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The relationship between the Wechsler Adult Intelligence Scale-Revised and the Stanford-Binet Intelligence Scale: Fourth Edition in brain-damaged adults

Steffey, Dixie Rae, Ph.D.

The University of Arizona, 1988

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THE RELATIONSHIP BETWEEN THE WECHSLER ADULT INTELLIGENCE SCALE-REVISED AND THE STANFORD-BINET INTELLIGENCE SCALE: FOURTH EDITION IN BRAIN-DAMAGED ADULTS

by

Dixie Rae Steffey

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A Dissertation Submitted to the Faculty of the DIVISION OF SPECIAL EDUCATION AND REHABILITATION In Partial Fulfillment of the Requirements For the Degree of DOCTOR OF PHILOSOPHY WITH A MAJOR IN REHABILITATION In the Graduate College THE UNIVERSITY OF ARIZONA 1988
As members of the Final Examination Committee, we certify that we have read the dissertation prepared by Dixie Rae Steffey entitled THE RELATIONSHIP BETWEEN THE WECHSLER ADULT INTELLIGENCE SCALE-REVISED AND THE STANFORD-BINET INTELLIGENCE SCALE: FOURTH EDITION IN BRAIN-DAMAGED ADULTS and recommend that it be accepted as fulfilling the dissertation requirement for the Degree of Doctor of Philosophy.

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ACKNOWLEDGMENTS

This author should like to recognize and thank some of the individuals who have been most helpful throughout my doctoral studies including the dissertation research phase. Ms. Mary Jean Hage and Drs. Anne J. Miller, Natalie C. Recely, and Margaret I. Ronstadt have been both professional and personal role models. Their willingness to share their knowledge and experience throughout my studies as well as their supportive friendship have been invaluable to me during somewhat difficult times.

Enthusiasm, wise guidance, and constant sharing of knowledge by both my major and minor professors have enabled me to complete my studies with understanding and respect for new vistas of service provision for disabled clients as well as with the tools necessary to further explore my interest in rehabilitation psychology and neuropsychology. Drs. James E. Organist, Amos Sales, Bob G. Johnson, Glen I. Nicholson, and Darrell L. Sabers have been consummate committee members whom I consider not only my mentors but also my friends. I should like to express my gratitude for their unselfish demonstration of individual expertise, leading to a healthy stimulation of intellectual curiosity within me.

Appreciation is extended to Dr. Robert Keith, Research Director of Casa Colina Hospitals, Inc. and Ed McGonagle, Director and Dr. L. Kent Wilson, Associate Director of South Valley Ranch for their consent and cooperation in this project. Appreciation is also extended to the residents of both programs without whom research and increasing knowledge of effects of brain damage would be inconceivable.

Finally, data analysis for this project would have been excruciatingly tedious without the expertise of a colleague, Dr. Christopher Myers. Both he and his wife Nancy have been friends since my arrival in Arizona and have helped to make my pursuit of higher education palatable and meaningful.
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This study investigated the relationship between the Wechsler Adult Intelligence Scale-Revised (WAIS-R) and the Stanford-Binet Intelligence Scale: Fourth Edition (SBIV) in a brain-damaged adult sample. The sample in this study was composed of 30 adult patients at two residential treatment programs who completed comprehensive psychological evaluations between August, 1986 and November, 1987. Each patient was administered both the WAIS-R and the SBIV as part of these evaluations.

Data gathered in this study was submitted to Pearson product moment correlational statistical procedures. Significant correlations were found in the following pairs of summary scores: the SBIV Test Composite Standard Age Score (SAS) and the WAIS-R Full Scale IQ; the SBIV Abstract/Visual Reasoning Area SAS and the WAIS-R Performance IQ; the SBIV Quantitative Reasoning Area SAS and the WAIS-R Verbal Scale IQ; the SBIV Verbal Reasoning Area SAS and the WAIS-R Verbal Scale IQ; the SBIV Short-Term Memory Area SAS and the WAIS-R Verbal Scale IQ; and the SBIV Short-Term Memory Area SAS and the WAIS-R Full Scale IQ. Significant correlations were also found in the following pairs of individual subtest results: the SBIV
and WAIS-R Vocabulary subtests; the SBIV Memory for Digits subtest and the WAIS-R Digit Span subtest; the SBIV Pattern Analysis subtest and the WAIS-R Block Design subtest; and the SBIV Paper Folding and Cutting subtest and the WAIS-R Picture Arrangement subtest. Directions for future research were also suggested upon review of the subtest correlation matrix and the descriptive statistics of data generated.
CHAPTER 1

INTRODUCTION

In recent decades the study of neuropsychology has expanded rapidly as evidenced by its increasing body of literature. The diagnosis of deficits in brain-behavior relationships has especially advanced in the last several years. Neuropsychological assessment has progressed from the administration of single tests of organicity to empirically validated test batteries evaluating diverse brain functions (Filskov & Leli, 1981). According to Lezak (1983) a neuropsychological evaluation may serve such purposes as to aid in diagnosis of specific deficits, to assist in planning case management concerns including short and long range goals, to evaluate treatment effects, to provide information in litigation cases, or to add to the body of research literature. Sophistication in neuropsychological test batteries has dramatically improved accuracy of prediction of impairment of brain-behavior relationships, localization of such impairment, and type of impairment (Filskov & Leli, 1981). However, information regarding brain-behavior relationships is currently insufficient to contribute towards the development of a test battery that would completely reflect the full range
of behavioral correlates of brain functions in each brain (Reitan, 1986). Research is necessary to validate new tests of cognition on the market as to their ability to reflect deficits in brain-behavior relationships.

The development of the battery approach to neuropsychological assessment has taken many different turns over the past few decades. One of the most researched and empirically validated batteries is the Halstead-Reitan Neuropsychological Test Battery (HRNTB). This battery has been studied to determine if it included a sufficient range of measurements to indicate deficits of patients regardless of location, type, and duration of lesion and other lesser variables which contribute to the uniqueness of each brain (Reitan, 1986). Based upon Halstead's (1947) biological theory of intelligence and developed by observing and working with brain-damaged patients, the HRNTB uniquely contributes towards the knowledge of the individual's specific brain functioning. The battery is designed to measure general and specific indicators using measurement strategies found to be valid in assessment of brain-behavior relationships (level of performance, specific deficits or pathognomonic signs, patterns and relationships among test results, and comparisons of functional efficiency of the two sides of the body by exploiting the anatomical organization of the
nervous system) (Reitan & Wolfson, 1985). Thus the content of the HRNTB includes measures of input, central processing, and output. These general content areas assess sensory perception, motor functions, attention, concentration, memory, abstraction abilities, language and visual-spatial abilities (Reitan, 1986). An integral part of this battery is the inclusion of the age level appropriate Wechsler Intelligence Scale.

Another less empirically validated battery approach is the Boston Process Approach (BPA). This approach emphasizes the qualitative aspects of patient performance on psychometric instruments and their relationship to the conceptual framework of experimental neuropsychology (Milberg, Hebben, & Kaplan, 1986). A core of standardized tests is used to evaluate functions of intelligence and cognition, memory, language, visual perception, academic skills, and self-control and motor skills. The Wechsler Adult Intelligence Scale-Revised (WAIS-R) is most frequently used to assess the intellectual and conceptual functions of the patient. Even though adherence to standardized administration of the WAIS-R is attempted in order to be able to maintain reliable and generalizable test scores from available normative data, the BPA emphasizes procedural modifications in order to facilitate data collection about individual strategies. Modifications
include keeping detailed, verbatim accounts of patient performance for analysis of strategies used and "testing the limits" because of the inconsistent performance inherent in the nature of neurological impairment. Special encouragement is used to push beyond consistent "I don't know" and minimal one or two word responses. Time limits are extended in order to evaluate response slowing separately from actual loss of information processing ability. Specific modifications are delineated for each subtest of the Wechsler scales with more modifications reserved for the visual-spatial performance items than for the verbal subtests. Patient responses on the verbal subtests are analyzed for language deficits.

A recently developed battery frequently used in comprehensive neuropsychological assessment is the Luria-Nebraska Neuropsychological Battery (LNNB). The LNNB has been developed with goals of providing a battery using A. R. Luria's qualitative procedures of identification of basic neuropsychological processes underlying observed behavior, administered and evaluated in a standardized manner (Golden, 1981). The LNNB yields scores in the areas of motor skills, rhythmic and pitch skills, tactile skills, expressive and receptive language skills, reading, writing, arithmetic, memory, visual-spatial skills, and intellectual skills. Even though evaluation of intellectual function is
an integral part of this battery, a standardized intelligence assessment is not recommended for use with this battery.

As reviewed above, intelligence tests are often included in comprehensive neuropsychological assessments. Most batteries incorporate standardized intelligence tests in order to obtain an evaluation of general intelligence as well as specific cognitive abilities (Filskov & Leli, 1981; Lezak, 1983). Appropriate levels of the Wechsler Intelligence Scales are most often used in neuropsychological batteries. Since Wechsler's tests were developed for use with normal subjects and standardized upon samples assumed to be normal, it is expected that overall results of Wechsler scales, in general, are much less sensitive to effects of cerebral damage than the results of tests specifically designed to be used with brain-damaged patients (Reitan, 1959). However, the capacity of the Wechsler scales to test different kinds of intellectual functions does contribute important information regarding the comparative status and specialized functions of the left and right cerebral hemispheres as well as specific information about lesion localization (Reitan, 1955).
Wechsler Adult Intelligence Scale-Revised

The Wechsler Intelligence Scales are among the more popular and widely researched instruments of individual intelligence assessment as evidenced by the expansive body of literature available. Originally conceived and developed as a measurement of the global capacity of the individual to think rationally and to effectively deal with the environment, the scales were first published as the Wechsler-Bellevue Intelligence Scale in 1939 (Wechsler, 1958). A second form of the Wechsler-Bellevue was subsequently published in 1944. A major revision, the Wechsler Adult Intelligence Scale (WAIS) was published in 1955, followed by its revision, the Wechsler Adult Intelligence Scale-Revised (WAIS-R) in 1981 (Wechsler, 1981). Development of children's batteries also occurred in the forms of the Wechsler Preschool and Primary Scales of Intelligence and the Wechsler Intelligence Scale for Children and its revision Wechsler Intelligence Scale for Children-Revised (Anastasi, 1982; Sattler, 1982).

The WAIS-R is divided into two basic groupings of subtests--Verbal Scale and Performance Scale. The Verbal Scale is composed of six subtests including Information, Digit Span, Vocabulary, Arithmetic, Comprehension, and Similarities. The Performance Scale is composed of five subtests including Picture Completion, Picture Arrangement,
Block Design, Object Assembly, and Digit Symbol (see Appendix A). Raw scores on each subtest are converted to scaled scores. The sums of the scaled scores are then converted to Verbal, Performance, and Full Scale IQs. These IQs are deviation IQs which define a level of intelligence through the comparison of the individual's performance with his/her age group from the standardization sample. The purpose of the groupings of subtests into verbal and performance type is to emphasize the dichotomy of the possible types of ability called for in the individual subtests (Wechsler, 1958). Thus, the Performance Scale may be administered alone to individuals who are unable to adequately manage language, and the Verbal Scale may be used alone with those individuals who are visually or motorically handicapped. The groupings do not presume different kinds of intelligence nor do they imply only the existence of the named abilities within the subtests. It is implied that there are varying manifestations of intelligence. The subtests within the scales are thought to be different measures of intelligence, not measures of different kinds of intelligence (Matarazzo, 1972).

In the last several decades the WAIS and its revision, the WAIS-R, have been used extensively in research studies attempting to establish patterns of performance relating to
various degrees and types of brain impairment (Guertin, Ladd, Frank, & Rabin, 1971; Guertin, Ladd, Frank, Rabin, & Hiester, 1966; Matarazzo, 1972). Filskov and Leli (1981) indicate that many types of injuries to the brain result in loss of abilities referred to as intelligence. Although other factors such as depression, anxiety, and lack of motivation may also account for deficient performance, discrepancies in overall intelligence should be subjected to further neuropsychological investigation. A basic assumption in clinical neuropsychology is that through the systematic measurement of intellectual, motor, and sensory functions with standardized instruments, inferences may be made concerning the organic integrity of the brain (Klove, 1974).

A number of studies of brain-impaired subjects of varying types have substantiated the suggestion that discrepant verbal/performance scores imply differential lateralization (Andersen, 1951; Fields & Whitmyre, 1969; Klove, 1959, 1965; Parsons, Vega, & Burn, 1969; Reitan, 1955). These studies involving both the Wechsler-Bellevue Scale (Form I) and the WAIS indicate that the Verbal Scale tends to be impaired in cases of damage to the left cerebral hemisphere. The Performance Scale tends to be impaired in damage to the right cerebral hemisphere. More recent studies using the WAIS and the WAIS-R suggest the
continuation of such clinical interpretation with the WAIS-R (Black, 1980; Kelly, Montgomery, Felleman, & Webb, 1984; Ryan, 1984; Ryan, Nowak, & Geisser, 1987; Ryan, Rosenberg, & Prifitera, 1983). However, caution is advised in substituting the WAIS-R for the WAIS subtest score results in an actuarial cutoff method of interpretation. Further research in this area of substituting the WAIS-R for the WAIS is needed. Scores for the two tests cannot be considered as interchangeable for neurologic patients (Kelly et al., 1984).

Location of lesions within the hemispheres has not been a controlled variable in many studies of Wechsler scales with neurologic patients. However, clinical evidence indicates that differential performance of certain subtests of the Performance Scale tends to localize anterior/posterior lesions of the right cerebral hemisphere (R. M. Reitan, personal communication, October 3, 1983). A differentially deficient score on the Picture Arrangement subtest suggests a right anterior fronto-temporal lesion when presented with other clinically significant performances in brain-related measures. A differentially deficient score on the Block Design subtest suggests a right posterior temporal-parietal lesion when presented
with other clinically significant performances in brain-related measures. Overall interpretation of brain sensitive measures suggest that the Digit Symbol subtest is the fifth most sensitive indicator of generalized diffuse brain impairment following the Halstead Impairment Index, Category Test, Tactual Performance Test--Total Time, and Trailmaking Test B (Reitan & Wolfson, 1985).

Moses (1986) compared WAIS summary and subtest variables to HRNTB variables in a multiple regression formula. Results support the clinical practice of interpreting Wechsler subtest patterns as a source of explanatory information beyond the summary IQ variables. Subtest variables explain significantly more variance in the HRNTB than were predicted by the summary scores.

Various factor analytic studies of the WAIS have been published (Berger, Bernstein, Klein, Cohen, & Lucas, 1964; Cohen, 1957; Reed & Fitzhugh, 1966; Silverstein, 1969; Zimmerman, Whitmyre, & Fields, 1970). The purpose of such studies has been to identify the components of measurable intelligence, operationally defined as scores on a particular test (Leckliter, Matarazzo, & Silverstein, 1986). Most commonly found factors were the following: a super-ordinate factor of general intelligence, identified as g, and three group factors including verbal
comprehension, perceptual organization, and memory, also referred to as freedom from distractibility.

The WAIS-R has also been subjected to factor analytic studies (Blaha & Wallbrown, 1982; Gutkin, Reynolds, & Galvin, 1984; Plake, Gutkin, Wise, & Kroeten, 1987; Silverstein, 1982; Wechsler, 1981). Controversy exists regarding the choice of appropriate procedures. Plake et al. (1987) investigated the comparability of the traditional Wechsler (1981) and Gutkin et al. (1984) factor structure models for the WAIS-R by a confirmatory factor analysis. This study suggested that neither model demonstrated a strong fit to the empirical data. Matarazzo (1972) has suggested that the choice of factor solution providing the best fit to the data is dependent upon theoretical biases and clinical purposes of the investigator. Leckliter, Matarazzo, and Silverstein (1986) have proposed a three-factor solution for the WAIS-R composed of a Verbal Comprehension Factor (Vocabulary, Information, Comprehension, and Similarities subtests), Perceptual Organization Factor (Object Assembly and Block Design subtests), and Memory/Freedom from Distractibility Factor (Digit Span and Arithmetic subtests). This organization of subtests is suggested as an improvement in the method of clinical interpretation of results, especially in subjects with suspected brain
impairment. Further research is needed to test viability of various theoretical models (Plake et al., 1987). This review of literature suggests that administration of standardized intelligence tests contributes useful information in the assessment of brain-related deficits among brain-impaired or neurologic subjects. Traditionally, the intelligence test of choice by clinical psychologists and neuropsychologists has been the appropriate age level of the Wechsler scales. An extensive body of literature supports use of this test. Mishra (1983) indicated, however, that the Wechsler scales and the Stanford-Binet Intelligence Scale, Form L-M were incomplete estimates of global intelligence. He suggested that the content and format of test items have not kept pace with advances in clinical psychology and neuropsychology. Validity of assessed traits can be enhanced through the inclusion of test items constructed to measure preferred processing strategies. Lezak (1983) predicted the development of a set of tests for appraising adult intellectual functions with a more scientific and systematic foundation. She questioned, however, if the new test, no matter how efficient and theoretically sound, would be able to replace the familiarity and experience with the Wechsler scales currently embraced by clinical neuropsychologists.
The recent development and publication in 1986 of the Stanford-Binet Intelligence Scale: Fourth Edition (SBIV) has attempted to meet the current needs for an assessment instrument to measure cognitive abilities that provide an analysis of patterns as well as an overall level of an individual's general abilities (Thorndike, Hagen, & Sattler, 1986a). The SBIV is based upon a three-level model. At the top of this hierarchical model is the general reasoning factor which is analogous to the general abilities factor of intelligence. The second level contains three broad factors which include crystallized abilities, fluid-analytic abilities, and short-term memory. The third level in this hierarchical model contains three specific factors: verbal reasoning and quantitative reasoning which are thought to contribute to crystallized abilities and abstract/visual reasoning, thought to contribute to fluid abilities (Thorndike et al., 1986a).

Specifically, the SBIV is composed of 15 subtests divided into four general areas. The complete SBIV battery when administered consists of eight to thirteen subtests, depending upon the individual's chronological age and entry level of the test. Assessment of older children and adults usually includes the maximum thirteen subtests. The
authors suggest the administration of the complete battery in order to obtain the most reliable estimate of an individual's level of functioning and pattern of cognitive abilities. Appendix A gives detailed descriptions of each subtest in the SBIV.

Each SBIV subtest raw score is converted to a standard age score (SAS). The four content areas SAS are computed from the sum of subtest SAS. A Composite SAS is computed from the sum of the Area SAS. Subtest SAS are normalized standard scores (X=50, SD=8). Area and Composite SAS are normalized standard scores (X=100, SD=16) in order to facilitate comparison to other standardized intelligence assessment instruments.

Two major strengths of the SBIV are its provisions for a continuous scale for appraising cognitive development from the chronological age of two to adult and for an adaptive testing format (Thorndike, Hagen, & Sattler, 1986b). The SBIV is designed to make maximum use of the principles of adaptive testing with a central premise of focusing as quickly and efficiently as possible on tasks most closely suited to the individual's ability level (Thorndike et al., 1986a). Multistage testing has been developed using a vocabulary score combined with chronological age as an entry level and establishing basal and ceiling levels. The flexibility in adaptive testing is
thought to yield more reliable scores (Thorndike et al., 1986a).

The SBIV has been developed to adhere closely with accepted theories of intelligence. Thorndike et al. (1986b) have indicated that the best measure of general intelligence, the $g$ factor, will evolve from a diverse set of cognitive tasks requiring relational thinking in a diversity of contexts. This $g$ factor is measured by the Composite Area SAS on the SBIV. The crystallized and fluid-analytic abilities factors of the SBIV are based upon a theory of intelligence proposed by Cattell (1943) and Horn (1978) and joint efforts by Cattell and Horn (1978, 1966).

Crystallized intelligence may be defined as the cognitive skills necessary for acquiring and using information about verbal and quantitative concepts to solve problems. It is similar to achievement in its representation of accumulated knowledge of an individual based upon the many influences experienced which promote incorporation of the intelligence of a culture in loose harmony to produce a broad pattern of abilities. Thus, crystallized intelligence may be conceptualized as involving overlearned, well-established functions.

Fluid intelligence may be defined as the cognitive skills necessary for solving new problems that involve
figural or other nonverbal stimuli. It is more closely
related to analytical abilities, influenced by incidental
learning and associated with neurophysiological health.
Thus, fluid intelligence may be conceptualized as involving
the invention of new cognitive strategies or flexible
reassembly of existing strategies to deal with novel
situations.

The Short-Term Memory Area (STMA) of the SBIV draws
upon the information-processing emphasis in cognitive
research in which short-term memory is related to more
complex cognitive functions (Anderson, 1980; Klatzky,
1980). Short-term memory (STM) as assessed by the SBIV
temporarily retains newly perceived information until it
can be stored in long-term memory (LTM) and holds
information drawn from LTM that is being used in an ongoing
task. Strategies used by the individual in STM determines
what and how information is stored in LTM and how it is
later retrieved. Thus, relationships exist between STM and
LTM and between memory and more complex learning and
problem-solving (Thorndike et al., 1986a).

Due to the recency of the publication of the SBIV,
research studies attempting to establish patterns of
performance on the SBIV relating to various deficit brain-
behavior relationships are nonexistent. Studies were
conducted by the publishers to gather evidence of the
construct validity of the SBIV using exceptional samples to investigate the correlations between the SBIV and other individual standardized intelligence tests. Correlation coefficients were computed for area scores and composites of the SBIV and the Verbal, Performance, and Full Scales of the WAIS-R. Positive correlations led to the conclusion of strong support for the construct validity. Additional studies investigated performance differences of exceptional samples on the SBIV. Results indicated that the SBIV can reliably discriminate between groups of exceptional individuals (Thorndike et al., 1986b).

**Statement of the Problem**

A review of the literature in neuropsychological and intellectual assessment suggests the relevancy of such techniques in adequate measurement of an individual's current cognitive functioning level. Filskov and Leli (1981) indicated that many types of injuries to the brain result in loss of abilities referred to as intelligence. They found that brain-injured patients were not as significantly impaired in the ability to recall well-learned information as in the capacity to deal with present learning and problem-solving. The well-learned information may be considered crystallized intelligence and the adaptive or new learning capabilities as fluid
intelligence. The SBIV is a new standardized intelligence test designed to tap not only broad cognitive abilities, but also to assess specific crystallized and fluid-analytic abilities. Lezak (1983) predicted the development of a theoretically based assessment tool. Research is needed to enhance the understanding of the ability of new tests of cognition to reflect deficits in brain-behavior relationships.

The current investigation has addressed the need to evaluate the SBIV in terms of its contribution to the assessment of brain-damaged adults. Relationships generated by this study contribute toward the direction of future research as well as to the understanding of abilities assessed on various tasks on the SBIV. Through this heightened awareness, the SBIV may well be considered a viable alternate intelligence assessment for use in a comprehensive neuropsychological battery.

This project's primary goal has been to provide a preliminary exploration of data in order to generate hypotheses and to understand the potential role of variables considered. This exploratory research involved data fitting or partitioning in a less formal manner than statistical manipulation and its hypothesis testing (Bentler & Lettieri, 1976). Data gathered for this study included test results from the WAIS-R and SBIV as well as
such demographic information as age, sex, education, handedness and type of brain damage.

Results of this project have implications for assessment of brain-damaged subjects. The SBIV is expected to contribute to the identification of deficits in brain-behavior relationships in a manner similar to that of the widely researched Wechsler scales. In addition, the SBIV may imply contributions of crystallized and fluid intelligence factors to post-trauma functioning in brain-damaged adults. Only through exploratory followed by confirmatory research can the question of efficacy of the SBIV in neuropsychological assessment be addressed. To date, this relationship has not been explored. Considering the complexity of the brain impaired including the many variables possible, it is probable that confirmatory research regarding the contribution of the SBIV to neuropsychological assessment to the extent of that involving the Wechsler scales may be in the distant future. However, preliminary exploratory studies provide useful information for the direction of future research as well as for the practicing clinical neuropsychologist.

Hypotheses

Based upon the stated problem related to a pertinent review of the literature, and within the limitations set by
the data generated using brain-damaged subjects, the following alternate hypotheses were explored.

1. A significant (p<.05) correlation exists between the SBIV Test Composite SAS and the WAIS-R Full Scale IQ.

2. A significant correlation exists between the SBIV Abstract/Visual Reasoning Area SAS and the WAIS-R Performance Scale IQ.

3. A significant correlation exists between the SBIV Quantitative Reasoning Area SAS and the WAIS-R Verbal Scale IQ.

4. A significant correlation exists between the SBIV Verbal Reasoning Area SAS and the WAIS-R Verbal Scale IQ.

5. A significant correlation exists between the SBIV Short-Term Memory Area SAS and the WAIS-R Verbal Scale IQ.

6. A significant correlation exists between the SBIV Short-Term Memory Area SAS and the WAIS-R Full Scale IQ.

7. Vocabulary subtests of the SBIV and the WAIS-R are significantly correlated.

8. Memory For Digits subtest of the SBIV and Digit Span subtest of the WAIS-R are significantly correlated.

9. Pattern Analysis subtest of the SBIV and Block Design subtest of the WAIS-R are significantly correlated.

10. A positive correlation exists between the Paper Folding and Cutting subtest of the SBIV and Picture Arrangement subtest of the WAIS-R.
In addition to the aforementioned hypotheses the descriptive statistics (means and standard deviations) of the data generated and the correlation matrix of subtest scores of the SBIV and the WAIS-R were examined in order to suggest directions to be considered for future research involving the investigation of the viability of the SBIV in assessing cognitive functioning of brain-impaired adults. Further confirmatory analysis is needed to investigate contributions of crystallized and fluid/analytic abilities to cognitive functioning level in post-trauma brain-injured adults.

Assumptions Underlying the Problem

1. The sample of brain-damaged adults used for this study is representative of a larger population of brain-damaged adults. This larger population is limited to those individuals who have been medically diagnosed as having experienced a traumatic incident to the cerebral hemispheres resulting in impaired functioning in activities for daily living including attention, concentration and memory, higher level cognitive activities, vocational performance, and psychosocial aspects of daily living.

2. The measures identified represent variables important in the assessment of brain-behavior relationships.
Limitations of the Study

1. Generalizations to the larger population described in Assumption 1 may be limited due to the nonrandom selection process for participants. Selection for participation in the project was limited to those patients of two residential brain-injury treatment programs. Patients excluded from the present study were those with such severe dysarthria and cortical blindness as to interfere with valid administration of the two test instruments. No provision was made to limit participation in the study to individuals with particular type or location of lesion.

2. The approach used in this study is exploratory. Statistical significance is of less importance than the generation of viable hypotheses for future research (Bentler & Lettieri, 1976). However, information gathered from this study contributes to a greater understanding of the SBIV and its relationship to the WAIS-R in the assessment of brain-damaged adults.

3. The purpose of the residential treatment setting is to provide appropriate training to the brain-damaged adult to aid in the retraining of activities for daily living pending possible transition to community reintegration. Experimentation and data collection is secondary. The
relatively uncontrolled setting represents the limitations of research in applied settings.

4. The sample size (n=30) limits the generation of hypotheses for future research due to the uncontrolled variable of heterogeneity of type and location of lesion. The sample studied includes patients with impairments resulting from closed and penetrating head injury, cerebral vascular accident, toxic chemical poisoning, and disease of the central nervous system, involving primary location of lesions in the right cerebral hemisphere, left cerebral hemisphere, or generalized, diffuse localization of damage.

5. Medical histories and diagnoses were provided routinely at the time of referral. Such information is accepted as received. Strict controls of prescribed medications were beyond the scope of this study. Type and amount of medication reported in referral information was not included in the exploration of relationships among the variables.
CHAPTER 2

METHODOLOGY

Subjects

The brain-damaged subjects chosen for this study were clients at two residential treatment programs for brain injuries. One program was the Transitional Living Center of Casa Colina Hospital for Rehabilitative Medicine in Pomona, California. The second program was South Valley Ranch in Gilroy, California. Both programs place emphases upon increasing skills in activities for daily living as well as cognitive rehabilitation. Subjects were included in the study if three basic criteria were met. A medical diagnosis documenting cerebral trauma was the first criterion. Each patient was then screened by the respective programs in order to exclude patients that were cortically blind and that had severe dysarthria. Both conditions were considered as major interfering factors in the complete administration of both intelligence tests.

Variables not used as selection criteria were sex, age, handedness, and type and location of lesion. Typically, traumatic brain injuries occur more frequently in males with a ratio of four to one with females. The age range of
greatest occurrence is 17 to 44 years (Bakay & Glasauer, 1980). Borstein and Matarazzo (1984) found in a study investigating the relationship of sex and the effects of unilateral lesions on Wechsler Intelligence Scale performance that sex is not a potent variable to consider. Inglis and Lawson (1984) found no effect of handedness on test results and a negligible effect of sex on test results in a study investigating handedness, sex, and intelligence in a neurologically impaired sample.

The sample studied represented a ratio of two to one males to females with 20 males and 10 females. At the time of testing, 23 subjects were right-handed, with 7 left-handed subjects. No provisions were made to determine change of handedness due to effects of injury. Table 1 reflects the variables of age, education, and time post-trauma for the subjects in the sample. The mean age at the time of testing was 29.5 years. The mean years of formal education completed was 12.9 years. The mean time post-trauma for testing was 2.7 years.

Table 2 reflects the frequency distribution of type of brain trauma suffered by the 30 subjects of the sample. Medical reports and initial referral information indicating exact location of lesion were not available for all subjects. However, subjects with right cerebral hemisphere
Table 1. Age, Education, and Time Post-Trauma: Means Standard Deviations, and Ranges.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Years)</td>
<td>29.5</td>
<td>12.9</td>
<td>17.2 to 62.9</td>
</tr>
<tr>
<td>Education (Years Completed)</td>
<td>12.9</td>
<td>2.0</td>
<td>10.0 to 18.0</td>
</tr>
<tr>
<td>Time Post-Trauma (Years)</td>
<td>2.7</td>
<td>2.6</td>
<td>.2 to 10.8</td>
</tr>
</tbody>
</table>

Table 2. Frequency Distribution of Type of Brain Trauma.

<table>
<thead>
<tr>
<th>Type of Trauma</th>
<th>f</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed Head Injury</td>
<td>25</td>
<td>84</td>
</tr>
<tr>
<td>Cerebral Vascular Accident</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Penetrating Head Injury</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Chemical Toxicity</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Disease</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>30</td>
<td>100</td>
</tr>
</tbody>
</table>
lesions, left cerebral hemisphere lesions, and
generalized, diffuse lesions were represented.

Instrumentation

Each subject in this study was administered the
Wechsler Adult Intelligence Scale-Revised (WAIS-R) and the
The WAIS-R was administered before the SBIV in each case.
Time between administrations of the two tests was no more
than one week in each case. A comprehensive description of
each subtest contained in the tests may be found in
Appendix A. Standardization studies of the WAIS-R
indicated average reliability coefficients of .97, .93,
and .97 for Verbal, Performance, and Full Scale IQs,
respectively (Wechsler, 1981). Coefficients for the
individual subtests fall above .70 with the exception of
only six of 89 coefficients tested across eleven subtests
and nine age groups. Recent studies have compared the
WAIS-R with the WAIS (Kelly et al., 1984; Ryan et al.,
1987) and with the Stanford-Binet Intelligence Scale, Form
L-M (Templer, Schmitz, & Corgiat, 1985). In cases
involving the WAIS and WAIS-R, WAIS Verbal Scale,
Performance Scale, and Full Scale IQs were higher. Median
WAIS/WAIS-R IQ point discrepancies were Verbal Scale, 6.6;
Performance Scale, 6.4; and Full Scale, 6.8. In the
Binet/WAIS-R studies, the WAIS-R Full Scale IQ was lower than the Binet IQ.

Reliability studies of the SBIV as reported from the standardization sample (Thorndike et al., 1986b) indicated median coefficients for individual subtests and area scores ranging from .73 to .94. Validation studies compared the SBIV and the WAIS-R in a nonexceptional sample. Correlations between the WAIS-R Verbal Scale IQ and the SBIV Verbal Reasoning, Quantitative Reasoning, and Short-Term Memory Areas ranged from .82 for Short-Term Memory to .86 for Verbal Reasoning. Correlations between the WAIS-R Performance Scale IQ and the SBIV Abstract/Visual Reasoning Area was .81. The correlation of the WAIS-R Full Scale IQ with the SBIV Composite Area score was .91.

Data Collection

The two intelligence tests were administered to the subjects over a period of sixteen months as part of a general periodic testing procedure at each of the facilities. The two tests were administered by the investigator, supervised by clinical directors of each of the programs. The investigator is trained at the pre-doctoral level in rehabilitation psychology and neuropsychology and is a practicing school psychologist.
Data retrieval required access to confidential patient files. Permission for patient file access was obtained from Robert Keith, Ph.D., research director of Casa Colina Hospitals, Inc. and Ed McGonagle, program director and L. Kent Wilson, Ph.D., associate director of South Valley Ranch. Confidentiality of individual identities of subjects has been maintained. Approval of this study from the University of Arizona Human Subjects Committee was obtained.

**Method of Data Analysis**

Data generated from this study was subjected to a Pearson product moment correlation (Minium, 1978, p. 146) by using the SPSS/PC+ statistical package (Norusis, 1986). Power, defined as the probability that a statistical test will yield statistically significant results, was considered in determining the sample size for the study (Cohen, 1977). The investigator considered a probable effect size (degree to which the relationship is present in the sample) to be high based upon preliminary validation studies of the SBIV. Cohen (1977) considers $r=.50$ as a high effect size. Significance criterion of $p<.05$ on a two-tailed test was deemed adequate for the current study. A two-tailed test was chosen for this exploratory study in order to allow for the possibility of unexpected negative correlations as well as positive correlations. In
consulting appropriate tables (Cohen, 1977, p. 92) power of .83 was maintained with a sample size of 30.

Correlation coefficients were obtained between each of the subtests and area scores of the SBIV and each of the subtests and summary scores of the WAIS-R. Analysis of the significance of correlation coefficients led to the support of the study's hypotheses and to future concerns for probable research direction.
CHAPTER 3
RESULTS

The results of this study demonstrate two important findings. First, the SBIV does show a significant relationship with the WAIS-R on the specific variables tested in a brain-damaged adult sample. Second, review of additional data generated suggests viable directions for future research. The evidence of these two findings is detailed below.

The first section examines the results of correlations between the SBIV and the WAIS-R as hypothesized. Table 3 shows the correlations and resulting p-values for SBIV area scores and WAIS-R summary scores. Appendix B provides a correlation matrix of SBIV and WAIS-R subtest scores with resultant p-values. Hypotheses 1 through 6 involve results from Table 3. Hypotheses 7 through 10 involve results from Appendix B.

Hypothesis 1 stated that a significant relationship exists between the SBIV Test Composite Area (TCA) score and the WAIS-R Full Scale IQ (FSIQ). A correlation of .7807 with a resultant p=.000 was obtained on this sample of brain-damaged adults. This hypothesis is supported by the data.
Table 3. Correlation Matrix: WAIS-R Summary Scores and SBIV Area Scores.

<table>
<thead>
<tr>
<th>SBIV</th>
<th>VRA</th>
<th>AVRA</th>
<th>QRA</th>
<th>STMA</th>
<th>TCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>WAIS-R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VIQ</td>
<td>.7574</td>
<td>.5328</td>
<td>.6771</td>
<td>.6483</td>
<td>.7323</td>
</tr>
<tr>
<td></td>
<td>p=.000</td>
<td>p=.002</td>
<td>p=.000</td>
<td>p=.000</td>
<td>p=.000</td>
</tr>
<tr>
<td>PIQ</td>
<td>.4572</td>
<td>.6365</td>
<td>.6486</td>
<td>.5250</td>
<td>.6288</td>
</tr>
<tr>
<td></td>
<td>p=.011</td>
<td>p=.000</td>
<td>p=.000</td>
<td>p=.002</td>
<td>p=.000</td>
</tr>
<tr>
<td>FSIQ</td>
<td>.7008</td>
<td>.6688</td>
<td>.7647</td>
<td>.6735</td>
<td>.7807</td>
</tr>
<tr>
<td></td>
<td>p=.000</td>
<td>p=.000</td>
<td>p=.000</td>
<td>p=.000</td>
<td>p=.000</td>
</tr>
</tbody>
</table>

Hypothesis 2 stated that the SBIV Abstract/Visual Reasoning Area (AVRA) score has a significant correlation with the WAIS-R Performance Scale IQ (PIQ). A correlation of .6365 with a resultant $p=.000$ was obtained, indicating that this hypothesis is supported by the data.

Hypotheses 3 and 4 stated that significant correlations exist between the WAIS-R Verbal Scale IQ (VIQ) and the SBIV Quantitative Reasoning Area (QRA) and the Verbal Reasoning Area (VRA) scores. Table 3 shows that a correlation of .6771 with $p=.000$ is evident between the WAIS-R VIQ and the SBIV QRA. The WAIS-R VIQ and SBIV VRA have a correlation of .7574 with $p=.000$. Both Hypothesis 3 and Hypothesis 4 are supported by the data.
Hypotheses 5 and 6 stated that significant correlations exist between the SBIV Short-Term Memory Area (STMA) score and the WAIS-R VIQ and FSIQ. Table 3 shows a correlation of .6483, p=.000 between the STMA score and the VIQ. STMA score and FSIQ have a correlation of .6735, p=.000. Hypothesis 5 and 6 are both supported by the data.

The next four hypotheses examined the relationships between subtests of the WAIS-R and the SBIV. Hypothesis 7 stated that the Vocabulary subtests of the WAIS-R and the SBIV are significantly correlated. Appendix B shows that a correlation of .7302, p=.000 exists between the Vocabulary subtests. Hypothesis 7 is supported by the data.

Hypothesis 8 stated that the SBIV Memory for Digits subtest and the WAIS-R Digit Span subtest are significantly correlated. A correlation of .7423, p=.000 is found between these two subtests, thus supporting this hypothesis.

Hypothesis 9 stated that the SBIV Pattern Analysis subtest and the WAIS-R Block Design subtest are significantly correlated. This hypothesis is supported by the data with a correlation of .7381, p=.000.

The last hypothesis stated that a positive relationship exists between the SBIV Paper Folding and Cutting subtest and the WAIS-R Picture Arrangement subtest. A correlation of .4942, p=.006 was obtained. This hypothesis is
supported by demonstrating a positive correlation between the subtests.

The second part of this investigation has examined data generated in an informal manner through exploration of descriptive statistics (means and standard deviations) of the WAIS-R and SBIV results and through examining the correlation matrix obtained in comparing SBIV and WAIS-R subtest scores. Appendix C details the means, standard deviations, and range of scores of the SBIV and WAIS-R results of the sample of brain-damaged adults in this investigation. Appendix B contains the SBIV and WAIS-R subtest score correlation matrix. Review of such data is particularly directed at pertinent aspects of evaluation of neurologically impaired individuals.

The SBIV Memory For Digits mean score is higher than other SBIV memory subtests. Memory For Digits correlates significantly with each of the other SBIV memory tests (Bead Memory, Memory for Sentences and Memory for Objects). Further investigation regarding the manner of this relationship is warranted. Differentiation of auditory and visual stimuli as well as consideration of sequential and simultaneous processing may provide additional information to the clinical neuropsychologist for use in his work with the brain impaired.
The SBIV Verbal Reasoning Area score has a higher mean than the Quantitative Reasoning Area score although both scores are significantly correlated (r=.7649, p=.000). Further investigation of retention of numeric reasoning skills versus retention of verbal reasoning skills in brain-impaired adults is warranted in order to provide additional information to the clinician working with this targeted population.

The SBIV Short-Term Memory Area score has the lowest mean score of the four SBIV areas. Memory loss has been a major presenting complaint in brain-impaired groups, particularly the closed head injured (Levin, Benton, & Grossman, 1982). A study of the relationship between the SBIV STMA score and another validated comprehensive memory test among brain-damaged adults is warranted.

Additional relationships are noted in review of the SBIV and WAIS-R subtest correlation matrix in Appendix B. The WAIS-R Arithmetic subtest has a positive, significant correlation with the SBIV Quantitative and Number Series subtests but not with the Equation Building subtest. Further investigation of the nature of the subtests and meaning of test scores is suggested for the brain-impaired population.

In addition to the positive relationship noted in Hypothesis 10 between the WAIS-R Picture Arrangement
subtest and the SBIV Paper Folding and Cutting subtest
\((r=.4592, \ p=.006)\), the Picture Arrangement subtest has high correlations and resultant significant p-values with three other SBIV subtests. A correlation of \(.7005, \ p=.000\) is obtained with SBIV Matrices; a correlation of \(.6256, \ p=.000\) with SBIV Equation Building; and a correlation of \(.6240, \ p=.000\) with SBIV Memory For Objects. As stated in the review of literature, a differentially deficient score on the Picture Arrangement subtest when present in conjunction with other clinically significant performances in brain-related measures, suggests localization of lesions to the anterior fronto-temporal area of the right cerebral hemisphere. Further investigation is needed involving the SBIV subtests in order to determine if similar inferences can be made with deficit performances on the SBIV subtests in question.

In addition to the relationship noted in Hypothesis 9 between the WAIS-R Block Design subtest and the SBIV Pattern Analysis subtest \((r=.7381, \ p=.000)\), Block Design is also significantly correlated with SBIV Bead Memory \((r=.6383, \ p=.000)\). As reviewed earlier, a differentially deficient score on Block Design when present with other clinically significant collaborating deficit performances on brain-related measures, lateralizes to the posterior temporal-parietal area of the right cerebral hemisphere.
Further investigation is needed in order to determine if similar inferences can be made with deficit performances on the SBIV Bead Memory subtest.
CHAPTER 4
DISCUSSION

This investigation employed Pearson product moment correlation statistical procedures to determine the possibility of a significant ($p < .05$) relationship between the Stanford-Binet Intelligence Scale: Fourth Edition (SBIV) and the Wechsler Adult Intelligence Scale-Revised (WAIS-R) in heterogeneous brain-damaged adults. Additional correlations and descriptive statistics (means and standard deviations) were reviewed in order to provide direction for future research of the SBIV.

Major Findings

1. The SBIV area scores and the WAIS-R summary scores are significantly correlated in the tested pairs. Specifically, the SBIV Test Composite Area and the WAIS-R Full Scale IQ are correlated. The WAIS-R Verbal Scale IQ is correlated with the SBIV area scores thought to indicate crystallized intelligence, the Verbal Reasoning Area and the Quantitative Reasoning Area scores. The SBIV Short-Term Memory Area score, also thought to contribute to crystallized intelligence, is significantly correlated to the WAIS-R Verbal and Full Scale IQs. The SBIV
Abstract/Visual Reasoning Area is thought to measure fluid/analytic abilities and has a significant correlation with the WAIS-R Performance Scale IQ. The correlation of those variables in a heterogeneous brain-damaged adult sample suggests that the SBIV may discriminate sufficiently in content areas in the assessment of cognitive functioning. Further research is needed with more homogeneous brain-damaged adult samples. Location of lesion may be limited to right cerebral hemisphere, left cerebral hemisphere, or to generalized diffuse damage.

2. Specific subtests of the SBIV are significantly correlated with comparable subtests of the WAIS-R. The Vocabulary subtests of each test were compared, as were the SBIV Pattern Analysis with the WAIS-R Block Design; the SBIV Memory for Digits with the WAIS-R Digit Span; and the SBIV Paper Folding and Cutting with the WAIS-R Picture Arrangement. All pairs of subtests were significantly correlated. The significant correlation of these variables suggests that the SBIV may be used as a viable alternative to the WAIS-R in the assessment of cognitive functioning of brain-damaged adults. Further research is needed with homogeneous groupings of lesion site (right cerebral hemisphere, left cerebral hemisphere, generalized diffuse damage) in order to determine continued significant relationships with the WAIS-R subtests.
3. The SBIV Memory For Digits subtest has a higher mean than the remaining subtests of the SBIV Short-Term Memory Area. Although these four subtests are significantly correlated, further investigation regarding the nature of memory tasks for each subtest should be pursued. Consideration should be given to the manner of presentation of stimuli, visual or auditory, sequential or simultaneous. The SBIV Short-Term Memory Area score has the lowest obtained mean of the content area scores. This lowered memory performance is not unexpected in that a primary presenting complaint of brain-damaged adults is that of memory loss. Further research of the relationship of the SBIV STMA score with other comprehensive tests of memory is needed.

4. Level of retention of crystallized abilities after brain trauma has been addressed as indicated in this study's review of the literature. The SBIV Verbal Reasoning Area score has a higher mean than the Quantitative Reasoning Area score. The difference introduces the question of whether verbal reasoning skills are more readily retained than numeric reasoning skills after brain trauma. Further research in this area is warranted. Possible variables to consider include amount of pre-injury education in math skills and amount and type of math used in vocation pre-injury.
5. The WAIS-R Arithmetic subtest has a positive significant relationship with the SBIV Quantitative and Number Series subtests. However, the third SBIV subtest contributing to the Quantitative Reasoning Area score, Equation Building, is not significantly correlated with the WAIS-R Arithmetic subtest. Further investigation of the nature of the tasks necessary for these subtests is needed.

6. The WAIS-R Picture Arrangement subtest has significantly high correlations with the SBIV Matrices, Paper Folding and Cutting, Equation Building, and Memory for Objects subtests. In view of the clinical interpretation of a differentially deficient score on the Picture Arrangement subtest localizing to the right anterior cerebral hemisphere, additional research is warranted to substantiate or refute such a relationship with the named SBIV subtests.

7. The WAIS-R Block Design subtest has a high, significant correlation with the SBIV Pattern Analysis and Bead Memory subtests. Due to the clinical interpretation of a differentially deficient score on Block Design localizing lesions to the posterior right cerebral hemisphere, further research on the SBIV Bead Memory and Pattern Analysis subtests is warranted to determine if lesion localization can be inferred from differentially deficient scores on these SBIV subtests.
Directions for Future Research

This investigation is intended to be a preliminary study of the SBIV in its relationship to the WAIS-R in brain-damaged adults. A heterogeneous sample of brain-damaged adults was studied. Type and location of damage were variables not limited in the scope of this study. The obvious relationship between the two tests as outlined in this investigation suggests that further research is warranted.

1. It is suggested that future researchers investigate the differential results of the SBIV in brain-damaged adults with specific lesion sites, comparing subjects with right hemisphere lesions, left hemisphere lesions, and generalized diffuse lesions to a control group of nonbrain-damaged adults. The results of such a study should contribute to the knowledge of the SBIV discrimination abilities in light of location of damage.

2. Additional research is needed in the contribution of the SBIV memory subtests to the functional efficiency of the brain. The memory area results may contribute to knowledge of the relative abilities in visual and auditory memory as well as sequential and simultaneous processing of storage and retrieval of items to be remembered.

3. Confirmatory analysis of current relationships should be conducted in order to support use of the SBIV in
assessment of cognitive functioning in brain-damaged adults.

4. The relationship of the SBIV with brain-related measures should be investigated. Such a relationship should be established through empirical validation in order to substantiate or refute the viability of use of the SBIV in a comprehensive neuropsychological assessment of brain-damaged adults.

5. Within the population of brain-damaged adults in residential treatment facilities, further analysis of individual differences in psychosocial and cognitive functioning is recommended. This group tends to receive similar services, regardless of etiology or individual differences in brain-behavior relationships and psychosocial functioning. Analysis of differences with appropriate social and rehabilitation intervention strategies may contribute to a greater number of brain-damaged adults living satisfactory lives within the community. Residential placement may not be necessary for higher levels of functioning. Outpatient treatment and training of the client and significant others may be more successful as a result of further investigation in this area. Continued systematic investigation could clarify psychosocial issues and perhaps lead to more effective and efficient programs in the future.
WECHSLER ADULT INTELLIGENCE SCALE-REVISED (WAIS-R)
(Matarazzo, 1972; Sattler, 1982)

Verbal Scale (VIQ)

Information (I)

The Information subtest assesses an individual's general fund of knowledge gained from experience and education. It contains 29 general information questions.

Digit Span (DSp)

The Digit Span subtest assesses an individual's short-term auditory memory including attention for digits. The examinee is asked to repeat a series of digits forward (maximum, 9) and a series of digits backwards (maximum, 8).

Vocabulary (V)

The Vocabulary subtest assesses an individual's knowledge of words. This test is thought to correlate most highly with level of formal education.

Arithmetic (A)

The Arithmetic subtest assesses an individual's mental manipulation of basic number facts. A maximum of 14 questions is asked with five receiving bonus points for speed of response.

Comprehension (C)

The Comprehension subtest assesses an individual's ability to provide solutions to specific problems. This
subtest depends on the individual's possession of a certain amount of practical information and a general ability to evaluate past experience. This subtest contains 16 questions.

**Similarities (S)**

The Similarities subtest assesses an individual's capacity for associative thinking. It is thought to be highly correlated with the g factor of intelligence. This subtest is composed of 14 pairs of words which the examinee must evaluate for major similar categorization.

**Performance Scale (PIQ)**

**Picture Completion (PC)**

The Picture Completion subtest is composed of 20 pictures with an important part missing. This subtest assesses an examinee's visual attention to details. Responses must be given within a time limit.

**Picture Arrangement (PA)**

The Picture Arrangement subtest is ten sets of cards which the examinee must arrange in sequential order to tell the most sensible story within a given time limit. This subtest assesses an examinee's visual planning ability including visual comprehension and sequencing.

**Block Design (BD)**

The Block Design subtest is composed of nine geometric designs which must be reproduced by a given number of
blocks. Bonus points are assessed for speedy performance. The subtest assesses one's ability to perceive, analyze, synthesize, and reproduce abstract designs.

**Object Assembly (OA)**

The Object Assembly subtest is composed of four puzzles to be put together within a time limit. Bonus points are given for speed of response. This subtest assesses one's visual perception of spatial relationships.

**Digit Symbol (DSy)**

The Digit Symbol subtest requires an individual to associate certain numeric symbols with other symbols within a given time limit. Speed and accuracy are essential to adequate performance.

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**STANFORD-BINET INTELLIGENCE SCALE:**

FOURTH EDITION (SBIV)

(Thorndike et al., 1986a)

**Verbal Reasoning Area (VRA)**

**Vocabulary (Vc)**

The Vocabulary subtest assesses the examinee's knowledge of words. It is used in conjunction with chronological age for determining entry level for the remaining subtests.
**Comprehension (Cm)**

The Comprehension subtest assesses an individual's ability to respond with appropriate solutions to given problem situations.

**Absurdities (Ab)**

The Absurdities subtest assesses an individual's ability to analyze a visual situation to determine what is not appropriate. This subtest is not recommended for individuals beyond age 14.

**Verbal Relations (VR)**

The Verbal Relations subtest assesses one's ability to determine similarities among words. Knowledge of the meanings as well as determination of an appropriate relationship is necessary. This test is not given to individuals below age 10.

**Abstract/Visual Reasoning Area (AVRA)**

**Pattern Analysis (PAN)**

The Pattern Analysis subtest is composed of blocks of various geometric designs on different sides which are then put together to reproduce a stimulus design. This subtest assesses an examinee's ability to perceive, analyze, synthesize, and reproduce an abstract design.
Copying (Cy)

The Copying subtest assesses an individual's capacity to reproduce designs with a pencil or with blocks. This test is not given to individuals over age 17.

Matrices (M)

The Matrices subtest assesses an individual's ability to follow a visual pattern in order to determine the appropriate item to complete it using the same principle. This subtest is not given to individuals below the age of five.

Paper Folding and Cutting (PFC)

The Paper Folding and Cutting subtest models in a series of drawings certain folds and cuts made to one piece of paper. The examinee must decide upon the configuration of the paper if it were completely unfolded. This subtest is not given to examinees below age ten.

Quantitative Reasoning Area (QRA)

Quantitative (Q)

The Quantitative subtest assesses the examinee's knowledge of basic number concepts including basic operations, money, measurement, fractions, and decimals. The examinee is allowed to use paper and pencil to solve the problems.
Number Series (NS)

The Number Series subtest presents a series of numbers progressing in a standard manner. The examinee must determine the next two numbers in the progression. This is not given to individuals below age five.

Equation Building (EB)

The Equation Building subtest is a set of numbers followed by signs that are used in number sentences. The examinee must rearrange the numbers and signs to make a true number sentence or equation. This test is not given to individuals below age 10.

Short-Term Memory Area (STMA)

Bead Memory (BM)

The Bead Memory subtest is composed of beads of four shapes and three colors. The examinee must reproduce a stimulus exactly after five seconds of exposure. This subtest assesses short-term visual memory.

Memory for Sentences (MS)

The Memory for Sentences subtest assesses an individual's ability to recall sentences exactly as stated.

Memory for Digits (MD)

The Memory for Digits subtest assesses the individual's ability to recall digits forward and backward.
in the correct order. This test is not given to individuals below age five.

**Memory for Objects (MO)**

The Memory for Objects subtest assesses the individual's ability to recall in order stimulus objects presented at the rate of one per second. This subtest is not given to individuals below age five.
APPENDIX B

CORRELATION MATRIX: SBIV SUBTEST SAS AND WAIS-R SUBTEST SCALED SCORES
SBIV    Stanford-Binet Intelligence Scale: Fourth Edition
VRA    Verbal Reasoning Area
VC    Vocabulary
CM    Comprehension
VR    Verbal Relations
AVRA    Abstract/Visual Reasoning Area
PAN    Pattern Analysis
M    Matrices
PFC    Paper Folding and Cutting
QRA    Quantitative Reasoning Area
Q    Quantitative
NS    Number Series
EB    Equation Building
STMA    Short-Term Memory Area
BM    Bead Memory
MS    Memory For Sentences
MD    Memory For Digits
MO    Memory For Objects

WAIS-R    Wechsler Adult Intelligence Scale-Revised
I    Information
DSp    Digit Span
V    Vocabulary
A    Arithmetic
C    Comprehension
S    Similarities
PC    Picture Completion
PA    Picture Arrangement
BD    Block Design
OA    Object Assembly
DSy    Digit Symbol
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<tr>
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<th>VRA</th>
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<th>SBIV</th>
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<td>VR</td>
<td>PAN</td>
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<td></td>
</tr>
<tr>
<td>I</td>
<td>.6893</td>
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