equations use the same variables, however these variables are weighted differently in each set of equations with respect to determining estimated Full

Scale, Verbal, and Performance IQ.

Eppinger, Craig, Adams, and Parsons (1987) attempted to cross validate the B84 equations. They classified their 163 subjects into two groups - either neurologically-impaired or neurologically-normal. Individuals with a history of psychosis or substance dependence were not used in the study. However, a number of the controls may have had other psychological disturbances. To determine the validity of the B84 regression equations, Eppinger et al. (1987) relied on "(a) the degree of correlation between obtained WAIS-R and formula-estimated IQs and (b) the percentage of obtained WAIS-R IQs within one standard error of estimate (SEE) of the formula-estimated IQs" (p. 87).

Eppinger et al. (1987) found that the differences between the obtained and the estimated IQs were greater for the neurologically-impaired group. This would be an expected result, as these individuals would be likely to be functioning at an intellectual level below that of their peers. However, they also found that the B84 equations, in general, tended to overestimate the level of intellectual functioning, regardless of group membership, and they suggested using a difference score in conjunction with Barona's equations in individual cases. They concluded that "the Barona Index formulas have a high degree of accuracy in estimating WAIS-R IQs, although there is a tendency for the prediction equations to [slightly] overestimate scores" (p. 88). They suggested a possible explanation of this tendency to overestimate obtained IQ in the control group namely, that the control group's "psychological difficulties may have produced a small negative effect on obtained IQ scores" (p. 89). In addition, they point out several limitations of the B84 regression equations. These limitations are that the accuracy of the equations decreases due to regression toward the mean when obtained IQs are below 69 or above 120, that the occupational and educational categorizations frequently are not specific enough to account for individual cases, that the equations have a limited ceiling, and that motivation may affect obtained IQ but cannot be accounted for by the regression equations. Since their creation, the B84 regression equations have been used in research to assist in the selection of a matched control group for investigating the effects of electroconvulsive therapy and depression on memory (Steif, Sackheim, Portnoy, Decina, & Malitz, 1986) and in the selection of a control group in research conducted on migraine headache sufferers (Hooker & Raskin, 1986).

Studies investigating the relationship between WAIS-R scores and the demographic characteristics used in the B84 and the B86 equations tend to support the use of regression equations for estimating premorbid intellectual functioning. Chastain and Joe (1987) used a rotated canonical correlational technique to identify three factors containing relationships between demographic characteristics and WAIS-R performance. All of the WAIS-R subtests, educational level, occupational type, and race were found to load on a General Intelligence Factor. The performance subtests, age, and marital status loaded on a second factor. A third factor contained Block Design, Picture Completion, Object Assembly, Arithmetic, Picture Arrangement, sex, occupational type, and race.

Reynolds, Chastain, Kaufman, and McLean (1987) also conducted a study investigating the relationship between demographic characteristics and obtained WAIS-R IQ scores. They found that race, education, and occupation were strongly associated with IQ scores. Regarding Full Scale IQ, Reynolds et al. (1987) found that whites obtained a mean score that was 14-1/2 points greater than the mean score obtained by blacks, that college graduates obtained a mean score that was 32-1/2 points greater than the mean score obtained by individuals with an elementary school education, and that individuals employed in professional and technical occupations obtained a mean score that was 22 points greater than that obtained by unskilled workers. Significant differences between mean WAIS-R IQ scores were not found for sex, geographic region, or urban-rural residence, although there was a trend favoring males, residence in urban areas, and living in the West and Northeast geographic regions.

Silverstein (1987), argued against the use of regression equations for predicting individual estimates of premorbid functioning. He used the Wilson et al. (1978), the Reynolds and Gutkin (1979), and the B84 regression equations to calculate estimates of premorbid intellectual functioning and then compared the resulting distribution with that expected for obtained IQ scores. He concluded that in the majority of individual cases, the estimates would not be accurate in predicting membership in Wechsler's categories of intellectual functioning, namely "very superior, superior, high average, average, low average, borderline, [and] mentally retarded" (p. 493-494). The regression equations, however, are not typically used to estimate the placement of an individual in Wechsler's intellectual classification system. Rather, they are used to determine an estimate of IQ score within a given standard error of estimate.

Intellectual Correlates Scale

Recently, there has been an attempt to use an individual's set of beliefs, interests, and attitudes to estimate premorbid intellectual functioning (Johnsen, 1987). This type of approach was suggested by Gentry (1972), who developed items for inclusion in an Intellectual Correlates Scale (ICS). These items were based on their correlations with the Shipley-Hartford Institute for Living Scale. Gentry (1972) administered the items and the Shipley-Hartford Institute for Living Scale to 100 college undergraduates. Items found to correlate with performance on the Shipley Scale were retained for inclusion in the ICS. Gentry (1972) then cross-validated the resulting ICS scale on thirty college undergraduates who were administered the ICS, Shipley, and a shortened version of the WAIS. He found a correlation of .66 between performance on the ICS and performance on the Shipley. The Shipley scores were converted to estimated WAIS IQs. These estimated IQ scores were compared to the observed WAIS IQ scores to determine if there were significant mean differences. A significant mean difference was found for male subjects, such that their actual IQ scores were underestimated. However, no significant mean differences were found for either female subjects or for the total group. This lack of significant mean differences between actual and estimated scores reflects accuracy in estimating the actual IQ scores.

Gentry (1972) also found higher correlations between estimated and observed scores for Verbal subtests than for Performance subtests. As a result, he suggested the future development of separate scales for estimating Verbal and Performance IQ. Gentry (1972) speculated that the ICS could be useful in estimating premorbid intellectual ability in cases of acute brain injury, but not in chronic cases, as an individual´s interests and attitudes would be expected to change as he or she adapted to the effects of brain impairment.

Johnsen (1987) further developed the ICS as a method of estimating premorbid intellectual functioning in organically-impaired individuals. He used 33 adults below 60 years of age to investigate the degree of correlation between the scale items developed by Gentry (1972) and WAIS-R intelligence scores, retaining those items with the strongest correlations for inclusion in the scale. This resulted in a 71 item self-rating questionaire which uses a Likert type scale of response. He also devised equations to predict Verbal, Performance, and Full Scale WAIS-R IQ scores. Johnsen (1987) then cross-validated his revised scale using 64 subjects who belonged either to a brain-injured group or to a non-brain-injured control group matched on age and education. Both groups were administered the WAIS-R so that observed and estimated IQs could be compared. Estimates of Verbal, Performance, and Full Scale IQ were obtained using the Barona et al. (1984) equations and the ICS. Johnsen (1987) found that the ICS estimates correlated .86 with WAIS-R Verbal IQ, .84 with WAIS-R Performance IQ, and .87 with WAIS-R Full Scale IQ. Standard errors of estimate were found to be 9.80 for Verbal IQ, 10.20 for Performance IQ, and 9.22 for Full Scale IQ. Also encouraging was the finding that the ICS means estimated the control group's Verbal, Performance, and Full Scale obtained IQ means within one IQ point. The brain-injured group obtained lower observed than estimated IQs, reflecting the intellectual impairment suffered by members of this group. Based on multiple and semi-partial correlational data, Johnsen (1987) concluded that "the three ICS-based IQ estimates accounted for a greater percentage of the variance in obtained IQs than did the

Barona-based estimates" (p. 44).

The ICS scale can be used to obtain Full Scale, Performance, and Verbal IQ estimates. Items on the scale are thought to correlate with the current level of intellectual functioning in nonbrain-injured populations as measured by the WAIS-R. Use of the scale is based on two assumptions: (1) that an individual´s interests, beliefs, and attitudes correlate with intellectual ability and (2) "that this information is believed to be less affected by brain damage, at least initially, than are IQ scores" (Johnsen, 1987, p. 22).

Objectives

The present research involves an attempt to cross-validate the ICS (Johnsen, 1987) and two sets of regression equations (Barona et al., 1984, Barona & Chastain, 1986). This study goes beyond previous research efforts in that the effects of lateralization and chronicity of injury are also investigated. The ability of the two sets of regression equations and the ICS to estimate premorbid intellectual functioning in brain-injured individuals is compared. Elderly populations are used as these individuals frequently present with problems requiring estimation of premorbid abilities and have a high incidence of strokes resulting in lateralized impairment. Use of this population allows for investigation of the ability of the ICS and regression equations to separately predict Verbal and Performance IQ. The ability of the B84 equations, the B86 equations, and the ICS to accurately predict the average older individual's current level of intellectual functioning as measured by the WAIS-R is also investigated. Previous research (Gentry, 1972; Johnsen, 1987) has not attempted to assess differences in the ability to predict IQ related to the chronicity of brain impairment. Such research also has tended to use younger subjects and brain-injured populations with bilateral damage. The present research takes these factors into account.

A difference between estimated and obtained IQ scores is expected to occur for brain-injured groups, but not for the control group. The difference between estimated and obtained IQ scores for the brain-injured group is expected to reflect the intellectual impairment suffered by this group. Thus, estimated IQ would be expected to reflect premorbid functioning for the brain-injured group. Since the control group will not have a history of brain-injury, estimated scores are expected to reflect current intellectual functioning for this group, resulting in no difference between obtained and estimated IQ.

The use of the ICS, the B84 equations, and the B86 equations are considered with respect to left-hemisphere, right-hemisphere, and diffuse brain injury. Individuals with lateralized damage to the left hemisphere are expected to display impaired performance on verbal subtests, whereas individuals with lateralized damage to the right hemisphere are expected to display impaired performance on non-verbal subtests (Bornstein, 1983). The comparative ability of the ICS and the Barona equations to provide an accurate estimate of premorbid abilities is of interest.

Also of interest is the usefulness of the three premorbid estimators (ICS, B84, and B86 equations) in brain-injured populations with respect to the amount of time that has elapsed since the onset of brain injury. The location, severity, and chronicity of damage will not affect the Barona et al. (1984) and the Barona and Chastain (1986) estimates, as these are based solely on demographic information. Lateralization is not expected to affect the ICS estimates. It is expected that the ICS will reflect premorbid abilities in cases of recent injury. However, as the injury becomes chronic and the individual readjusts to it, changes in attitudes and beliefs may occur in conjunction with the degree of readjustment. As the ICS is influenced by attitudes and beliefs, it is possible that chronically-impaired individuals will respond to the ICS in such a way that these scores will reflect present abilities, rather than premorbid abilities. This result, however is not expected in more acute cases or in individuals who have been unable to readjust to the effects of their injury. Thus, the degree of correlation between obtained IQ and ICS estimates is expected to be a function of the time of onset since injury and the degree of readjustment exhibited by the individual. The greater the degree of recovery and adaptation, the smaller the expected difference between ICS estimated and obtained IQ scores is likely to be.

In the current research, it is specifically hypothesized that: (1) Estimated IQ scores for the control group will reflect their current level of intellectual functioning, resulting in no difference between their obtained and estimated IQs. (2) For each of the brain-injured groups, the estimated Full Scale IQs will be greater than the obtained Full Scale IQs, with obtained scores reflecting the intellectual impairment suffered from brain injury and estimates reflecting premorbid intellectual functioning. (3) Lateralized effects are expected to occur for the right hemisphere brain-injured group such that their WAIS-R Performance IQs will be significantly less than their WAIS-R Verbal IQs, thus reflecting the impairment of non-verbal intellectual abilities suffered from right-hemisphere injury. (4) Lateralized effects are expected to occur for the left hemisphere brain-injured group, such that their WAIS-R Verbal IQs will be significantly less than their WAIS-R Performance IQs, thus reflecting the impairment of verbal intellectual abilities suffered from lateralized left-hemisphere brain injury. (5) Lateralized effects are not expected to occur for the diffuse brain-injured group. Therefore, both WAIS-R Verbal and Performance IQs are expected to be impaired and to not differ significantly from each other, reflecting the impairment of both verbal and non-verbal intellectual abilities suffered from diffuse brain injury. (6) Chronic brain-injured groups will display greater recovery and, thus, are likely to obtain higher WAIS-R Full Scale IQs than acute brain-injured groups. (7) In the control group, IQ estimates will be correlated with WAIS-R IQs, reflecting the accuracy of the estimators in predicting current level of functioning. (8) The ICS will correlate negatively with KAS-R scores and duration, indicating a relationship between the accuracy of the

ICS as a measure of premorbid intellectual functioning and the degree of recovery or adaptation that has occurred. Additionally, the relationship between KAS-R scores, chronicity, extent of impairment, and WAIS-R IQ will be investigated.

Method

Subjects

Brain-injured subjects were recruited from two inpatient and outpatient neuropsychological hospital units and from an outpatient head injury unit in Oklahoma City. Control subjects were recruited either through referral into the study by other subjects and persons familiar with the research or through hospital records following admission and discharge for hip replacement surgery. An attempt was made to equate subjects in the control group for a similar age and educational distribution with brain-injured subjects. However, due to the clinical nature of the brain-injured sample and the inability to experimentally assign subjects to groups, demographic distributions varied between groups. For example, subjects suffering from diffuse injuries, such as motor vehicle accidents and work injuries, tend to be younger than subjects suffering from lateralized injuries, such as strokes.

In order to participate in the study, subjects were required to (1) be between the ages of 20 and 74, (2) be either black or white, and (3) be sufficiently high functioning to be administered the WAIS-R and the ICS. This third requirement may have resulted in creating differences between groups with respect to severity of injury. For example, left hemisphere impaired subjects who were severely aphasic could not participate as subjects, as their test results would be invalid. Brain-injured subjects were required to be clearly identifiable as having suffered either a lateralized or a diffuse brain injury. Control subjects were required to have no significant history of previous brain injury or significant psychiatric impairment.

Ninety-eight subjects were recruited into the study. Of these subjects, 18 were disqualified due to either reports of a previous brain injury which brought into question their group assignment, an inability to complete the testing due to low motivation and/or fatigueability, and/or a failure to meet the general requirements for participation as outlined previously. In addition, one subject was disqualified due to drinking alcohol shortly prior to his appointment. Thus, a total of 80 subjects completed participation in the research.

Subjects were assigned to one of four groups based on neurological and/or neurosurgical records and diagnoses contained in their hospital or outpatient files. When available, CAT scan and/or MRI data were used to confirm group classification. The four subject groups were (1) left-hemisphere brain-injury, (2) right-hemisphere brain-injury, (3) diffuse brain-injury, and (4) a control group with no reported history of brain injury or psychological impairment. The right and left-hemisphere brain-injured groups consisted of subjects diagnosed with a lateralized brain injury, whereas the diffuse groups consisted of subjects diagnosed with a diffuse brain injury. Subjects in brain-injured groups had no history of brain injury prior to their current injury. Subjects in the control groups had no history of previous brain injury or significant psychiatric difficulties. Each group consisted of 20 subjects. One-half of the subjects in each of the brain-injured groups consisted of individuals who had sustained brain injury less than four months prior to participation in the study (acute condition). The other one-half of the subjects in each of the brain-injured groups consisted of individuals who had sustained injury greater than six months prior to participation (chronic condition).

Control subjects were divided into two groups in the following manner. Each control who had been referred by a member of one of the acute brain injury groups was assigned to the acute control group. Each control who had been referred by a member of one of the chronic brain injury groups was assigned to the chronic control group. Remaining controls were randomly assigned to one or the other of the control groups based upon whether the numbers in the first column of a random numbers table were odd (i.e., control assigned to the acute control group) or even (i.e., control assigned to the chronic control group). The last subject was assigned to the acute control group irregardless of the random numbers table, in order to have an equal number of subjects in both groups.

Descriptive data regarding all subject groups is contained in Table 1. Groups are acute-right brain-injured (AR), acute-left brain-injured (AL), acute-diffuse brain-injured (AD), acute controls (AC), chronic-right brain-injured (CR), chronic-left brain-injured (CL), chronic-diffuse brain-injured (CD), and chronic controls (CC). The table contains the following information for each group: mean age and standard deviation (S.D.), age range of subjects within each group, median age, mean years of education and S.D., range of years of schooling for subjects within each group, median years of schooling, number of males and females, number of whites and blacks, number of individuals who are from either primarily an urban or a rural area, number of individuals from the south,

Table 1

Demographic Characteristics of Subject Groups

	AR	AL	AD	AC	CR	CL	CD	CC
Age								
Mean	65.0	57.2	36.0	43.2	59.3	61.4	38.1	51.0
S. D.	9.45	14.91	19.24	15.60	15.48	10.24	15.74	16.94
Range	43-74	30-73	20-71	20-67	22-73	41-70	22-71	24-70
Median	67.5	59.0	25.5	38.5	64.0	66.0	32.0	50.0
Education								
Mean	14.0	10.40	11.90	14.8	11.9	12.5	11.80	13.6
S. D.	6.02	2.50	2.18	2.04	2.73	3.06	1.62	2.32
Range	6-28	6-14	9-16	12-18	6-16	8-18	9-14	10-18
Median	12.2	10.2	11.8	15.0	12.0	12.2	11.8	12.8
Gender								
Female	4	4	2	7	5	5	0	8
Male	6	6	8	3	5	5	10	2
Race								
White	10	8	10	9	8	9	10	10
Black	0	2	0	1	2	1	0	0
Area								
Urban	9	5	8	7	7	7	6	8
Rural	1	5	2	3	3	3	4	2

(table continues)

	AR	AL	AD	AC	CR	CL	CD	CC
Region								
South	8	8	9	7	7	10	10	8
NE	1	1	0	0	0	0	0	0
NC	1	1	0	3	3	0	0	2
West	0	0	1	0	0	0	0	0
Handedness								
Right	9	9	9	9	9	10	8	9
Left	1	1	1	1	0	0	2	0
Ambidextrous	0	0	0	0	1	0	0	1
Occupation								
Professional	3	1	1	5	1	1	1	5
Managerial	3	1	0	3	6	5	3	4
Skilled	1	2	6	2	2	2	5	0
Unemployed	0	1	2	0	0	1	0	1
Semi-skilled	1	4	1	0	1	1	1	0
Unskilled	2	1	0	0	0	0	0	0
Months Since Onset								
Mean	1.7	2.0	1.8	0	21.9	19.7	19.6	0
S. D.	.48	1.2	.92	0	10.3	11.2	22.1	0
Range	1-2	1-4	1-3	0	5-36	6-38	6-80	0
Median	1.8	1.3	1.2	0	17.3	15.0	11.8	0

(table continues)

	AR	AL	AD	AC	CR	CL	CD	CC
Diagnosis								
CVA	8	7	1	0	7	9	0	0
Aneurysm	0	1	0	0	3	1	0	0
Meningioma	1	1	0	0	0	0	0	0
CHI	0	0	7	0	0	0	7	0
OHI	0	1	0	0	0	0	0	0
Encephalitis	0	0	1	0	0	0	1	0
Anoxia	0	0	1	0	0	0	1	0
Hematoma	1	0	0	0	0	0	1	0

Note. AR = Acute-Right group; AL = Acute-Left group; AD = Acute-Diffuse group; AC = Acute-Control group; CR = Chronic-Right group; CL = Chronic-Left group; CD = Chronic-Diffuse group; CC = Chronic-Control group; NE = Northeast; NC = Northcentral; CVA = Cerebrovascular Accident; CHI = Closed Head Injury; OHI = Open Head Injury northeast (NE), northcentral (NC), and western sections of the country, and the number of individuals in each group who are right-handed, left-handed, and ambidextrous. Also listed are the number of individuals in each of several occupational categories which were originally outlined by Barona, Reynolds, and Chastain (1984). These occupational categories are professional workers, managerial, clerical, and sales workers, foremen and skilled workers, unemployed persons, farmers, operatives, and semi-skilled workers, and unskilled workers. In addition, the mean, standard deviation, range, and median number of months since onset of injury is described for each of the brain-injured groups, as is the primary type of diagnosis. Diagnoses included in this study were cerebrovascular accidents (CVA), aneurysms, meningiomas, closed head injuries (CHI), open head injuries (OH), encephalitis, anoxia, and hematomas.

Each of the participating subjects was asked to refer a relative or close friend who could fill out the Katz Adjustment Scale: Relative´s Form (KAS-R) regarding their perception of the subject. This form was completed for 64 of the 80 subjects. Fifty nine of the respondents lived with the subject. Five respondents did not live with the subject, but maintained frequent and regular contact with him or her. The persons who completed the KAS-R are related to subjects in the following ways; 44 spouses, 8 offspring, 7 parents, 2 friends, 1 sibling, and 1 cousin. The number of KAS-Rs obtained for each subject group is as follows: 6 for the acute-right group, 6 for the acute-left group, 9 for the acute-diffuse group, 10 for the acute-control group, 9 for the chronic-right group, 9 for the chronic-left group, 8 for the chronic-diffuse group, and 7 for the chronic-control group. KAS-R data was not obtained on 16 subjects due to either the subject declining to refer a respondent, an inability to contact the respondent, or the referred respondent declining to participate.

Materials

Materials administered to all subjects were Consent Form A (See Appendix A), the WAIS-R, the ICS, a demographic questionaire (See Appendix E) for use in computing the B84 and the B86 equations, and a medical history questionaire (See Appendix F) for use in screening for previous psychological or neuropsychological difficulties. Subjects also were asked to sign Consent Form B (See Appendix B), allowing up to three acquaintances, friends, or relatives to be contacted for recruitment into the control group and

Consent Form C (See Appendix C), allowing a friend or relative to be contacted to provide information about the subject's degree of adjustment. Friends or relatives named on Consent Form C were asked to sign Consent Form D (See Appendix D) and to fill out the Katz Adjustment Scale: Relative's Form (KAS-R). Use of the KAS-R allows a measure of adjustment to be obtained so that the relationship between ICS performance and readjustment after brain injury can be investigated.

The Katz Adjustment Scales are a set of inventories designed by Katz and Lyerly (1963) to assess the social, behavioral, and psychological adjustment of psychiatric outpatients. Different portions of the inventory can be administered to the subject (S scales) and to a significant person in his or her daily life (R scales). Responses provide information about the subject's behavior as perceived both by him or her and by the other significant person. Information is also provided about the expectations being placed on the subject, his or her ability to meet these expectations, and his or her level of distress. Katz and Lyerly (1963) compared clinician's ratings of adjustment with test results, concluding that their scale has good concurrent validity and an ability to distinguish between well-adjusted and poorly-adjusted outpatients. Cluster analysis of items on the questionaire for relatives produced the following 12 clusters: belligerence, verbal expansiveness, negativism, helplessness, suspiciousness, anxiety, withdrawal and retardation, general psychopathology, nervousness, confusion, bizarreness, and hyperactivity. In an attempt to cross-validate their scale, Katz and Lyerly (1963) demonstrated internal consistency for all of the clusters except confusion. Factor analysis of the clusters found three factors, excluding the clusters of confusion, suspiciousness, and nervousness. Katz and Lyerly (1963) labeled these three factors as Social Obstreperousness, Acute Psychoticism, and Withdrawn Depression. Additionally, the KAS-R provides measures of the subject´s social role functioning, leisure time functioning, and a significant other person´s degree of satisfaction with each. The KAS-R is useful for assessing the adjustment of outpatients suffering from neuropsychological deficits (Lezak, 1983). Copies of this scale and instructions for scoring were provided by Martin M. Katz of the Montefiore Medical Center in Bronx, New York.

The ICS is a questionaire consisting of 71 items. The subject responds to each item by indicating whether he or she strongly agrees, agrees, disagrees, or strongly disagrees with the item. The Medical History Questionaire is a brief questionaire used to screen for a history of psychological and neuropsychological impairment. The Demographic Questionaire (See Appendix E) is a one page questionaire constructed for the purposes of the present research. This questionaire was used to record information about the demographic variables required for computation of the B84 and the B86 equations.

Procedure

Subjects were assigned to the appropriate group by the researcher after review of the patient's records and consultation with the appropriate staff. Historical information and data obtained from the Medical History Questionaire were used to screen all subjects for a significant history of brain-injury and psychiatric or psychological disorders. Subjects with evidence of brain injury or significant psychiatric or psychological disorders were not used as part of the control group. Subjects with evidence of confounding brain injury or neuropsychological conditions were not used in forming the brain-injured groups. Due to the acute nature of the injury and possible severity of resulting effects, for example, severely impaired cognitive functioning, the resident physician at the inpatient units or the neuropsychologist at the outpatient unit made a determination regarding whether potential subjects were competent to make informed decisions about their participation in the research. Only those subjects deemed competent to give consent, or those who gave their consent along with the consent of the responsible family member, were allowed to participate. The resident physician on the inpatient units documented this determination of competency by filling out the Competency To Give Consent Form. See Appendix G.

Brain-injured and control subjects were administered the WAIS-R, from which a Full Scale IQ, a Performance IQ, and a Verbal IQ were derived. Demographic information was used to compute the B84 and the B86 equations to derive two types of measures of premorbid intellectual functioning for the individual based on demographic characteristics. Calculation of the equations required information regarding age, sex, race, educational level, occupation, geographic region, and urban/rural residence. The ICS was administered to all subjects to obtain an individualized measure of premorbid intellectual functioning based on attitudes, interests, and beliefs. The KAS-R was given to a relative or a friend of consenting subjects to obtain a measure of their level of functioning in everyday life at the time of testing. The order of test administration was as follows: collection of demographic information, Medical History Questionaire, WAIS-R, and ICS. The KAS-R was administered to a significant other as soon as possible after testing.

Subjects were informed that the purpose of the research was to investigate the measurement of intellectual ability, both in individuals who have suffered some form of a brain injury and in individuals who have not suffered a brain injury. Subjects also were informed that they would be administered an intelligence test and a questionaire about their attitudes and interests. Subjects and their relatives or friends who participated were informed that the relative or friend would be administered a questionaire asking for information relevant to the subject's adjustment. It was explained to all subjects that they were free to withdraw from participation in the study at any time and that all information would be kept confidential. Following the subject's completion of his or her participation in the study, brief feedback was given regarding general level of performance and areas of strengths and weaknesses on the testing. The giving of feedback was supervised by a clinical neuropsychologist. A copy of the subject's test data was provided to the appropriate inpatient unit or outpatient head-injury unit. When appropriate and desired by the subject, this information was given to the neuropsychologist on the inpatient unit for recently discharged patients receiving follow up care.

Results

<u>Within-Group Analyses of Procedure</u>. One-way multivariate analyses of variance (MANOVAs) were conducted to investigate whether there were differences within each group on verbal, performance, or full scale scores depending upon the procedure used to obtain the score or estimate. The independent variable in these analyses was the procedure, of which there were four levels, namely the ICS, B84, B86, and WAIS-R. Dependent variables were VSCORE (the Verbal IQ estimate or score obtained using a procedure), PSCORE (the Performance IQ estimate or score obtained using a procedure), and FSCORE (the FSIQ estimate or score obtained using a procedure). This analysis was conducted on the control, right, left, and diffuse brain-injured groups, collapsed across duration, since a between-groups analysis, reported later, revealed that duration effects were not significant. Each of these groups, thus, has 20 subjects. Planned t -tests, using the mean square (MS) error terms obtained from the univariate analyses were conducted to investigate hypothesized results. Dunn's procedure was used to control the overall error rate. When the overall F value for the MANOVA and a given univariate analysis were significant, Tukey's tests were conducted

to investigate the remaining comparisons. On the within-subjects analyses, it was not necessary to consider any effects of sex, age, or education between groups.

Procedure Effects Within The Control Group. Since the control subjects had not suffered any significant brain injury, none of their WAIS-R IQ scores were expected to be significantly decreased and, thus, no difference between procedures was expected. Using the MS error terms obtained from the univariate analyses, *t* -tests were conducted to determine whether there were significant differences between obtained and estimated IQs. The means for verbal, performance, and full-scale scores, along with the *t*-values for pre-planned comparisons are displayed in Table 2. As expected, none of these *t*-test comparisons were significant. The *F* value for this MANOVA, using the Wilks' lambda criterion was significant, $F\ (9,\ 134) = 3.12$, $p < .01$, thus justifying further analysis of the univariate results, $F\ (9,\ 134) = 3.12$, $p < .01$. Inspection of the univariate results revealed that there were no significant main effects for procedure within the control group on either VSCORE, $F\ (3,\ 57) = 1.57$, $p > .05$, PSCORE, $F\ (3,\ 57) = 1.01$, $p > .05$, or FSCORE, $F\ (3,\ 57) = .27$, $p > .05$. These results indicate that

Table 2

Control Group Means on the ICS, B84, B86, and WAIS-R Verbal, Performance, and Full Scale Scores and t - Values for Planned Comparisons

	Means				t Values		
	ICS	B84	B86	WAIS-R			
	(1)	(2)	(3)	(4)	1 vs 4	2 vs 4	3 vs 4
VIQ	106.65	110.45	108.90	108.25	.9005	1.238	.366
PIQ	110.30	107.35	107.10	108.40	.926	.512	.634
FSIQ	108.10	109.75	109.10	109.20	.587	.293	.053

Note: As Dunn´s procedure was used to control the overall error rate at .05, the critical value for t (57) using two-tailed tests is 2.704, the value needed for significance at the .05/3 level.

* $p < .05$

all three estimators (i.e., ICS, B84, and B86) did not differ significantly from each other or from the WAIS-R IQs they were predicting. The means for verbal, performance, and full scale scores on each of the procedures are graphically represented for the control group in Figure 1.

Procedure Effects Within Groups Suffering a Brain Injury. One-way MANOVAs were conducted to investigate procedure effects within each of the brain-injured groups collapsed across duration. It was expected that for each of the brain-injured groups, the estimated full scale IQs would be greater than the obtained full scale IQs. Using the MS error terms obtained from the univariate analyses, t-tests were conducted to test hypothesized differences. The means for full scale scores, along with the t-values for pre-planned comparisons are displayed in Table 3. As expected, the three IQ estimation procedures (i.e., the ICS, B84, and B86) all significantly overestimated Full Scale WAIS-R IQ within the right, left, and diffuse brain-injured groups.

Using the Wilks´ lambda criterion, the MANOVA F values were significant at the .05 level for the right brain-injured group, F (9, 134) = 18.40, $p < .01$, the left brain-injured group, F (9, 134) = 8.66, $p < .01$,

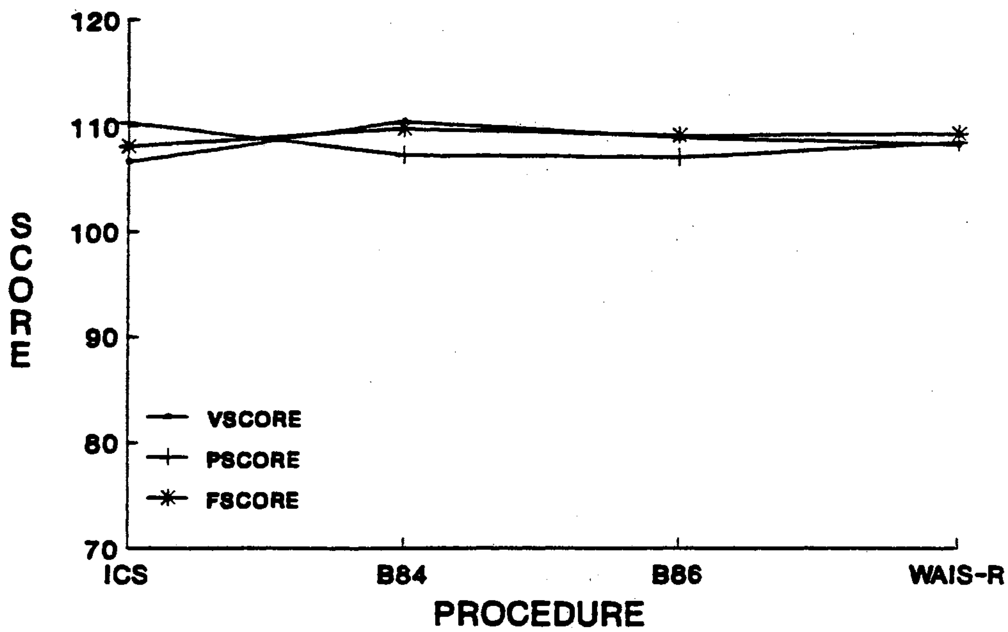

Figure 1. Mean VSCORE, PSCORE, and FSCORE for the Control Group

Table 3.

Right, Left, and Diffuse Brain-Injured Group Means on the ICS, B84, B86, and WAIS-R Full Scale Scores and t - Values for Planned Comparisons.

Group	Means				t - Values		
	ICS	B84	B86	WAIS-R			
	(1)	(2)	(3)	(4)	1 vs. 4	2 vs 4	3 vs. 4
Right	107.25	104.60	106.10	88.00	7.39*	6.37*	6.95*
Left	103.75	99.40	100.05	85.40	6.02*	4.60*	4.81*
Diffuse	105.35	102.55	100.70	83.40	14.65*	12.78*	11.55*

Note. As Dunn's procedure was used to control the overall error rate at .05, the critical value for t (57) using one-tailed tests is 2.423, the value needed for significance at the .05/3 level.

* $p < .05$

and the diffuse brain-injured group, F (9, 134) = 23.96, $p < .01$, thus justifying further analysis of the univariate results for each brain-injured group. Results of the one-way univariate ANOVAs indicated that significant main effects were found for procedure on VSCORE, PSCORE, and FSCORE within every one of the brain-injured groups. The F values and their probabilities for these main effects for procedure within each group are listed in Table 4. Using the Tukey's Studentized Range and pairwise comparisons, it was found that the three estimation procedures (i.e., the ICS, B84, and B86) all overestimated both Verbal and Performance IQ for the right, left, and diffuse brain-injured groups. Similar results were reported above for Full Scale IQ. The mean ICS, B84, B86, and WAIS-R verbal, performance, and full scale scores are displayed in Figure 2 for the right-hemisphere brain-injured group, Figure 3 for the left-hemisphere brain-injured group, and in Figure 4 for the diffuse brain-injured group. The Tukey's Studentized Range and pairwise comparisons between the IQ estimation procedures showed that, in the diffuse group, the ICS estimates were significantly higher than the B84 estimates on VSCORE and higher than the B86 estimates on VSCORE, PSCORE, and FSCORE.

Table 4

F Values for Main Effects for Procedure Within Brain-Injured Groups

Measure	Right	Left	Diffuse
VSCORE	6.91**	20.10**	64.00**
PSCORE	62.26**	9.94**	83.90**
FSCORE	24.16**	14.01**	87.70**

Note. *df* = 3, 57

* $p < .05$; ** $p < .01$;

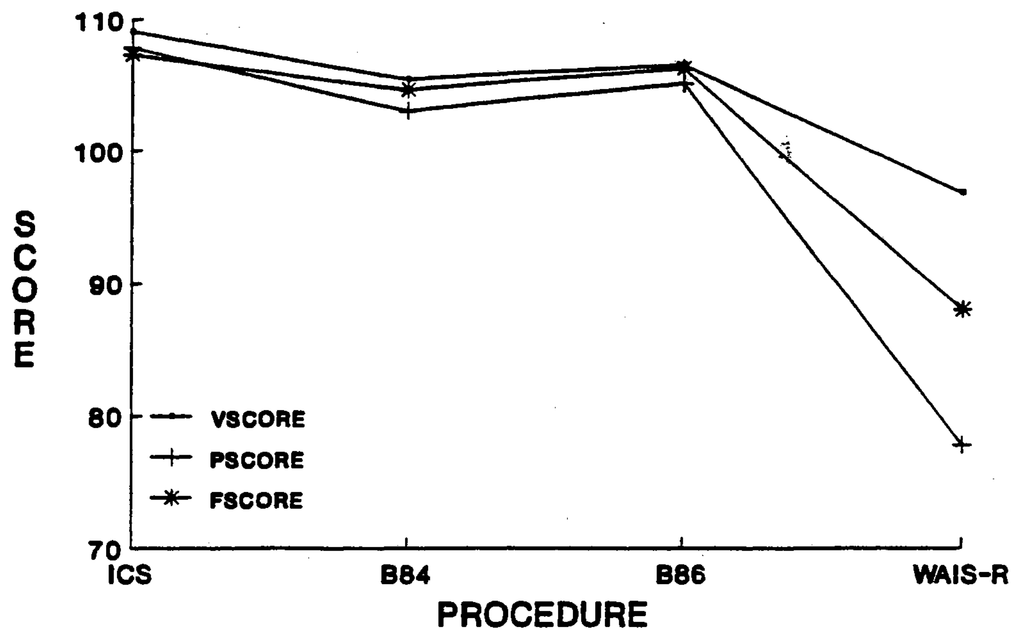

Figure 2. Mean VSCORE, PSCORE, and FSCORE for the Right Brain-Injured Group

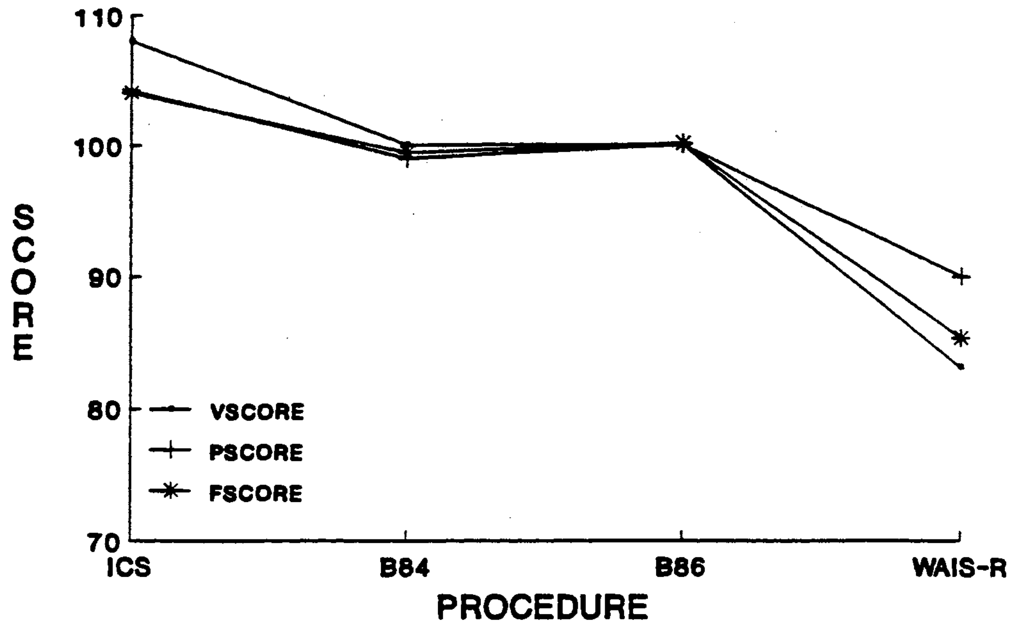

Figure 3. Mean VSCORE, PSCORE, and FSCORE for the Left Brain-Injured Group

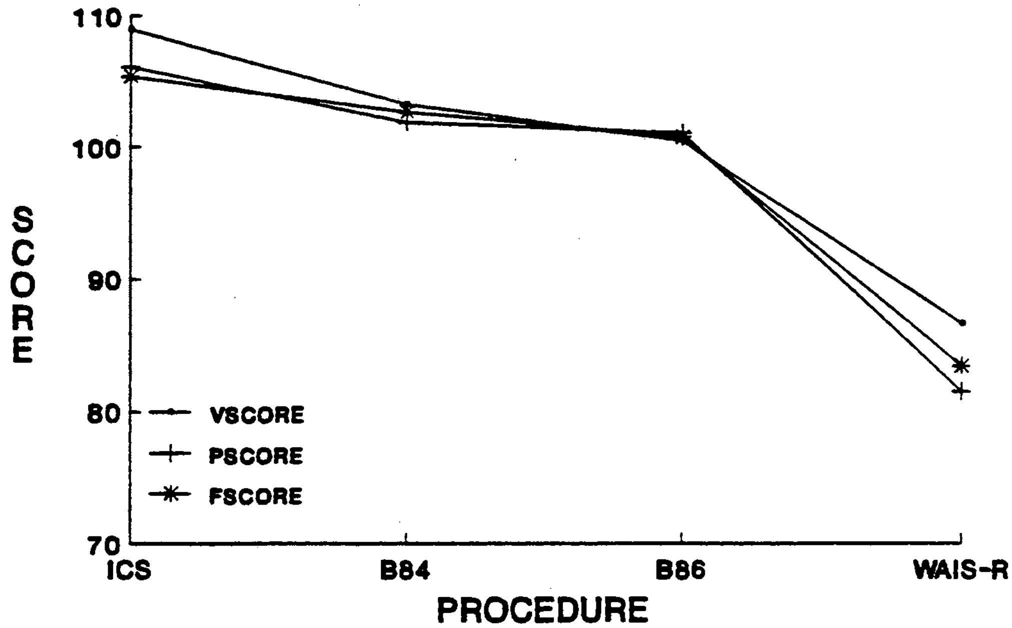

Figure 4. Mean VSCORE, PSCORE, and FSCORE for the Diffuse Brain-Injured Group

The occurrence of lateralized effects was investigated in the right, left, and diffuse brain-injured groups, collapsed across duration. Lateralized effects were expected to occur for the right and left brain-injured groups, but not for the diffuse brain-injured group. Thus, it was expected that right-hemisphere brain-injury would result in a pattern where WAIS-R Performance IQ was more impaired than WAIS-R Verbal IQ. This pattern was expected to be reversed for the left-hemisphere brain-injured group, thus, resulting in a pattern in which WAIS-R Verbal IQ was more impaired than WAIS-R Performance IQ. Since lateralized effects were not expected to result from diffuse brain injury, WAIS-R Verbal and Performance IQs for this group were not expected to differ significantly from one another. In each brain-injured group, t-tests for related measures were conducted to determine whether there were significant differences between WAIS-R Verbal and Performance IQ. As Dunn's procedure was used to control the overall error rate at .05 for a family of three comparisons, the critical value for t (19) using one-tailed tests is 2.539 and the critical value for t (19) using two-tailed tests is 2.861. The expected results regarding lateralization were found. In the right hemisphere brain-injured group, WAIS-R Performance IQ (*M* = 77.80) was found to be significantly lower than WAIS-R Verbal IQ (*M* = 96.80), t (19) = 6.185, $p < .05$, one-tailed. The effect was found to be reversed for the left-hemisphere brain-injured group, such that their WAIS-R Verbal IQ (*M* = 83.15) was significantly lower than their WAIS-R Performance IQ (*M* = 89.55), t (19) = -2.725, $p < .05$, one-tailed. The diffuse brain-injured group did not display lateralization effects as their WAIS-R Verbal IQ (*M* = 86.60) did not differ significantly from their WAIS-R Performance IQ (*M* = 81.45), t (19) = 2.063, $p < .05$, two-tailed. Additional investigation of lateralization effects was conducted using a between-groups analysis.

Group Differences A 4 X 2 ANOVA was performed on Brain-Impairment Groups (Right-hemisphere injury, Left-hemisphere injury, Diffuse injury, and Controls) X Duration (Acute, Chronic) on Age and Education to determine if there were differences in age and/or education between groups. A significant main effect was found between groups for both age, F (3, 72) = 11.89, $p < .0001$ and education, F (3, 72) = 3.19, $p < .05$. The mean ages were 62.15 for the right brain-injured group, 59.30 for the left brain-injured group, 47.10 for the control group, and 37.05 for the diffuse group. Pairwise comparisons using the Tukey's Studentized Range showed that the subjects in the right brain-injured group were significantly older than the subjects in the diffuse brain-injured group. The other groups did not differ significantly on age. The mean education for groups was 14.20 for the controls, 12.95 for the right brain-injured group, 11.85 for the diffuse brain-injured group, and 11.45 for the left brain-injured group. The Tukey's Studentized Range showed that subjects in the control group were significantly more educated than subjects in the left brain-injured group. It was apparent from review of the demographic characteristics of subject groups that there were large differences in gender (i.e., ratio of males to females) between groups (see Table 1). The mean IQ scores and IQ estimates are displayed for all acute and chronic groups in Table 5.

Analysis of Covariance Since the groups differed on age, education, and gender, an analysis of covariance procedure was used to statistically control for their effects. A 4 X 2 multivariate analysis of covariance (MANCOVA) was conducted using age, education, and gender as covariates. The independent variables were Brain-Impairment Groups and Duration since injury. The dependent variables used in the

Table 5

Group IQ Means Unadjusted for Age and Education

	Right Acute (N = 10)		Right Chronic (N =10)	
Variable	Mean	SD	Mean	SD
ICS VIQ	109.00	2.581	109.10	4.533
ICS PIQ	106.60	2.875	109.00	5.850
ICS FSIQ	106.30	3.129	108.20	3.55
B84 VIQ	106.70	12.093	104.10	10.049
B84 PIQ	104.00	9.393	101.90	8.412
B84 FSIQ	105.90	11.911	103.30	10.144
B86 VIQ	110.20	20.682	102.50	11.227
B86 PIQ	107.50	14.916	101.60	8.934
B86 FSIQ	109.90	19.936	102.30	11.136
WAIS-R VIQ	95.80	14.305	97.80	11.545
WAIS-R PIQ	75.50	5.148	80.10	9.814
WAIS-R FSIQ	86.60	8.113	89.40	9.021
	Left Acute (N = 10)		Left Chronic (N = 10)	
ICS VIQ	108.50	5.543	107.50	4.625
ICS PIQ	104.50	7.605	103.90	5.174
ICS FSIQ	103.50	7.590	104.00	5.696
B84 VIQ	95.30	8.820	104.10	8.075

(table continued)

	Left Acute		Left Chronic	
Variable	Mean	S.D.	Mean	S.D.
B84 PIQ	95.60	7.734	101.90	6.523
B84 FSIQ	95.10	8.900	103.10	8.006
B86 VIQ	94.60	8.922	104.90	9.158
B86 PIQ	95.70	7.499	103.20	7.729
B86 FSIQ	95.00	8.907	104.70	8.994
WAIS-R VIQ	83.70	13.259	82.60	18.198
WAIS-R PIQ	85.80	11.302	93.30	17.932
WAIS-R FSIQ	83.80	11.400	87.00	17.833
	Diffuse Acute (N = 10)		Diffuse Chronic (N = 10)	
ICS VIQ	108.80	3.490	109.20	4.442
ICS PIQ	104.70	2.983	107.50	5.061
ICS FSIQ	106.40	2.413	104.30	5.658
B84 VIQ	102.60	6.363	103.90	6.280
B84 PIQ	101.40	4.502	102.40	4.452
B84 FSIQ	101.80	6.015	103.50	5.930
B86 VIQ	100.00	7.645	101.00	6.896
B86 PIQ	100.90	6.226	101.00	4.784
B86 FSIQ	100.20	7.406	101.40	6.48
WAIS-R VIQ	85.10	9.994	88.10	9.758
WAIS-R PIQ	76.70	9.604	86.20	8.162
WAIS-R FSIQ	80.70	9.019	86.10	8.171

(*table continued*)

	Acute Control (N = 10)		Chronic Control (N = 10)	
Variable	Mean	S.D.	Mean	S.D.
ICS VIQ	107.40	5.441	105.90	3.071
ICS PIQ	109.20	6.477	111.40	5.956
ICS FSIQ	108.10	6.641	108.10	3.843
B84 VIQ	111.70	4.423	109.20	5.94
B84 PIQ	108.20	3.853	106.50	4.478
B84 FSIQ	110.90	4.864	108.60	6.059
B86 VIQ	109.70	5.794	108.10	7.445
B86 PIQ	108.10	4.841	106.10	5.626
B86 FSIQ	110.00	6.236	108.20	7.642
WAIS-R VIQ	107.60	12.607	108.90	7.637
WAIS-R PIQ	107.20	12.744	109.60	9.640
WAIS-R FSIQ	108.20	13.088	110.20	8.456

MANCOVA were the WAIS-R VIQ, WAIS-R PIQ, and WAIS-R FSIQ. The use of the MANCOVA analysis allowed the familywise error rate to remain controlled at .05, since multiple dependent variables were involved. Using the Wilks´ lambda criterion, it was found that there was significance for a Brain-Impairment Group effect, F (9, 163) = 10.91, $p < .01$. However, both the effect of Duration, F (3, 67) = 2.26, $p > .05$ and the interaction of Brain-Impairment Group X Duration, F (9, 163 = .762, $p < .05$ were not significant. Thus, univariate analyses were carried out, but Duration effects and the Group X Duration interaction were ignored, since they were not significant in the MANCOVA. The results of the MANCOVA and the pairwise comparisons of the adjusted group means are used to investigate differences between groups on WAIS-R IQs.

<u>Group differences on WAIS-R IQ scores</u> Brain-injured groups were found to differ significantly on the WAIS-R VIQ, F (3, 69) = 12.47, $p < .01$, on the WAIS-R PIQ, F (3, 69) = 23.06, $p < .01$, and on the WAIS-R FSIQ, F (3, 69) = 17.55, $p < .01$. The control group (adjusted M = 107.65) obtained significantly higher WAIS-R VIQ scores than either the right brain-injured group (adjusted M = 93.71), $p < .01$, the left brain-injured group (adjusted M = 82.65), $p < .01$, or

the diffuse brain-injured group (adjusted *M* = 90.79), *p* < .01). The left brain-injured group (adjusted *M* = 82.65) obtained significantly lower WAIS-R VIQ scores than the right brain-injured group (adjusted *M* = 93.71), *p* < .01.

Similar results were found for group differences on WAIS-R PIQ. The control group (adjusted *M* = 108.28) obtained significantly higher WAIS-R PIQ scores than either the right brain-injured group (adjusted *M* = 77.08), *p* < .01, the left brain-injured group (adjusted *M* = 89.16), *p* < .01, or the diffuse brain-injured group (adjusted *M* = 82.68), *p* < .01. As expected, the right brain-injured group (adjusted *M* = 77.08) obtained significantly lower WAIS-R PIQ scores than the left brain-injured group (adjusted *M* = 89.16), *p* < .01.

WAIS-R FSIQ scores were found to be significantly higher for the control group (adjusted *M* = 108.71) than for either the right brain-injured group (adjusted *M* = 85.63), *p* < .01, the left brain-injured group (adjusted *M* = 84.88), *p* < .01, or the diffuse brain-injured group (adjusted *M* = 86.78), *p* < .01.

Investigation of Duration Effects As stated before, the effect of Duration, *F* (3, 67) = 2.26, *p* > .05 was found not to be significant in the 4 X 2 MANCOVA, using the Wilks´ lambda criterion. However, it had been hypothesized that chronic brain-injured groups would display greater recovery and thus, be likely to obtain greater WAIS-R Full Scale IQs than acute brain-injured groups. Therefore, *t*-tests were carried out, using the MS error terms obtained from the univariate analyses, to test for hypothesized differences between acute and chronic brain-injured groups on FSIQ. Additionally, exploratory *t*-tests were conducted to investigate whether any differences would be found for Verbal or Performance WAIS-R IQ between acute and chronic groups. The adjusted means for Verbal, Performance, and Full Scale IQ, along with the *t*-values for comparisons are displayed in Table 6. It can be seen that, with the exception of the left brain-injured group on Verbal IQ, the adjusted means are slightly higher for chronic than for acute groups. However, the *t*-test results indicate that these differences are not significant for any of the brain-injured groups. Thus, no duration effects were found.

Effectiveness of the ICS, B84, and B86 in Predicting WAIS-R Scores. Using data from the control group, Pearson correlation coefficients were performed to investigate the relationship between each of the estimators and the WAIS-R Verbal, Performance, or Full Scale IQ they were predicting. Only the control group

Table 6

Acute and Chronic Adjusted Group Means for Right, Left, and Diffuse Brain-Injured Groups on Verbal, Performance, and Full Scale WAIS-R IQ and t-Values for Comparisons

Scale			Means			
WAIS-R	AR (1)	CR (2)	AL (3)	CL (4)	AD (5)	CD (6)
VIQ	90.63	96.79	84.99	80.31	89.59	91.98
PIQ	74.53	79.63	85.68	92.63	77.92	87.44
FSIQ	82.76	88.50	84.59	85.18	84.25	89.30

Scale		t-Values	
WAIS-R	1 vs. 2	3 vs. 4	5 vs. 6
VIQ(2)	1.197	.9096	.0465
PIQ(2)	1.01	1.377	1.886
FSIQ(1)	1.214	.125	1.067

Note. As Dunn´s procedure was used to control the overall error rate at .05 for a family of three comparisons, the critical value for t (69) using one-tailed tests is 2.390 and the critical value for t (69) using two-tailed tests is 2.660. AR = Acute Right group; CR = Chronic Right group; AL = Acute Left group; CL = Chronic Left group; AD = Acute Diffuse group; CD = Chronic Diffuse group; (2) = two-tailed test; (1) = one-tailed test

* $p < .05$

data were used in these computations since it is only in this group that the estimates are predicting current WAIS-R IQ scores. In all the brain-injured groups, the estimates are considered to be measures of premorbid intellectual functioning and WAIS-R IQs are expected to be decreased from premorbid levels. Thus, validity is established by finding a correlation between estimated and obtained IQ scores in subjects who have not suffered any brain injury. The B84 and B86 estimation procedures were both found to produce significant correlations with WAIS-R IQ. The B84 scores were found to correlate significantly on verbal score, (r = .52, p < .02), and on full scale score, (r = .48, p < .03). The correlation between the B84 performance score and the WAIS-R PIQ, however, was not significant,(r = .27, p < .26). The B86 estimation procedure produced similar results. The B86 verbal score was significantly correlated with WAIS-R VIQ, (r = .52, p < .02) and the B86 full scale score was significantly correlated with WAIS-R FSIQ, (r = .52, p < .02). Again, the correlation with Performance IQ was not significant, (r = .21,, p < .37).

The ICS scores were not found to be significantly correlated with WAIS-R IQs on either the verbal score, (r = .01, p < .95), the performance score, (r = .02, p

< .95), nor the full scale score,(r = .17, p < .47). Thus, although the ICS group data approximated WAIS-R group IQs, little relationship was actually found between the obtained IQ and the ICS estimated score for individual subjects. Since it was known that groups differed on gender, age, and education, an effort was made to see if the ICS estimation procedure could be improved by taking age, gender, and education into account. Regression equations were generated by using the SAS PROC REG procedure. This procedure generated the following regression equations: ICS VIQ = -94.53 + 1.36 X ICS VIQ + .22 X age - 16.03 X gender + 3.66 X education; ICS PIQ = 75.50 + .07 X ICS PIQ - .01 X age - 10.03 X gender + 1.99 X education; and ICS FSIQ = 4.86 + .53 X ICS FSIQ + .17 X age - 10.19 X gender + 2.97 X education. However, use of these regression equations could only be justified if the ICS was a good predictor beyond that of age, gender, and education (i.e., demonstrated incremental validity). Therefore, squared semi-partial correlations were conducted for the ICS as a predictor of WAIS-R scores for Verbal, Performance, and Full Scale IQ. The dependent variables in this procedure were the WAIS-R VIQ, PIQ, and FSIQ, whereas the independent variables were education, gender, age, and ICS score. Computation of

the squared semi-partial correlations revealed that the ICS did not significantly improve IQ estimation beyond that attained by the use of demographic factors. The ICS was added into the squared semi-partial correlation as a fourth predictor above age, gender, and education. For verbal IQ, the multiple correlation using the three predictors of age, gender, and education was .449. The multiple correlation with four predictors, having added in the ICS, was .633. The resulting *F* value was 2.68, which is not significant at the .05 level. For performance IQ, the multiple correlation using the three predictors of age, gender, and education was .252. The multiple correlation with four predictors, adding in the ICS was .253. The resulting *F* value was .008, which was not significant at the .05 level. For the full scale IQ, the multiple correlation using the three predictors of age, sex, and education was .427. The multiple correlation with four predictors, adding in the ICS was .487. The resulting *F* value was .0396, which also was not significant at the .05 level.

Effectiveness of the B84 and B86 In The Identification of Brain Impairment. A classification analysis (Huberty, 1984) was used to determine the ability of the estimated B84 and B86 premorbid intelligence scores to accurately predict the presence or absence of brain injury for the left-hemisphere injured, right-hemisphere injured, diffuse brain-injured, and control groups. The ICS estimates were not used in the classification analysis, since they had not correlated with WAIS-R IQs in the control group and thus, did not demonstrate validity as estimators of premorbid intellectual functioning. In the analysis, subjects scoring more than one standard error of estimate below their estimated verbal IQ score were classified as having left-hemisphere injury, whereas subjects scoring more than one standard error of estimate below their estimated performance IQ were classified as having right-hemisphere injury. Subjects scoring more than one standard error of estimate below both their estimated verbal and performance IQ scores were classified as having diffuse brain injury. All other subjects were classified as controls. The standard errors of estimate for the B84 regression equations are 11.79 for the verbal score, 13.23 for the performance score, and 12.14 for the full scale score (Barona, Reynolds, and Chastain, 1984). The standard errors of estimate for the B86 regression equations are 10.96 for the verbal score, 12.91 for the performance score, and 11.54 for the full scale score (Barona and Chastain, 1986). The hit rate or percent of individuals correctly classified in each group was calculated. The proportional chance criterion was also calculated to determine whether the number of correct classifications per group exceeded the level of chance. The proportional chance criterion is defined as the percentage of people who could be classified correctly by chance (Huberty, 1984). It is estimated by dividing the number of subjects in a given group by the total number of subjects being classified and then multiplying the resulting figure by the number of people in the same group (Huberty, 1984). Dunn's procedure was used to control for the possibility that multiple tests would result in an increased probability of obtaining significance. The number of false negatives and false positives also was calculated.

Table 7 lists the number and percentage of subjects classified into each of four groups (i.e., control, diffuse, right, and left brain-injured groups), when a classification analysis was conducted using either the B84 or B86 and WAIS-R discrepancy scores. The estimation procedure that was used and the actual group that the subjects belonged to is displayed in the left hand column of the table. Row totals are displayed in the far right column and column totals are displayed at the bottom of each column for each

Table 7

Number and Percentage of Subjects Classified in Control, Diffuse, Right, or Left Brain-Injured or Control Groups using either the B84 or B86 and WAIS-R Discrepancy Scores

Actual	Predicted Group Membership				
Group	Control	Diffuse	Left	Right	Total
B84					
Control	18(90%)	1(5%)	1(5%)	0(0%)	20
Diffuse	1(5%)	11(55%)	3(15%)	5(25%)	20
Left	10(50%)	8(40%)	1(5%)	1(5%)	20
Right	3(15%)	7(35%)	1(5%)	9(45%)	20
Total	32	27	6	15	
B86					
Control	19(95%)	1(5%)	0(0%)	0(0%)	20
Diffuse	1(5%)	10(50%)	4(20%)	5(25%)	20
Left	8(40%)	8(40%)	2(10%)	2(10%)	10
Right	3(15%)	8(40%)	0(0%)	9(45%)	20
Total	31	27	6	16	

estimation procedure.

Using this classification analysis, the B84 was able to correctly classify 90% of the control group, 55% of the diffuse group, 5% of the left-hemisphere injured group, and 45% of the right-hemisphere injured group. Only 10% of the control group were incorrectly classified as having suffered a brain injury. However, 50% of the left-hemisphere injured group, 15% of the right-hemisphere injured group, and 5% of the diffuse brain-injured group were incorrectly classified as controls when they had suffered a previous brain injury. Additionally, 35% of the diffuse brain-injured group, 45% of the left brain-injured group, and 40% of the right brain-injured group were correctly classified as having suffered a brain injury, but were incorrectly classified regarding lateralization.

When the classification analysis was conducted using the discrepancies between the B86 estimates and the WAIS-R IQ scores, the B86 estimates were able to correctly classify 95% of the control group, 50% of the diffuse brain-injured group, 10% of the left-hemisphere injured group, and 45% of the right-hemisphere injured group. Only 5% of the control group was classified as false positives. However, 40% of the left-hemisphere injured group, 15% of the right-hemisphere injured group, and 5% of the diffuse brain-injured group were classified as false negatives. Although correctly classified as having suffered a brain injury, 45% of the diffuse brain-injured group, 50% of the left-hemisphere injured group, and 40% of the right-hemisphere injured group, were incorrectly classified regarding lateralization.

Calculation of the proportional chance criterion, along with use of Dunn's test to control the overall error rate indicated that the B84 and B86 correctly predicted group membership for the diffuse group and for the control group at a significantly better than chance level. The *z* statistic for each group using the B84 or B86 estimators is reported in Table 8. Table 8 clearly illustrates that both of these estimation procedures were able to classify controls and diffuse brain-injured subjects significantly better than chance. The improvement over chance classification for the control group was 86.66% when the B84 estimates were used and 93.33% when the B86 equations were used. The improvement over chance classification for the diffuse brain-injured group was 40% when the B84 estimates were used and 33.33% when the B86 estimates were used.

In reviewing Table 8, it is of note that neither

Table 8

The z Statistics For Frequency of Hits in the Control, Left, Right, and Diffuse Brain-Injured Groups Using the B84 or B86 Estimates

Estimator	Control	Diffuse	Left	Right
B84	6.7132*	3.0984*	-2.0656	2.0656
B86	7.2296*	2.5820*	-1.5492	2.0656

Note. As Dunn's procedure was used to control the overall error rate at .05, the critical value for z using one-tailed tests is 2.24.

* $p < .05$

of the estimators was able to correctly predict group membership for either the right or left-hemisphere injured groups at a level better than could be obtained by chance. Both of the estimators appeared to do a better job of identifying brain-injured and control groups than of identifying lateralization of injury for the brain-injured groups. Thus, a second classification analysis was conducted, using only two groups (i.e., brain-injured and controls). In this analysis, subjects were classified as brain injured if their estimated IQ was more than one standard error of estimate greater than their obtained IQ for either verbal, performance, or full scale scores. If the estimated IQ was not more than one standard error of estimate greater than the obtained IQ, the subject was classified as part of the control group. The brain-injured group consisted of all the subjects from the diffuse, right, and left brain-injured groups. The control group remained unchanged. Using this classification analysis, the B84 estimates were able to correctly classify 76.67% of the brain-injured group and 90% of the control group. The B86 estimates were able to correctly classify 80% of the brain-injured group and 95% of the control group. Ratios of percentages of false negatives to false positives were

23.33:10.00 using the B84 estimates, and 20.00:5.00 using the B86 estimates. As Dunn's procedure was used to control the overall error rate at .05, the critical value for *z* using one-tailed tests is 1.96. Neither the B84 (z = .2981, p > .05) nor the B86 estimates (z = .8944, p > .05) were able to correctly classify the brain-injured subjects any better than chance, although they did classify the majority of these subjects correctly. However, the control group was classified by the B84 estimates with an 86.66% improvement over chance (z = 6.71, p < .05) and by the B86 estimates with a 93.33% improvement over chance (z=7.23, p <.05).

Correlational Analyses With the KAS-R. A correlational analysis was used to investigate the degree of relationship between chronicity of impairment and KAS-R adjustment scores for the brain-injured groups. Table 9 lists the correlations and their probabilities for each of the KAS-R measures with months since onset of brain injury (MONSET). The KAS-R measures are Belligerence (BEL), Verbal Expansiveness (EXP), Negativism (NEG), Helplessness (HEL), Suspiciousness (SUS), Anxiety (ANX), Withdrawal and Retardation (WDL), General Psychopathology (PSY), Nervousness (NER), Confusion (CON), Bizarreness (BIZ), Hyperactivity (HYP), the Social Obstreporousness factor

Table 9

Pearson Correlation Coefficients for KAS-R Adjustment Scores with Months Since Onset of Brain Injury (MONSET)

KAS-R	MONSET	p	KAS-R	MONSET	p
BEL	.207	$p > .002$	HYP	-.020	$p > .002$
EXP	-.076	$p > .002$	STA	.004	$p > .002$
NEG	.109	$p > .002$	SO	.151	$p > .002$
HEL	.112	$p > .002$	APSY	.033	$p > .002$
SUS	.017	$p > .002$	WD	.269	$p > .002$
ANX	.060	$p > .002$	R2	.050	$p > .002$
WDL	.302	$p > .002$	R3	.098	$p > .002$
PSY	.160	$p > .002$	R4	.143	$p > .002$
NER	.035	$p > .002$	R5	.057	$p > .002$
CON	-.035	$p > .002$	DST	-.114	$p > .002$
BIZ	.026	$p > .002$			

Note. As the multistage Bonferroni procedure was used to control the overall error rate at .05, only Pearson correlation coefficients with a probability of less than .002 were considered significant.

* $p < .002$

(SO), the Acute Psychoticism factor (APSY), the Withdrawn Depression factor (WD), R2 (which provides a measure of social role functioning), R3 (which provides a measure of the subject's ability to meet social expectations), R4 (which provides a measure of leisure time functioning), R5 (which provides a measure of the subject's ability to meet expectations regarding leisure time functioning), and a level of dissatisfaction score (DST) regarding social functioning. Since multiple correlational tests were conducted, the Bonferroni multistage procedure was used to control the overall error rate at .05. Using this procedure, it was found that only Pearson correlation coefficients with a probability of less than .002 were considered significant. No significant correlations were found for any of the KAS-R scores with months since onset.

A second correlational analysis, also using the multistage Bonferroni procedure to control the overall error rate was performed to investigate the relationship of intellectual functioning with each of the KAS-R adjustment scores for subjects from all groups. Pearson correlation coefficients were carried out on WAIS-R Verbal, Performance, and Full Scale IQs with each of the KAS-R scores. See Table 10.

Table 10

Pearson Correlation Coefficients for KAS-R Adjustment Scores with WAIS-R Verbal, Performance, and Full Scale IQ

KAS-R	WAIS-R			KAS-R	WAIS-R		
Scale	VIQ	PIQ	FSIQ	Scale	VIQ	PIQ	FSIQ
BEL	-.213	-.110	-.202	HYP	-.110	-.246	-.208
EXP	.322	.097	.236	STA	.094	.063	.103
NEG	.082	.075	.082	SO	-.001	-.037	-.028
HEL	-.212	-.443*	-.375	APSY	-.042	-.170	-.130
SUS	-.138	-.188	-.198	WD	-.238	-.451*	-.384
ANX	-.027	-.119	-.090	R2	.408	.525*	.520*
WDL	.213	-.382	-.326	R3	.437*	.565*	.559*
PSY	-.057	-.091	-.082	R4	-.053	-.038	-.049
NER	-.164	-.215	-.218	R5	-.173	-.174	-.202
CON	-.236	-.309	-.295	DST	-.095	-.176	-.143
BIZ	.039	-.056	-.021				

Note. As the multistage Bonferroni procedure was used to control the overall error rate at .05, only Pearson correlation coefficients with a probability of less than .0003 were considered significant.

* $p < .0003$

Helplessness, as measured by the KAS-R, was found to correlate negatively with WAIS-R PIQ, ($r = -.44$, $p < .0003$). This finding indicates that those individuals obtaining higher KAS-R helplessness scores also tended to obtain lower WAIS-R PIQs. None of the other KAS-R cluster scales measuring psychological symptomatology correlated significantly with WAIS-R IQ scores. Previous research by Katz & Lyerly (1963) found that the cluster scales of helplessness and withdrawal load onto a factor of "withdrawn depression" (p. 530). This factor is calculated by summing the helplessness and withdrawal clusters. The withdrawn depression factor was found to correlate negatively with WAIS-R PIQ ($r = -.45$, $p < .0002$), such that those individuals obtaining higher KAS-R withdrawn depression factor scores tended to obtain lower WAIS-R PIQs, thus following a generally accepted clinical pattern. Other factor scores were not found to correlate significantly with WAIS-R IQs.

Measures of the subject's social role functioning, leisure time functioning, and a significant other's level of satisfaction with each of these areas are also provided by the KAS-R. The level of social role functioning was found to correlate significantly with the WAIS-R, such that those individuals obtaining lower social role functioning scores tended to also obtain lower WAIS-R PIQs ($r = .53$, $p < .0001$) and FSIQs ($r = .52$, $p < .0001$). The level of social role expectations was found to correlate significantly with all WAIS-R scores, such that a lower level of expectations tended to be present regarding those individuals obtaining either lower WAIS-R VIQs ($r = .44$, $p < .0003$), PIQs ($r = .57$, $p < .0001$), or FSIQs ($r = .56$, $p < .0001$).

Extent of impairment scores were obtained for all subjects by subtracting the WAIS-R Verbal, Performance, and Full Scale IQs from their estimates. Two sets of extent of impairment scores were created, one using the estimates predicted by the B84 equations and the other using the estimates predicted by the B86 equations. The ICS estimates were not used, since they had not demonstrated validity as estimators of premorbid intellectual functioning. The correlational analysis investigated the relationship between the extent of impairment scores and each of the KAS-R variables. The resulting Pearson correlation coefficients are displayed in Table 11. When the B84 equations were used, level of social role functioning correlated negatively with extent of impairment, such that those subjects obtaining lower social role functioning scores tended to obtain higher extent of impairment scores on both Performance IQs ($r = .44$, $p < .0003$) and Full

Table 11

Pearson Correlation Coefficients for KAS-R Adjustment Scales with Extent of Impairment Scores on Verbal, Performance, and Full Scale IQ Obtained Using the B84 and B86 Estimates

KAS-R		B84			B86	
Scale	VIQ	PIQ	FSIQ	VIQ	PIQ	FSIQ
BEL	.168	.048	.139	.084	.016	.065
EXP	-.250	-.030	-.146	-.225	-.023	-.119
NEG	-.062	-.057	-.059	-.032	-.028	-.024
HEL	.176	.401	.351	.220	.403	.366
SUS	.004	.082	.059	-.003	.070	.055
ANX	-.009	.096	.057	.022	.106	.081
WDL	.184	.341	.295	.274	.379	.364
PSY	.088	.096	.114	.085	.109	.116
NER	.117	.168	.172	.083	.158	.141
CON	.172	.247	.238	.199	.248	.244
BIZ	-.075	.033	-.008	-.042	.045	.022
HYP	-.002	.164	.107	-.049	.150	.068
STA	-.036	-.010	-.038	.002	.015	-.001
SO	.032	.048	.058	.032	.062	.063
APSY	-.029	.121	.066	-.020	.124	.074
WD	.203	.406	.352	.286	.434	.408
R2	-.321	-.440*	-.436*	-.376	-.452*	-.463*

(table continued)

KAS-R		B84			B86	
Scale	VIQ	PIQ	FSIQ	VIQ	PIQ	FSIQ
R3	-.342	-.489*	-.476*	-.288	-.431	-.395
R4	.018	.003	.015	.086	.053	.079
R5	.036	.057	.066	-.017	.036	.023
DST	.078	.144	.118	.205	.225	.240

Note: As the multistage Bonferroni procedure was used to control the overall error rate at .05, only Pearson correlation coefficients with a probability of less than .0003 were considered significant.

* $p < .0003$

Scale IQs (r = .44, $p < .0003$). Similarly, when the B86 was used, level of social role functioning correlated negatively with extent of impairment on both performance scores (r = −.45, $p < .0002$) and on full scale scores (r = −.46, $p < .0001$). The relationship between level of social role expectations and extent of impairment, however, varied depending upon whether the B84 or B86 IQ estimates were used. When the B84 was used, level of social expectations correlated negatively with extent of impairment, such that a lower level of expectations tended to be present for subjects who obtained greater extent of impairment scores on both performance scores (r = −.49, $p < .0001$) and full scale scores (r = −.48, $p < .0001$). When the B86 was used, the correlations between level of expectations and extent of impairment were not significant. None of the other KAS-R scales correlated significantly with extent of impairment scores.

Discussion

The main objectives of the current research were: (1) to investigate the patterns of results found when using the ICS, B84, and B86 to estimate WAIS-R IQs for both brain-injured and control subjects, (2) to go beyond previous research efforts and investigate the effects of lateralization and chronicity of injury, (3) to attempt to cross-validate the ICS, B84, and B86 regression equations and assess their usefulness in estimating WAIS-R IQs, (4) to investigate whether the Johnsen (1987) findings, supporting the use of the ICS as a measure of premorbid intellectual ability, were replicable, and (5) to compare the ability of each of the estimation procedures to predict premorbid intellectual functioning in brain-injured individuals.

The pattern of results found when using the ICS, B84, and B86 to estimate WAIS-R IQs with brain-injured and control subjects was of interest in the current study. The estimation procedures were expected to approximate the current level of intellectual functioning in the control group, while overestimating the current level of intellectual functioning in each of the brain-injured groups. Thus, it had been hypothesized that: (1) estimated IQ scores for the control group would reflect their current level of intellectual functioning, resulting in no difference between their obtained and estimated IQs, and (2) for each of the brain-injured groups, the estimated Full Scale IQs would be greater than the obtained Full Scale IQs, with obtained scores reflecting the intellectual impairment suffered from brain injury and with estimated scores reflecting premorbid intellectual functioning. Both of these hypotheses were supported in the current research. For the control group, all three estimation procedures did not differ significantly from either each other or from the WAIS-R IQs they were predicting. This finding suggests that the estimation procedures were serving as predictors of current intellectual functioning in individuals who had not suffered any brain injury. For each of the brain-injured groups, the three IQ estimation procedures all significantly overestimated WAIS-R Full Scale IQ. This finding suggests that the estimation procedures were serving as predictors of premorbid intellectual functioning in individuals who had suffered a brain injury.

In the current research, the use of the ICS, B84, B86, and WAIS-R were considered with respect to left-hemisphere, right-hemisphere, and diffuse brain injury. It was specifically hypothesized that: (3) lateralized effects would occur for the right-hemisphere brain-injured group such that their WAIS-R Performance IQs would be significantly less than their WAIS-R Verbal IQs, thus reflecting the impairment of non-verbal intellectual abilities suffered from right-hemisphere injury; (4) lateralized effects would occur for the left-hemisphere brain-injured group, such that their WAIS-R Verbal IQs would be significantly less than their WAIS-R Performance IQs, thus reflecting the impairment of verbal intellectual abilities suffered from lateralized left-hemisphere brain injury; and (5) lateralized effects would not occur for the diffuse brain-injured group, with the result that both Verbal and Performance IQs would not differ significantly from each other. Hypotheses 3, 4, and 5 were supported. The right-hemisphere brain-injured group displayed significantly lower WAIS-R Performance IQ than Verbal IQ, whereas the left hemisphere brain-injured group displayed significantly lower WAIS-R Verbal IQ than Performance IQ. Also, as expected, the diffuse brain-injured group did not display lateralization effects, as their WAIS-R Verbal IQ did not differ significantly from their WAIS-R Performance IQ. Similarly, between-groups analyses found that the left brain-injured group obtained significantly lower WAIS-R Verbal IQs than the right brain-injured group and that the right brain-injured group obtained significantly lower WAIS-R Performance IQs than the left brain-injured group. All of the brain-injured groups obtained significantly lower WAIS-R Verbal, Performance, and Full Scale IQs than the control group. Thus, it is concluded that left hemisphere injury resulted in more severe, but not exclusive, impairment of verbal abilities, whereas right-hemisphere injury resulted in more severe, but not exclusive, impairment of non-verbal abilities.

Next to be discussed is the ability of the ICS, B84, and B86 procedures to estimate premorbid intellectual functioning with respect to lateralized brain injuries. In the within-group analyses, it was found that all three estimation procedures overestimated both WAIS-R Verbal and Performance IQ for the right, left, and diffuse brain-injured groups. Additionally, it was concluded from investigation of the WAIS-R results that lateralized injuries resulted in more severe impairments of particular types of abilities rather than in exclusive impairments of only these abilities. Thus, it would be overly simplistic and inaccurate to assume that the estimates would overpredict certain abilities, but not others, in cases of lateralized injury. Rather, what occurs is that the more severely impaired abilities are overestimated to a greater degree than are other less severely impaired abilities. To provide an illustration of this concept, the degree of overestimation observed in the current study for verbal and non-verbal abilities will be considered in right and left-lateralized injuries. For the right-hemisphere injured group, WAIS-R Performance IQs, considered to be more severely impaired, were overpredicted 25.15 points by the B84, 26.75 points by the B86, and 30.0 points by the ICS. Comparatively, the WAIS-R Verbal IQs, considerd to be less severely impaired by right-hemisphere injury, were overpredicted 8.6 points by the B84, 9.55 points by the B86, and 12.55 points by the ICS. For the left-hemisphere group, WAIS-R Verbal IQs, considered to be more severely impaired, were overpredicted 16.8 points by the B84, 16.85 points by the B86, and 24.85 points by the ICS. Comparatively, the WAIS-R Performance IQs, considered to be less severely impaired by left-hemisphere injury, were overpredicted 9.45 points by the B84, 10.1 points by the B86, and 14.65 points by the ICS. It is of note that for the diffuse brain-injured group, the degree of overestimation was similar for both WAIS-R Verbal and Performance IQs, ranging from 13.75 to 23.4 points for Verbal IQ and 19.55 to

24.65 points for Performance IQ. From this illustration, it would appear that in cases of lateralized-left or right injury, the estimators would tend to overpredict both WAIS-R Verbal and Performance IQs, although one would be overpredicted to a greater extent than the other. This concept would be difficult to apply in a practical manner, such as that of making decisions about the lateralization of brain injury in individual cases. As can be observed in the first classification analysis conducted in the present study, the estimation procedures were not able to accurately predict group membership for either the right or left-hemisphere injured groups at a level better than could be identified by chance. Thus, it is concluded that in cases of left or right-lateralized brain injury, lateralized effects are most easily and accurately observed by considering the differences between WAIS-R Verbal and Performance IQ. It is recommended that none of the estimation procedures be used to make decisions about the lateralization of brain injury, particularly in individual cases.

The current research clearly represents a failure to replicate the Johnsen (1987) findings supporting the use of the ICS, in its current state of development, as an accurate estimator of intellectual functioning.

Although the ICS achieved the predicted pattern of results between groups, no relationship was found to exist between the ICS and the WAIS-R scores for individual controls. Thus, hypothesis 7, namely that the IQ estimates would be correlated with the WAIS-R IQ scores in the control group was not supported when the ICS was used as an estimator. As stated before, the real test of validity for an estimation procedure depends upon whether it can be shown to correlate with the scores it is predicting. The results of the current study will be considered with respect to the Johnsen (1987) study. During the time the current research was being conducted, Schlottmann and Johnsen (1991) reanalyzed the Johnsen (1987) data to include the use of the B86 regression equations. They dropped out those subjects who were inappropriate for inclusion when using the B86 equations. This resulted in a reduction in the size of the control group from 31 to 28 individuals and also produced mild changes in the descriptive statistics for each group. The results of the current study will also be compared with the Schlottmann and Johnsen (1991) reanalysis of the earlier data.

Some explanation may be required regarding why certain results found in both Johnsen's (1987) research and in the current study do not establish validity for the ICS. In the Johnsen (1987) study, the ICS means estimated the control group's Verbal, Performance, and Full Scale obtained IQ means within one point. Similar results were found in the current study, in that the control group ICS estimates differed from their WAIS-R IQ means by only -1.6 points on Verbal IQ, 1.9 points on Performance IQ, and less than one point on Full Scale IQ. Also, in both studies, it was found that the brain-injured group obtained lower observed than estimated IQs. These results sound impressive. However, in light of the non-significant correlations for the ICS with WAIS-R IQs, these findings can not be taken to indicate validity for the ICS. It is important to consider that the control group has not suffered any brain injury, and thus will tend to have a restricted IQ range, around 100. Thus, randomly using some number near 100, or near the mean IQ of the group to predict IQ scores could result in producing similar results. The real test of validity is in the ability of the estimator to display some relationship with the scores it is estimating. It is this which the ICS was unable to accomplish in the current research.

The lack of a significant correlation between the ICS estimates and the WAIS-R IQs for the control group in the current study represents the failure to successfully cross-validate the ICS. Specifically, Johnsen (1987) had found that the ICS estimates correlated .86 with WAIS-R Verbal IQ, .84 with WAIS-R Performance IQ, and .87 with WAIS-R Full Scale IQ. The reanalysis of the data by Schlottmann and Johnsen (1991) found much lower correlations, although they were still significant. The correlations for the ICS were .57 with WAIS-R Verbal IQ, .54 with WAIS-R Performance IQ, and .65 with WAIS-R Full Scale IQ. However, in the current study, the ICS correlations of .01 with WAIS-R Verbal IQ, .02 with WAIS-R Performance IQ, and .21 with WAIS-R Full Scale IQ all were non-significant. Thus, the finding of a strong relationship between ICS estimates and WAIS-R IQ scores is not robust across the two different samples. This leads to a new question, namely, are there particular subject populations for which the ICS is useful as a predictor of IQ and other subject populations for which it is not useful. Comparison of the control group who participated in the Johnsen (1987) study with the current control group may provide some clues regarding this question.

The control group used in the Johnsen (1987) study differed from the control group used in the current research. Specifically, the control group in the current research allowed older subjects to participate, was comprised solely of individuals from the Southern and North Central regions, and included higher percentages of females (75%), professionals (50%), managers and clerical staff (35%), and individuals of rural background (25%). Comparatively, the control group participating in Johnsen's (1987) study was 68% female, 25% professional, 29% managerial and clerical, and only 3% were of rural background. Also, a considerably higher number of individuals (23%) were from regions of the country other than the North Central and Southern sections. It is of note that with respect to the two major demographic variables of age and education, the control groups were similar. The Johnsen (1987) control group had a mean age of 45.97 and a mean educational level of 13.81 and the control group in the present study had a mean age of 47.1 and a mean educational level of 14.2. Thus, although the current research allowed older individuals to participate, the two control groups did not differ significantly with respect to age. Comparison of the different control groups participating in the current study and in Johnsen's (1987) study suggests that the ICS may be more effective for males and/or subjects with urban backgrounds. It also may be sensitive to occupational choice and region of residence. However, this cannot be ascertained with any degree of certainty from the current study.

It is of note that the ICS does not take any demographic variables into account. In the present study, it was found that both gender and education correlated with ICS scores. When squared semi-partial correlations were calculated for Verbal IQ, 45% of the variance was accounted for by age, gender, and education. With the ICS added into the squared semi-partial correlation, 63% of the variance could be accounted for. This represents a considerable improvement over the ICS results obtained when no demographic variables were taken into account. However, the results for Full Scale and Performance IQ were less impressive, in that the ICS accounted for very little of the variance beyond that accounted for by age, gender, and education. Although none of the squared semi-partial results attained statistical significance, they suggest that a more robust estimator of Verbal IQ might be created by formulating regression equations that take into account both different demographic factors and the type of individual characteristics tapped by the ICS. It is of interest that Johnsen (1987) reached a similar conclusion, suggesting the possibility of combining the ICS and B84 equations to estimate Verbal IQ. Johnsen's (1987) suggestion was due to his finding that the amount of variance accounted for by the ICS in his sample could be increased from 32% to 45% for Verbal IQ, when he added in the B84 equations containing values for demographic data. Just as in the present study, he did not find that the amount of variance accounted for could be significantly increased in this manner for either Performance or Full Scale IQ. However, Schlottmann and Johnsen (1991) felt that the use of the B84 or B86 equations, along with the ICS could be useful when estimating either Full Scale or Verbal IQs. The combined results from these three studies suggest that the ICS might be improved if demographic factors could be incorporated into the calculation of the ICS estimates.

At this time, it cannot be concluded that the ICS is a valid predictor of IQ scores. Rather, it appears to be subject to great variability in its usefulness. Much of this variability, particularly for the verbal estimates may be dependent upon the demographic characteristics of the populations being sampled. Thus, it would be useful for future research with the

ICS to explore its reliability and validity across demographically different samples.

One of the purposes of the current study was to attempt to cross-validate the B84 and B86 demographic regression equations in addition to the ICS. Hypothesis 7 stated that in the control group, the IQ estimates would be correlated with the WAIS-R IQ scores, reflecting the accuracy of the estimators in predicting current level of intellectual functioning. The ICS, as already explained, was not successfully cross-validated. However, the current research does provide support for the continued use of the B84 and B86 regression equations as estimators of premorbid intellectual functioning. Both of these estimation procedures were found to correlate significantly with WAIS-R Verbal and Full Scale IQs for the control subjects. Neither of the equations correlated significantly with Performance IQ, although both of these correlations were higher than they had been for the ICS. There was little difference between the degree of correlation that the two equations had with WAIS-R IQ scores. Specifically, the correlations for the B86 were .52, .21, and .52 with WAIS-R Verbal, Performance, and Full Scale IQ. In comparison, the correlations for the B84 were .52, .27, and .48. Thus, either of the equations accounted for 27% of the variance associated with Verbal IQ. On Full Scale IQ, the B84 equations accounted for 23% of the variance, whereas the B86 showed a very slight advantage accounting for 27% of the variance. The results for the B84 regression equations are strikingly similar to those obtained by Johnsen (1987). In his research, he found correlations of .52, .30, and .48 for the B84 with WAIS-R Verbal, Performance, and Full Scale IQ, respectively. Thus, the correlations that he found for Verbal and Full Scale IQ were exactly the same as those found in this study. His results with respect to the correlation with Performance IQ are also similar. This similarity in the findings between the two studies suggests that these equations are reliable and robust across different samples.

Other research (Schlottmann & Johnsen, 1991; Eppinger et al., 1987) has found even more promising results with respect to the B84 and B86 regression equations, thus constituting additional evidence for their usefulness. See Table 12, which lists the correlations found in several studies, between obtained and estimated Verbal, Performance, and Full Scale IQs using the B84 and B86 equations. In the Schlottmann and Johnsen (1991) reanalysis of their data, significant correlations were found for all of the B84 estimates and for the B86 Verbal and Full Scale IQ estimates with WAIS-R IQ. Here, the B86 estimates also showed a slight advantage over the B84 verbal estimates. Eppinger et al. (1987), conducting their research in the same area of the country as this study, also found significant correlations for all of the B84 estimates with WAIS-R IQs. These correlations were noted by Eppinger et al. (1987) to be slightly higher than the correlations found for the B84 regression equations at the time of their construction (Barona et al., 1984). Both the Barona et al. (1984) and the Barona and Chastain (1986) studies had initially found significant correlations between the regression equations they had created and the corresponding Verbal, Performance, and Full Scale IQ. The repeated findings of significant correlations between WAIS-R IQs and the B84 and B86 estimates suggest reliability of these two regression equations over different samples, as all of these studies have found the B84 estimates to be related to the Verbal and Full Scale IQs they were predicting. Additionally, those studies incorporating the use of the B86 equations found they also were related to the Verbal and Full Scale IQs they were predicting and showed a very slight advantage over the

Table 12

Correlation Coefficients and Probability for WAIS-R IQs with B84 and B86 Verbal, Performance, and Full Scale Estimates Across Studies

Study	B84			B86		
	VIQ	PIQ	FSIQ	VIQ	PIQ	FSIQ
Current Study	.52*	.27	.48*	.52*	.21	.52*
Schlottmann & Johnsen (1991)	.64*	.40*	.59*	.69*	.33	.59*
Johnsen (1987)	.52*	.30	.48*	--	--	--
Eppinger et al. (1987)	.78**	.60**	.76**	--	--	--
Barona & Chastain (1986)a	--	--	--	.68	.53	.65
Barona et al. (1984)a	.62	.49	.60	--	--	--

Note: Dashes (--) indicate that correlations for either the B84 or B86 were not investigated in a study.

a - Significance levels were not reported in the study.

* $p < .05$, ** $p < .001$

B84 estimates. There appears, however, to be somewhat more variability involved in using either of the demographic regression equations to predict Performance IQ.

It is of note that previous studies, (Eppinger et al., 1987; Johnson, 1987; and Schlottmann & Johnson, 1991) found that the B84 and/or B86 equations tended to overestimate WAIS-R IQ scores. Comparison of the estimated and obtained means for the control group in the current study did not find this to be a significant problem. For the purposes of comparison, the control group´s means on Verbal, Performance, and Full Scale IQ were 108.25, 108.40, and 109.20, respectively. The B84 had estimated that these means would be 110.45, 107.35, and 109.75. These estimates all represent close approximations of the obtained group scores, although Verbal IQ is slightly, but not significantly, overestimated. The B86 displayed a similar pattern, showing a slight advantage in its estimation of the control group´s mean Verbal IQ. For Verbal, Performance, and Full Scale IQ, the B86 had estimated means of 108.90, 107.10, and 109.10, all excellent approximations of the scores being estimated. In the Eppinger et al. (1987) study, it was thought that the overestimation might be related to using controls who had been referred for neuropsychological assessment, but who had not been given a neurological diagnosis. The current research used controls without any known psychological or neurological difficulties. This strategy appears to reduce the likelihood of overestimation by the B84 and B86 regression equations, although it does not necessarily control for it. In the current study, both the B84 and the B86 equations resulted in forming the predicted patterns between groups with the WAIS-R scores. This ability to predict the group means, taken in conjunction with the finding of significant correlations provide support for the continued use of the B84 and B86 regression equations.

The second method used to investigate the usefulness of the estimation procedures was to attempt to classify subjects into their respective groups based upon the difference between estimated and obtained scores. The classification analysis was conducted only with the B84 and B86 regression equations, since the ICS was clearly invalid as a measure of premorbid ability in the current study. The first classification analysis investigated the ability of each of the estimation procedures to identify subjects who had suffered right, left, diffuse, or no brain injury. It was found that both of the estimation procedures were able to classify controls and individuals who had suffered diffuse brain injury at a significantly better than chance level. However, neither of the estimation procedures was able to correctly classify individuals who had suffered either right or left-hemisphere lateralized injuries at a level better than could be identified by chance. Thus, a second classification analysis was conducted, using only two classifications, namely, brain-injured and non-brain-injured subjects. Using this analysis, the percentage of all cases correctly classified by the B84 and B86, respectively, was 80% and 83.75%. Looking at the hit rates separately for brain-injured and control groups, neither the B84 nor the B86 was able to classify brain-injured subjects at better than a chance level. The percentage of brain-injured subjects correctly classified by the B84 and B86 respectively, was 76.67% and 80%. Both the B84 and B86 equations did a better job of predicting membership in the control group than they had done of predicting membership in the brain-injured group. The percentage of controls correctly classified by the B84 and B86, respectively, was 90%, and 95%, both of which were significantly better than chance.

It is of interest that both of the demographic regression equations were better able to classify controls as opposed to brain-injured subjects. This pattern may be explainable by the number of false negatives and false positives derived by using each of the estimation procedures. The number and percentage of false negatives produced by the B84 and B86, respectively, are 14(23.33%) and 12(20%). The number and percentage of false positives produced by the B84 and B86, respectively, are 2(10%), and 1(5%). Thus, the demographic equations appear more likely to classify people as not having suffered a brain injury and to give more false negatives than false positives. While it is best to minimize both false negatives and false positives, it would appear preferable to be most concerned with minimizing the rate of false positives, as it would be quite a serious miscalculation to identify someone as having suffered a brain injury when they had not. The occurrence of false negatives is considered to be less serious, as negative findings are not generally considered to constitute proof of lack of injury. However, judging from the results of this classification analysis and from the correlational findings, extreme caution is advised if using either of the demographic regression equations clinically, as there is much room for error in the individual case.

Certainly, it would not be advisable to base clinical decisions on the use of these estimation procedures. If they are used clinically, it should be with an understanding of the potential for false positives and false negatives in individual cases. Of interest with relation to this topic is Eppinger et al.'s (1978) discussion regarding the use of difference scores with different cutoffs for the individual case. Finally, it is noted that in the classification analysis, the B86 equations appeared to again show a very slight advantage over the B84, both with respect to correctly classifying subjects and with respect to giving a lower rate of false negatives and false positives.

Hypothesis 8 specifically stated that the difference between ICS and obtained IQs would correlate negatively with KAS-R scores, indicating a relationship between the accuracy of the ICS as a measure of premorbid intellectual functioning and the degree of recovery or adaptation that had occurred. This hypothesis was based on the assumption that the ICS was a valid estimator of WAIS-R IQ. However, this assumption was not met, as the ICS estimates and the WAIS-R IQs were not significantly correlated for the control group. Thus, hypothesis 8 was not investigated further. However, also of interest in the current research was the effects of chronicity on estimated and obtained IQ. It had been hypothesized that (6) Chronic brain-injured groups would display greater recovery, and thus, be likely to obtain greater WAIS-R Full Scale IQs than acute brain-injured groups. However, hypothesis 6 was not supported, as no duration effects were found for brain-injured groups on WAIS-R Full Scale IQ. Furthermore, no effects for duration were found on either WAIS-R Verbal or Performance IQ. However, one method of looking more intensively at possible recovery in the acute versus chronic groups was to investigate the degree of relationship between the chronicity of impairment and the KAS-R adjustment scores for the brain-injured groups. However, there was no correlation between the degree of adjustment as measured by the KAS-R and months since onset of injury. Thus, this measure provided little evidence that the chronic groups used in this research had less severe social impairments due to recovery or anything else. These results may be due to the fact that severity of initial injury could not be controlled for in subject selection. Thus, some chronic subjects may have had more severe initial injuries than some of the acute subjects. One way in which this may have occurred was that subjects were not included in the current study unless they were functioning at a sufficiently high enough level to complete the WAIS-R and ICS. For example, acute left-hemisphere injured subjects with severe expressive or receptive language deficits were not recruited into the study. However, some chronic subjects may have experienced significant recovery from an aphasia, even though their initial injury had been more severe in terms of loss of functioning than for some of the acute left brain-injured subjects.

Thus, questions relating to severity of injury were explored by looking at the relationship between the KAS-R and the WAIS-R, since the WAIS-R is known to be sensitive to brain impairment. It was found that higher scores on the KAS-R helplessness cluster and on the KAS-R withdrawn depression factor (i.e., the KAS-R factor on which helplessness loads), were associated with decreases in WAIS-R Performance IQ. Also, it was found that subjects obtaining a lower level of social functioning tended to obtain lower WAIS-R Performance and Full Scale IQs. Similarly, subjects for whom the significant other had a lower level of social role expectations tended to obtain lower IQ scores on all WAIS-R IQ measures. These results are of interest in that they show a relationship between a person's level of intellectual functioning as measured by the WAIS-R and that person's level of helplessness, social role functioning, and the level of expectations placed upon that person by at least one significant person in his or her life.

To investigate the relationship between the estimation procedures and the KAS-R, two sets of extent of impairment scores were created, using the difference between the WAIS-R IQs and either the B84 or B86 regression equations. It was found that subjects obtaining higher performance and full scale extent of impairment scores using the B84 also tended to obtain lower KAS-R social role functioning and social role expectation scores. The B86 extent of impairment scores also correlated positively with social role functioning scores. Although WAIS-R Verbal IQ was related to level of social role expectations, none of the extent of impairment scores were sensitive to this. Otherwise, the results using the extent of impairment scores, particularly with the B84 equations were similar to the result obtained using the WAIS-R alone.

In summary, the conclusions of the present research are as follows: (1) The currently used B84 and B86 regression equations provide a more accurate and reliable measure of premorbid intellectual functioning than that which is provided by the ICS. Both the B84 and B86 regression equations appear to provide more reliable estimates of Verbal and Full Scale IQ than of Performance IQ. Also, the B86 regression equations appear to display a slight advantage over the B84 regression equations. (2) The ICS, in its current state of development, is subject to great variability in its usefulness as a predictor of intellectual functioning, depending upon the demographic characteristics of the population being sampled. (3) The Johnsen (1987) findings supporting the use of the ICS, in its current state of development, as an accurate estimator of intellectual funtioning were not replicated. (4) Left-hemisphere injury resulted in more severe, but not exclusive impairment of WAIS-R Verbal IQ, whereas right-hemisphere injury resulted in more severe, but not exclusive impairment of WAIS-R Performance IQ. Diffuse injury did not result in lateralized impairments. (5) In cases of left or right-lateralized brain injury, lateralized effects are most easily observed by considering the differences between WAIS-R Verbal and Performance IQ. It is recommended that none of the estimation procedures be used to make decisions about the lateralization of brain injury, particularly in individual cases. (6) Use of the ICS, B84, or B86 estimates result in a pattern whereby WAIS-R IQ scores are approximated when no brain injury has occurred, but WAIS-R IQ scores are overestimated when brain injury has occurred. (7) The B84 and B86 regression equations were better able to classify controls than brain-injured subjects. In classifying brain-injured individuals, they were better able to classify subjects with diffuse injuries than subjects with either right or left-hemisphere lateralized injuries. (8) No effects of duration were found in the current study, most likely reflecting differences in the severity of initial injuries between subjects. (9) Level of intellectual functioning as measured by the WAIS-R was related to helplessness, the withdrawn depression factor, social role functioning, and the degree of expectations placed upon the subject by at least one significant person in his or her life, as measured by the KAS-R.

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Appendix A

Consent Form A

I _____________________________, HEREBY VOLUNTARILY CONSENT TO ENGAGE IN THE RESEARCH ENTITLED "MEASUREMENT OF PREMORBID INTELLECTUAL ABILITY IN BRAIN-IMPAIRED INDIVIDUALS." I AM AWARE THAT THE PURPOSE OF THIS RESEARCH IS TO INVESTIGATE INTELLECTUAL ABILITY, BOTH IN INDIVIDUALS WHO HAVE SUFFERED SOME FORM OF BRAIN INJURY AND IN SIMILAR INDIVIDUALS WHO HAVE NOT SUFFERED A BRAIN INJURY. THE RESEARCH IS BEING CONDUCTED BY STEPHANIE A. PEREZ, M.S. UNDER THE SUPERVISION OF ROBERT SCHLOTTMANN, Ph.D. IN CONJUNCTION WITH THE OKLAHOMA STATE UNIVERSITY DEPARTMENT OF PSYCHOLOGY.

I ALSO GIVE PERMISSION FOR THE USE OF HOSPITAL OR CLINIC RECORDS FOR THE RESEARCHERS TO OBTAIN BACKGROUND INFORMATION REGARDING MY MEDICAL OR PSYCHIATRIC CONDITION. THE RESEARCH WILL CONSIST OF MY BEING ADMINISTERED SOME OR ALL OF THE FOLLOWING: AN ADULT INTELLIGENCE TEST CALLED THE WAIS-R, A DEMOGRAPHIC QUESTIONAIRE, A QUESTIONAIRE ASKING ME ABOUT MY ATTITUDES AND INTERESTS CALLED THE ICS. I WILL ALSO BE ADMINISTERED A BRIEF QUESTIONAIRE ASKING ABOUT MY PREVIOUS PSYCHOLOGICAL AND NEUROPSYCHOLOGICAL HISTORY. PARTICIPATION WILL TAKE APPROXIMATELY FOUR HOURS.

I UNDERSTAND THAT I AM FREE TO REVOKE CONSENT AND

WITHDRAW FROM THIS STUDY AT ANY TIME. I ALSO UNDERSTAND THAT ALL INFORMATION ABOUT ME WILL BE KEPT CONFIDENTIAL AND THAT DATA WILL BE REPORTED ON A GROUP RATHER THAN AN INDIVIDUAL BASIS. I VOLUNTARILY AGREE TO PARTICIPATE IN THIS RESEARCH.

I UNDERSTAND THAT I MAY CONTACT EITHER STEPHANIE A. PEREZ, M. S. AT (405) 743-3101 OR ROBERT SCHLOTTMANN, Ph.D. AT (405) 744-6567 SHOULD I WISH FURTHER INFORMATION ABOUT THE RESEARCH. I MAY ALSO CONTACT TERRY MACIULA, UNIVERSITY RESEARCH SERVICES, 001 LIFE SCIENCES EAST, OKLAHOMA STATE UNIVERSITY, STILLWATER, OK 74078: TELEPHONE (405) 744-5700.

I HAVE READ AND FULLY UNDERSTAND THE CONSENT FORM. I SIGN IT FREELY AND VOLUNTARILY.

____________________________ ________________________

SIGNATURE OF SUBJECT DATE AND TIME

I CERTIFY THAT I HAVE PERSONALLY EXPLAINED ALL ELEMENTS OF THIS FORM TO THE SUBJECT OR HIS/HER REPRESENTATIVE BEFORE REQUESTING THE SUBJECT OR HIS/HER REPRESENTATIVE TO SIGN IT.

____________________________ ________________________

SIGNATURE OF WITNESS DATE AND TIME

Appendix B

Consent Form B

I, ______________________________ , HEREBY ACKNOWLEDGE THAT I AM GIVING PERMISSION FOR THE ACQUAINTANCES, RELATIVES, OR FRIENDS THAT I NAME BELOW TO BE CONTACTED AND ASKED TO PARTICIPATE IN THE RESEARCH "MEASUREMENT OF PREMORBID INTELLECTUAL ABILITY IN BRAIN-IMPAIRED INDIVIDUALS." THESE INDIVIDUALS WILL BE ASKED TO PARTICIPATE IN THIS RESEARCH AS PART OF A GROUP OF SUBJECTS WHO HAVE NOT SUFFERED ANY FORM OF BRAIN OR HEAD INJURY. THEIR PARTICIPATION WILL CONSIST OF THEIR BEING ADMINISTERED THE FOLLOWING: AN ADULT INTELLIGENCE TEST CALLED THE WAIS-R, A DEMOGRAPHIC QUESTIONAIRE, A QUESTIONAIRE ASKING ABOUT ATTITUDES AND INTERESTS CALLED THE ICS, AND A BRIEF QUESTIONAIRE ASKING ABOUT PREVIOUS PSYCHOLOGICAL AND NEUROPSYCHOLOGICAL HISTORY.

THOSE PERSONS WHO ARE CONTACTED WILL BE INFORMED THAT I REFERRED THEM FOR INCLUSION IN THIS STUDY. I UNDERSTAND THAT THESE INDIVIDUALS WILL NOT BE GIVEN ACCESS TO ANY OF MY RECORDS BECAUSE OF THIS REFERRAL. ALSO, I UNDERSTAND THAT THESE INDIVIDUALS HAVE THE RIGHT TO REFUSE TO PARTICIPATE OR TO WITHDRAW FROM THE RESEARCH AT ANY TIME IF THEY DO CONSENT TO PARTICIPATE. ALSO, I UNDERSTAND THAT I WILL NOT HAVE ACCESS TO ANY

OF THE INFORMATION OBTAINED THROUGH THIS RESEARCH ABOUT ANYONE THAT I REFER.

THE PERSONS THAT YOU MAY CONTACT TO REQUEST THEIR PARTICIPATION IN THIS RESEARCH PROJECT ARE:

NAME:____

ADDRESS:____

PHONE:____

NAME:____

ADDRESS:____

PHONE:____

NAME:____

ADDRESS:____

PHONE:____

I HAVE READ AND UNDERSTOOD THIS FORM. I HAVE PROVIDED THE ABOVE INFORMATION FREELY AND VOLUNTARILY.

______________________________ ______________________________

SIGNATURE OF SUBJECT DATE AND TIME

I CERTIFY THAT I HAVE PERSONALLY EXPLAINED ALL ELEMENTS OF THIS FORM TO THE SUBJECT OR HIS/HER REPRESENTATIVE BEFORE REQUESTING HIS/HER SIGNATURE.

____________________ ____________________________

SIGNATURE OF WITNESS DATE AND TIME

Appendix C

Consent Form C

IN CONJUNCTION WITH MY PARTICIPATION IN THE RESEARCH ENTITLED "MEASUREMENT OF PREMORBID INTELLECTUAL ABILITY IN BRAIN-IMPAIRED INDIVIDUALS," I, ____________________________ AM WILLING TO PROVIDE THE NAME OF A CLOSE RELATIVE OR FRIEND WHO CAN BE CONTACTED TO COMPLETE A QUESTIONAIRE REGARDING THEIR PERCEPTION OF MY CURRENT ABILITIES AND PERSONALITY TRAITS. THE NAME OF THIS QUESTIONAIRE IS THE KATZ ADJUSTMENT SCALE-RELATIVE'S FORM.

I UNDERSTAND THAT THE INDIVIDUAL WHO I REFER WOULD BE INFORMED OF MY PARTICIPATION IN THIS RESEARCH. THIS INDIVIDUAL WOULD NOT HAVE ACCESS TO ANY OF THE RESULTS OF MY PARTICIPATION IN THIS RESEARCH UNLESS OTHERWISE INDICATED. I ALSO UNDERSTAND THAT I WILL NOT HAVE ACCESS TO THE INFORMATION THAT THIS INDIVIDUAL PROVIDES.

I HAVE READ AND FULLY UNDERSTAND THE CONSENT FORM. I AM PROVIDING THE FOLLOWING INFORMATION AND SIGNING THIS FORM FREELY AND VOLUNTARILY. I UNDERSTAND THAT MY PARTICIPATION IN THIS STUDY IS VOLUNTARY.

THE RELATIVE OR FRIEND THAT YOU MAY CONTACT IS:

NAME:____

ADDRESS:____

PHONE:____

RELATIONSHIP:____________________________________

SIGNATURE OF SUBJECT	DATE AND TIME

I CERTIFY THAT I HAVE PERSONALLY EXPLAINED ALL ELEMENTS OF THIS FORM TO THE SUBJECT OR HIS/HER REPRESENTATIVE BEFORE REQUESTING THE SUBJECT OR HIS/HER REPRESENTATIVE TO SIGN IT.

SIGNATURE OF WITNESS	DATE AND TIME

Appendix D

Consent Form D

I, ____________________________. HEREBY VOLUNTARILY CONSENT TO ENGAGE IN THE RESEARCH ENTITLED "MEASUREMENT OF PREMORBID INTELLECTUAL ABILITY IN BRAIN-IMPAIRED INDIVIDUALS." I AM AWARE THAT THE PURPOSE OF THIS RESEARCH IS TO INVESTIGATE INTELLECTUAL ABILITY, BOTH IN INDIVIDUALS WHO HAVE SUFFERED SOME FORM OF BRAIN INJURY AND IN SIMILAR INDIVIDUALS WHO HAVE NOT SUFFERED A BRAIN INJURY. THE RESEARCH IS BEING CONDUCTED BY STEPHANIE A. PEREZ, M. S. UNDER THE SUPERVISION OF ROBERT SCHLOTTMANN, Ph.D. IN CONJUNCTION WITH THE OKLAHOMA STATE UNIVERSITY DEPARTMENT OF PSYCHOLOGY.

I UNDERSTAND THAT MY PARTICIPATION IN THIS RESEARCH WILL CONSIST OF MY BEING ADMINISTERED THE KATZ ADJUSTMENT SCALE: RELATIVE'S FORM. THIS IS A QUESTIONAIRE WHICH I WILL FILL OUT REGARDING MY PERCEPTION OF _______________ CURRENT ABILITIES AND PERSONALITY TRAITS. PARTICIPATION WILL REQUIRE APPROXIMATELY ONE HOUR.

I UNDERSTAND THAT ALL INFORMATION IS TO BE KEPT CONFIDENTIAL. I WILL NOT HAVE ACCESS TO ANY OF THE RESULTS OF OTHER INDIVIDUALS WHO HAVE PARTICIPATED IN THIS STUDY. SIMILARLY, ALL INFORMATION ABOUT ME WILL ALSO BE KEPT CONFIDENTIAL. DATA WILL BE REPORTED ON A GROUP RATHER THAN AN INDIVIDUAL BASIS.

I UNDERSTAND THAT I AM FREE TO REVOKE CONSENT AND WITHDRAW FROM THIS STUDY AT ANY TIME. I VOLUNTARILY AGREE TO PARTICIPATE IN THIS RESEARCH. I UNDERSTAND THERE IS NO PENALTY FOR REFUSAL TO PARTICIPATE, AND THAT I AM FREE TO WITHDRAW MY CONSENT AND PARTICIPATION IN THIS PROJECT AT ANY TIME WITHOUT PENALTY AFTER NOTIFYING THE RESEARCHER.

I MAY CONTACT STEPHANIE PEREZ, M. S. AT (405) 743-3101 OR ROBERT SCHLOTTMANN, Ph.D. AT (405) 744-6567 SHOULD I WISH FURTHER INFORMATION ABOUT THE RESEARCH. I MAY ALSO CONTACT TERRY MACIULA, UNIVERSITY RESEARCH SERVICES, 001 LIFE SCIENCES EAST, OKLAHOMA STATE UNIVERSITY, STILLWATER, OK 74078; TELEPHONE (405) 744-5700.

I HAVE READ AND FULLY UNDERSTAND THE CONSENT FORM. I SIGN IT FREELY AND VOLUNTARILY.

__________________________ __________________________

SIGNATURE OF SUBJECT DATE AND TIME

I CERTIFY THAT I HAVE PERSONALLY EXPLAINED ALL ELEMENTS OF THIS FORM TO THE SUBJECT BEFORE REQUESTING HER/HIM TO SIGN IT.

__________________________ __________________________

SIGNATURE OF WITNESS DATE AND TIME

Appendix E

Demographic Questionaire

SUBJECT I.D.#__________

SEX:____________ AGE_________________

RACE: BLACK________ WHITE________ OTHER_______________

YEARS OF EDUCATION:_______________________________________

HIGHEST DEGREE OBTAINED:__________________________________

OCCUPATION: CHECK ONE AND SPECIFY JOB TITLE:

_____ AGRICULTURE_______________________________________

_____ CLERICAL____

_____ HOMEMAKER____

_____ MANAGERIAL ____

_____ PROFESSIONAL______________________________________

_____ TRADE____

_____ UNEMPLOYED____

TOWN AND STATE YOU WERE RAISED IN:

____

POPULATION:____

WAS IT URBAN OR RURAL:____________________________________

CURRENT ADDRESS:____

____

YEARS OF RESIDENCE AT CURRENT ADDRESS:_____________________

POPULATION OF TOWN:_______________________________________

IS TOWN OF CURRENT RESIDENCE URBAN OR RURAL:_______________

TOWN AND STATE IN WHICH I LIVED THE LONGEST:_______________

POPULATION:_____________ URBAN/RURAL_______________________

Appendix F

Medical History Questionaire

SUBJECT I. D. #_____

HAVE YOU RECEIVED PSYCHOLOGICAL OR PSYCHIATRIC SERVICES OR BEEN SEEN BY ANY OTHER TYPE OF MENTAL HEALTH WORKER?

____

____

HAVE YOU EVER BEEN HOSPITALIZED FOR PSYCHOLOGICAL OR PSYCHIATRIC CARE_______________________________

NUMBER OF HOSPITALIZATIONS_____________________

DIAGNOSIS______________________________________

ADDITIONAL INFORMATION_________________________

____

HAVE YOU EVER BEEN HOSPITALIZED FOR ANY OTHER TYPE OF AILMENT? DESCRIBE_______________________________

____

____

HAVE YOU EVER BEEN KNOCKED UNCONSCIOUS?___________

NUMBER OF TIMES________________________________

HAVE YOU EVER HAD	LIST ALL MAJOR ILLNESSES
SEIZURES_________	____________________
COMA_____________	____________________
HYPERTENSION_____	____________________
STROKE___________	____________________

____

Appendix G

Competency To Give Consent

IT IS MY PROFESSIONAL OPINION THAT

_____________________________, CURRENTLY A PATIENT AT

_____________________________, IS COMPETENT TO MAKE AN INFORMED DECISION ABOUT HIS/HER PARTICIPATION IN THE STUDY ENTITLED "MEASUREMENT OF PREMORBID INTELLECTUAL ABILITY IN BRAIN IMPAIRED INDIVIDUALS."

____

AUTHORIZED SIGNATURE

____

DATE

VITA

Stephanie Ann Perez

Candidate for the Degree of

Doctor of Philosophy

Thesis: MEASUREMENT OF PREMORBID INTELLECTUAL ABILITY IN BRAIN-INJURED INDIVIDUALS

Major Field: Clinical Psychology

Biographical:

Personal Data: Born in Bethpage, New York, May 30, 1957, the daughter of William and Dolores Sill.

Education: Attended Nassau Community College in Garden City, New York, Tulsa Junior College in Tulsa, Oklahoma, and Oklahoma State University in Stillwater, Oklahoma; received Bachelor of Science Degree with Departmental Honors in Psychology from Oklahoma State University at Stillwater in May, 1987; Outstanding Psychology Senior at Oklahoma State University at Stillwater for 1986/1987 school year; received Master of Science Degree in Psychology from Oklahoma State University at Stillwater in December, 1988; completed requirements for the Doctor of Philosophy Degree in Clinical Psychology at Oklahoma State University in May, 1993.

Professional Experience: Psychological Associate, Psychological Services Center, Oklahoma State University, September, 1988, to August, 1989; Psychotherapist, Edwin Fair Community Mental Health Center, July, 1989, to July, 1990; Psychotherapist, Marriage and Family Clinic, Oklahoma State University, June, 1989, to May, 1991; Psychological Associate, Psychological Services Center, Oklahoma State University, August, 1990, to May, 1991; Psychotherapist, South Community Hospital-RehabCare, Oklahoma City, June, 1990, to December, 1990; Psychotherapist, St. Anthony Hospital-RehabCare, Oklahoma City, January, 1991, to July, 1991; Clinical Psychology Intern, Long Island Jewish Medical Center/Hillside Hospital, Glen Oaks, New York, September, 1991, to August, 1992.